Project Specification and Contract Documents

THUNDERBIRD PASEO WASTEWATER RECLAMATION FACILITY

PROJECT NO. S867026

FLOOD CONTROL DISTRICT
FEB 1 0 '89
REMARKS

Engineering Department
City of Glendale, Arizona

DRAFT

NOT FOR CONSTRUCTION

FEB 9 1989

May 1989

MALCOLM PIRNIE

ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS

CITY OF GLENDALE

GLENDALE, ARIZONA

THUNDERBIRD PASEO WASTEWATER RECLAMATION FACILITY

CITY PROJECT NO.

S867026

MAY 1989

MALCOLM PIRNIE, INC.
CONSULTING ENVIRONMENTAL ENGINEERS

4636 East University Drive
Suite No. 150
Phoenix, Arizona 85034-7408

PROJECT NO. S867026

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PROJECT NO. S867026

NOTICE TO CONTRACTORS

Sealed bids shall be either mailed to the City of Glendale Engineering Department, 5850 West Glendale Avenue, Glendale, Arizona 85301, or hand delivered to the Engineering Department Office, Second Floor, 5850 West Glendale Avenue, Glendale, Arizona, for furnishing all plant, material, equipment and labor, and to complete construction of:

PROJECT S867026 - CONSTRUCTION OF THUNDERBIRD PASEO WASTEWATER RECLAMATION FACILITY

Bids must be received by the Engineering Department of the City of Glendale no later than 2:00 pm, May 25, 1989. Any bid received after that time will not be considered and will be returned to the bidder.

At that time, the bids will be publicly opened and read aloud in the Engineering Department Conference Room, Second Floor, 5850 West Glendale Avenue, Glendale, Arizona.

Plans, specifications and contract documents may be examined, and copies may be obtained at the City of Glendale Engineering Department, 5850 West Glendale Avenue, Second Floor, Glendale, Arizona. A non-refundable charge of $75.00 shall be made for each set of plans and specifications issued from this office.

A Pre-Bid conference will be held on May 11, 1989, at 2:00 pm, in Engineering Conference Room A, 5850 West Glendale Avenue, Glendale, Arizona. Bidders and other interested parties are invited to attend this conference which will be conducted by the OWNER and ENGINEER to answer any questions.

Each bid shall be in accordance with the plans, specifications and contract documents, and shall be set forth and submitted on the "BID DOCUMENTS" included with the project specifications book. The "BID DOCUMENTS" may be removed from the project specifications book and submitted independently of such book. Each bid shall be accompanied by a proposal guarantee, in the form of a Certified or Cashier's Check or Bid Bond for five percent (5%) of the amount of bid, made payable to the order of the City of Glendale, Arizona, to insure that the successful bidder will enter into the contract if awarded to him. All proposal guarantees, except those of the three lowest qualified bidders, will be returned immediately following the opening and checking of proposals. The proposal guarantees of the three lowest qualified bidders will be returned immediately after the contract documents have been executed. The proposal guarantee shall be declared forfeited as liquidated damages if the successful bidder refuses to enter into said contract after being requested to do so by the City of Glendale, Arizona.

The City of Glendale reserves the right to reject any or all bids or waive any informality in a bid. No bidder may withdraw his bid for a period of thirty (30) days after opening and reading of the bids.

PROJECT NO. S867026

The City of Glendale is an equal opportunity employer and minority business enterprises and women's business enterprises are encouraged to submit bids.

CITY OF GLENDALE, ARIZONA

BY: _____
City Manager

Date: April 7, 1989

Published: April 14, 1989

CITY OF GLENDALE
GLENDALE, ARIZONA

THUNDERBIRD PASEO
WASTEWATER RECLAMATION FACILITY

CITY PROJECT NO.

S867026

INSTRUCTIONS TO BIDDERS

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ARTICLE 1 - DEFINED TERMS AND STANDARD DOCUMENTS

1.1 Terms used in these Instructions to Bidders, which are defined in the General and Supplementary Conditions, have the meanings assigned to them in the General and Supplementary Conditions. The term "Successful Bidder" means the Bidder to whom OWNER (on the basis of OWNER'S evaluation as hereinafter provided) makes an award.

1.2 Construction and administration of this Project shall be in accordance with the requirements of the latest edition of the following separate documents except as modified and supplemented by these Contract Documents:

A. Maricopa Association of Governments Uniform Standard Specifications and Details for Public Works Construction (MAG Standard Specifications and Details).

ARTICLE 2 - PROPOSALS RECEIVED

2.1 Refer to NOTICE TO CONTRACTORS for information on receipt of Bids.

ARTICLE 3 - LOCATION AND DESCRIPTION OF PROJECT

3.1 Refer to Section 1A of the General Requirements for the location and description of the Project.

ARTICLE 4 - COPIES OF BIDDING DOCUMENTS

4.1 Refer to NOTICE TO CONTRACTORS for information on examination and procurement of documents.

4.2 Complete sets of Bidding Documents shall be used in preparing Bids; neither OWNER nor ENGINEER assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

4.3 OWNER and ENGINEER in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids on the Work and do not confer a license or grant for any other use.

ARTICLE 5 - QUALIFICATIONS OF BIDDERS

5.1 Bidders shall be experienced in the kind of Work to be performed, shall have the necessary equipment therefor, and shall possess sufficient capital to properly execute the Work within the time allowed. Bids received from Bidders who have previously failed to complete work within the time required, or who have previously performed similar work in an unsatisfactory manner, may be rejected. A Bid may be rejected if Bidder cannot show that he has the necessary ability, plant and equipment to commence the Work at the time prescribed and thereafter to prosecute and complete the Work at the rate or within the time specified. A Bid may be rejected if Bidder is already obligated for the performance of other work which would delay the commencement, prosecution or completion of the Work.

5.2 As evidence of his competency to perform the Work, Bidder shall complete and submit with his Bid the Bidder's Qualification Statement which a copy is bound in the Project Manual. Low Bidders may be asked to furnish additional data to demonstrate competency.

5.3 Each Bid must contain evidence of Bidder's qualification to do business in the State of Arizona or covenant to obtain such qualification prior to execution of Agreement.

ARTICLE 6 - EXAMINATION OF CONTRACT DOCUMENTS AND SITE

6.1 Before submitting a Bid, each Bidder shall (a) examine the Contract Documents thoroughly; (b) visit the site(s) to familiarize himself with local conditions that may in any manner affect cost, progress or performance of the Work; (c) familiarize himself with federal, state and local laws, ordinances, rules and regulations that may in any manner affect cost, progress or performance of the Work; and (d) study and carefully correlate Bidder's observations with the Contract Documents.

6.2 Reference is made to the Supplementary Conditions for the identification of those reports of investigations and tests of subsurface and latent physical conditions at the site, or those reports that otherwise may affect cost, progress or performance of the Work which have been utilized by ENGINEER in preparation of the Drawings and Specifications. OWNER will make copies of such reports available at the cost (non-refundable) of reproduction to any Bidder requesting them. These reports are not intended to constitute any explicit or implicit representation as to the nature of the subsurface and latent physical conditions which may be encountered at the site or to constitute explicit or implicit representations as to any other matter contained in any report. Such reports are not guaranteed as to accuracy or completeness and are not part of the Contract Documents. Before submitting his Bid, each Bidder will, at his own expense, make such investigations and tests as the Bidder may deem necessary to determine his Bid for performance of the Work in accordance with the Contract Documents.

6.3 No information derived from any reports or records will in any way relieve the Bidder or CONTRACTOR from any risk or from properly fulfilling the terms of the Agreement nor entitle the CONTRACTOR to any additional compensation.

6.4 The lands upon which the Work is to be performed, rights-of-way for access thereto and other lands designated for use by CONTRACTOR in performing the Work are identified in the Supplementary Conditions, General Requirements or Drawings.

6.5 The submission of a Bid will constitute an incontrovertible representation by the Bidder that he has complied with every requirement of this Article 6 and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance of the Work.

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

7.1 All questions about the meaning or intent of the Bidding Documents or the Contract Documents shall be submitted to OWNER in writing. In order to receive consideration, questions must be received by ENGINEER at least by or at the Pre-Bid Conference. The individual submitting the

question shall be responsible for its prompt delivery to the OWNER. Any interpretations of questions so raised, which in the opinion of ENGINEER require interpretations, will be issued by Addenda mailed or delivered to all parties recorded by ENGINEER as having received the Bidding and Contract Documents for receipt not later than three days prior to the date fixed for the opening of Bids. The ENGINEER and OWNER will not be responsible for oral interpretations or clarifications which anyone presumes to make on their behalf.

7.2 OWNER may issue such additional Addenda as may be necessary to clarify, correct or change the Bidding Documents or the Contract Documents. Such Addenda, if any, will be issued in the manner and within the time period stated in Paragraph 7.1.

7.3 Addenda issued before the time in which to submit Bids expires shall be included in the Bid and shall be made a part of the Contract.

ARTICLE 8 - BID SECURITY

8.1 Bids must be accompanied by a cashier's check, certified check or Bid Bond, with a properly executed Power of Attorney attached, in the sum of 5 percent of the amount of the Bid, satisfactory to and payable to the order of the OWNER. Said check or bond shall be given as a guarantee that the Bidder, if awarded the Contract, will enter into a Contract under alternate B and furnish the required bonds and insurance certificates and endorsements. Bid security shall cover the amount bid

8.2 Bid Bond shall be on the form bound in the Project Manual. Bid Bond shall be issued by a surety meeting the requirements of Paragraph 5.1 of the General Conditions. When a Bid Bond is used in lieu of a certified check, a Power of Attorney shall also be submitted with the bid.

8.3 The bid security of the Successful Bidder will be retained until such Bidder has executed the Contract and furnished the required contract securities and insurance certificates and endorsements, whereupon the bid security will be returned. If the Successful Bidder fails to execute and deliver the Contract and furnish the required contract securities and insurance certificates and endorsements, within 10 days or such additional time as may be allowed by the OWNER from the date of mailing the Notice of Award from the OWNER to the Successful Bidder or from the date of personal delivery of the Notice of Award to the Successful Bidder, OWNER may annul the Notice of Award and the bid security of that Bidder will be forfeited to the OWNER as liquidated damages for such failure. Forfeiture will not preclude the OWNER from seeking any or all other remedies provided by law to recover losses sustained as a result of the Bidder's failure to enter into the Agreement or to furnish the contract securities or insurance certificates and endorsements.

8.4 A Bidder who is awarded the Contract and fails to execute the Contract or furnish the required contract securities or insurance certificates and endorsements shall be liable to the OWNER for all damages resulting therefrom including reasonable attorney's fees. The bid security forfeited shall not be a limitation thereon.

ARTICLE 9 - CONTRACT TIME

9.1 The number of days within which the Work is to be substantially completed and completed (the Contract Time) are set forth in the Supplemental Contract Provisions.

ARTICLE 10 - LIQUIDATED AND SPECIAL DAMAGES

10.1 Provisions for liquidated damages, are set forth in Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction. See Article 5 of Supplemental Contract Provisions for Special Damages.

ARTICLE 11 - SUBSTITUTE MATERIAL AND EQUIPMENT

11.1 Whenever it is indicated in the Drawings or specified in the Specifications that a substitute or "or-equal" item of material or equipment may be furnished or used by CONTRACTOR if acceptable to ENGINEER, application for such acceptance will not be considered by ENGINEER until after the Effective Date of the Agreement. The procedure for submittal of any such application by CONTRACTOR and consideration by ENGINEER is set forth in Paragraph 6.3 of the General Conditions which may be supplemented in the General Requirements.

11.2 Refer to Section 1H2 of the General Requirements for the period of time after the Effective Date of the Agreement during which the ENGINEER will accept applications for substitute or "or-equal" items of material or equipment.

ARTICLE 12 - SUBCONTRACTORS AND OTHERS

12.1 All Bidders shall submit with the Bid a list of all major Subcontractors and other persons and organizations (including those who are to furnish the principal items of material and equipment) that the Bidder proposes to utilize on this Contract. Such list shall be accompanied by an experience statement with pertinent information as to similar projects and other evidence of qualification for each such Subcontractor, person and organization. The list of proposed major Subcontractors and other persons and organizations and experience statements shall be submitted with the Bid in a separate sealed envelope, plainly marked on the outside with the name of Bidder, his address, the name of the Project, and the notation "List of Subcontractors Enclosed". Only the envelope (containing the list of proposed Subcontractors) submitted by the apparent Successful Bidder will be opened by the OWNER. If OWNER or ENGINEER after due investigation has reasonable objection to any proposed Subcontractor, other person or organization, either may before giving the Notice of Award request the apparent Successful Bidder to submit an acceptable substitute without an increase in Bid price. If the apparent Successful Bidder declines to make any such substitution, the Contract shall not be awarded to such Bidder, but his declining to make any such substitution will not constitute grounds for sacrificing his bid security. Any Subcontractor, other person or organization so listed and to whom OWNER or ENGINEER does not make written objection

prior to the giving of the Notice of Award will be deemed acceptable to OWNER and ENGINEER.

12.2 The envelopes (containing the list and experience statements of the proposed Subcontractors) submitted by other Bidders will be returned by the OWNER following an award of Contract.

12.3 No CONTRACTOR shall be required to employ any Subcontractor, other person or organization against whom he has reasonable objection.

ARTICLE 13 - PREPARATION OF BID

13.1 A Bid must be made as described in the NOTICE TO CONTRACTORS.

13.2 The Bid Form must be completed in ink. Blank spaces in the Bid Form must be filled in correctly where indicated, and the Bidder must state, both in words and numerals, the prices for which he proposes to do each and every item of Work. Ditto marks shall not be used.

13.3 Quantities as shown in the Bid Form are estimates only based upon available information. The OWNER reserves the right to adjust the quantities as necessary to meet its needs.

13.4 Erasures, interlineations or other corrections shall be authenticated by affixing in the margin immediately opposite the correction the initials of the person signing the Bid.

13.5 Bids shall not contain any recapitulation of the Work to be done.

13.6 Alternative Bids will not be considered except where specifically called for in the Bid Form.

13.7 No oral, telegraphic or telephone proposals or modifications will be considered.

13.8 The Bid shall contain an acknowledgement of the receipt of all Addenda.

13.9 The address to which communications regarding the Bid are to be directed shall be shown.

13.10 In addition to the Bid Form, the following listed documents shall also be executed

A. Bid Bond (if used in lieu of cashier's check or certified check).

B. Bidder's Qualification Statement.

This may be enclosed in the separate sealed envelope used to meet the requirements of Article 12 - Subcontractors and Others, Paragraph 12.1 on Page ITB-6.

C. Noncollusive Bidding Certification.

D. Certified Copy of Resolution of Board of Directors (if Bidder is corporation).

E. 5 percent Preferential Affadavit.

ARTICLE 14 - SUBMISSION OF BID

14.1 Bids shall be submitted at the time and place indicated in the NOTICE TO CONTRACTORS.

14.2 The Bid shall be enclosed in an opaque sealed envelope plainly marked on the outside lower right-hand corner with the name of the Bidder, his address, the name of the Project, the contract number, and the time and date the bids are to be received. Bid shall be submitted with bid security and other required documents.

14.3 If the Bid is sent through the mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in another envelope plainly marked on the outside with the notation "Bid Enclosed". Mailed Bids shall be addressed to:

City of Glendale, Arizona
Engineering Department, Second Floor
5850 West Glendale Avenue
Glendale, Arizona 85301

14.4 A Bid will not be accepted after the time indicated in the NOTICE TO CONTRACTORS. Bid envelopes with insufficient postage will not be accepted by the OWNER. It is the sole responsibility of the Bidder to see that his Bid is delivered and received by the proper time and at the proper place.

ARTICLE 15 - MODIFICATION OR WITHDRAWAL OF BID

15.1 Withdrawal Prior to Bid Opening:

A. A Bidder may withdraw his Bid before the time fixed for the opening of Bids by communicating his purpose in writing to the OWNER. Upon receipt of such written notice, the unopened Bid will be returned to the Bidder. After opening and reading of the Bids, no Bidder may withdraw his Bid for a period of thirty (30) days from the date of opening and reading.

B. The withdrawal of a Bid does not prejudice the right of a Bidder to file a new Bid, so long as the new Bid is submitted as set forth in Article 14 of these Instructions to Bidders prior to the closing time indicated for Bids in the NOTICE TO CONTRACTORS.

15.2 Modification Prior to Bid Opening:

A. If a Bidder wishes to modify his Bid, he must withdraw his initial Bid in the manner specified in Paragraph 15.1.A and submit a new Bid.

ARTICLE 16 - OPENING OF BIDS

16.1 Bids will be opened by the City of Glendale at an open, public meeting at the time and place indicated in the NOTICE TO CONTRACTORS.

16.2 Bids received by mail or otherwise after the time specified for the opening of Bids will not be accepted and will be returned to the Bidder unopened.

16.3 No responsibility will attach to the OWNER for premature opening of a bid not properly addressed and identified in accordance with the bid documents.

ARTICLE 17 - DISQUALIFICATION OF BIDDERS

17.1 More than one Bid for the same Work from an individual, or a firm, partnership, corporation or an association under the same or different names will not be considered. Reasonable grounds for believing that any Bidder is interested in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder is interested.

17.2 An individual, firm, partnership or corporation submitting a subproposal to a Bidder, or who has quoted prices on material or equipment to a Bidder, is not thereby disqualified from submitting a subproposal or quoting prices to other bidders.

ARTICLE 18 - BIDS TO REMAIN OPEN

18.1 All Bids shall remain open for 30 days after the day of the opening of Bids. No bidder may withdraw his Bid during this period without written permission from the OWNER.

ARTICLE 19 - AWARD OF CONTRACT

19.1 OWNER reserves the right to reject any and all Bids, to waive any and all informalities, and the right to disregard all nonconforming, nonresponsive or conditional Bids.

19.2 OWNER reserves the right to reject any Bid not accompanied by specified documentation and bid security.

19.3 OWNER reserves the right to reject any Bid if it shows any omissions, alterations of form, additions not called for, conditions or qualifications, or irregularities of any kind.

19.4 OWNER reserves the right to reject any Bid that, in his sole discretion, is considered to be unbalanced or unreasonable as to the amount bid for any lump sum or unit price item.

19.5 In evaluating Bids, discrepancies between words and figures will be resolved in favor of words. Discrepancies in the multiplication of units of work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

19.6 In evaluating Bids, OWNER will consider the qualifications of Bidders; whether or not the Bids comply with the prescribed requirements; the alternatives, if any; the time or times for completion as stated in the Bid Form; and the lump sum and unit prices, if requested in the Bid Form.

19.7 OWNER may consider the qualifications and experience of Subcontractors and other persons and organizations (including those who are to furnish the principal items of material or equipment) proposed for those portions of the Work as to which the identity of Subcontractors and other persons and organizations must be submitted as provided in the Supplementary Conditions.

19.8 OWNER may conduct such investigation as he deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications and financial ability of the Bidders, proposed Subcontractors and other persons and organizations to do the Work in accordance with the Contract Documents. OWNER reserves the right to reject the Bid of any Bidder who does not pass any such evaluation to OWNER'S satisfaction.

19.9 If a Contract is to be awarded, it will be awarded to the lowest responsive and responsible Bidder who has neither been disqualified nor rejected pursuant to Article 17 or this Article 19. The Contract will be awarded to the lowest responsive and responsible bidder for the alternate selected by the OWNER who has neither been disqualified nor rejected pursuant to Article 17 on this Article 19.

19.10 In evaluating Bids a 5 percent preference will be given to Arizona taxpayers in accordance with the provisions of Section 34.241 of the Arizona Revised Statutes. Qualifying Bidders shall complete and submit a notarized statement, to accompany the Bid, that taxes have been paid in the State of Arizona in accordance with the terms and provisions of the Performance Statute, A.R.S. Secs. 34-241, 34-242, and 34-243.

ARTICLE 20 - CONTRACT SECURITIES

20.1 Performance and payment Bonds shall be furnished by the successful Bidder on the forms bound in the Project Manual.

20.2 The amounts of and other requirements for performance and payment Bonds are stated in Paragraph 5.1 of the General Conditions. The requirements for delivery of Bonds are stated in Paragraph 2.1 of the General Conditions. Additional requirements may be stated in the Supplementary Conditions.

20.3 The Successful Bidder shall within 10 working days from the date of the Notice of Award deliver to OWNER, for his review and approval, the performance Bond and payment (labor and material) Bond he proposes to furnish at the time of the execution of the Contract.

ARTICLE 21 - CONTRACTOR'S INSURANCE

21.1 The requirements for CONTRACTOR'S insurance are stated in Article 5 of the General Conditions and in Article 3 of the Supplementary Conditions.

The requirements for delivery of insurance certificates and endorsements are stated in Article 2.1 of the General Conditions.

21.2 A form of Certificate of Insurance and endorsement, CI-1 and CI-2, which the Successful Bidder, as CONTRACTOR, will be required to furnish is bound in the Project Manual.

21.3 The Bidder must complete the Certificate of Insurability completely with the bid that assures the CONTRACTOR is able to provide the minimum insurance coverage required. The certificate is attached to the Contract Documents.

ARTICLE 22 - EXECUTION OF CONTRACT

22.1 The Contract shall be signed by the Successful Bidder and returned to the OWNER, together with contract securities and certificates of insurance and endorsements, within 10 days or such additional time as may be allowed by the OWNER from the date of mailing the Notice of Award from the OWNER to the Successful Bidder or from the date of personal delivery of the Notice of Award to the Successful Bidder.

22.2 The Contract, contract securities, certificates of insurance and endorsements, and other documents to be executed by the CONTRACTOR shall be executed in original-quintuplicate.

22.3 Upon execution of the Contract, the CONTRACTOR shall provide a letter of certification from the Industrial Commission of Arizona that the CONTRACTOR is insured by the State Compensation Fund or is an authorized self-insurer, or a certificate of insurance issued by an insurance company authorized by the Insurance Department of Arizona to write Workmen's Compensation and Occupational Disease Insurance in the state of Arizona.

ARTICLE 23 - NOTICE TO PROCEED

23.1 Issuance of the Notice to Proceed shall be as stated in Article 2 of the General Conditions.

ARTICLE 24 - SPECIAL REQUIREMENTS

24.1 Compliance With Laws and Regulations:

A. The provisions of federal, state and local laws and regulations shall become a part of the Agreement.

24.2 Sales Tax:

A. CONTRACTOR will be subject to City of Glendale sales tax.

24.3 City of Glendale Transaction Privilege Tax License:

A. A City of Glendale privilege tax license will be required before the Notice to Proceed is issued. The fee for the license will be waived by the City.

24.4 Pre-Bid Conference:

A. A pre-bid conference will be held on a date and at a time to be indicated on the NOTICE TO CONTRACTORS.

B. Nothing discussed during the pre-bid conference will be construed to have changed the intent of the Contract Documents. These documents as issued stand. Any potential modifications, which may be discussed during the pre-bid conference, will not become official until issued in an Addendum to the Contract Documents.

24.5 Refer to Supplementary Conditions and the General Requirements for further Special Requirements.

25.0 Plans and Specifications to successful Bidder:

A. The successful bidder may obtain (10) sets of plans and specifications for this project from the City at no cost.

CITY OF GLENDALE

CERTIFICATE OF INSURABILITY

I hereby certify that as Bidder to City Project Thunderbird Paseo Wastewater Reclamation Facility, Project No. S867026, I am fully aware of the City of Glendale Insurance Requirements for Contractor and that by submitting this bid proposal, assure the City that I am able to produce the required minimum insurance coverage should I be selected to be the successful bidder.

Should I be selected to be the successful bidder and then become unable to produce the insurance coverage within five (5) working days, I understand that my bid will be rejected and that I will forfeit my bid bond.

_____ Date_____
COUNTERSIGNED BY
Insurance Representative

_____ Date_____
Signature

_____
Firm's Name

_____
Title

PROJECT NO. S867026

PROPOSAL

Place _____

Date _____

Proposal of _____;

a Corporation organized and existing under the laws of the State of

_____;

a partnership consisting of _____;

or an individual trading as _____.

TO THE HONORABLE MAYOR AND COUNCIL
CITY OF GLENDALE
GLENDALE, ARIZONA

Gentlemen:

The undersigned hereby proposed and agrees to furnish any and all required labor, materials, construction equipment, transportation and services for the construction of:

Project No. S867026 Thunderbird Paseo Wastewater Reclamation Facility in strict conformity with the Drawings and Specifications.

(Extension of these unit prices on the basis of estimated quantities and the totaling of these extensions are for the purpose of comparing bids only. The mathematics of such extensions and totaling will be checked and corrected by the Public Works/Engineering Department, before evaluating the bids, and the lowest of such corrected and checked totals will determine the lowest bid for Alternates A and B.)

NOTE: IN CASE OF DISCREPANCY, THE AMOUNT SHOWN IN WORDS SHALL GOVERN.

Estimated Item Description	Total Quantity	(Lump Sum)
Item 1. For Construction of Thunderbird Wastewater Reclamation Facility, the lump sum of _____ Dollars and _____ Cents ($)	Lump Sum	$_____
Item 2. For Additional Excavation, the unit price of _____ Dollars and _____ Cents ($) per cubic yard	____ c.y.	$_____
Item 3. For Additional General Backfill from Off-Site Sources, the unit price of _____ Dollars and _____ Cents ($) per cubic yard	____ c.y.	$_____
Item 4. For Additional Select Backfill from Off-Site Sources, the unit price of _____ Dollars and _____ Cents ($) per cubic yard	____ c.y.	$_____
Item 5. For Additional Crushed Stone and Gravel Backfill from Off-Site Sources, the unit price of _____ Dollars and _____ Cents ($) per cubic yard	____ c.y.	$_____

Estimated Item Description	Total Quantity	(Lump Sum)
Item 6. For Additional Class "A" Concrete, the unit price of _____ Dollars and _____ Cents ($) per cubic yard	____ c.y.	$_____
Item 7. For Additional Class "B" Concrete, the unit price of _____ Dollars and _____ Cents ($) per cubic yard	____ c.y.	$_____
Item 8. For Additional Reinforcing Steel, the unit price of _____ Dollars and _____ Cents ($) per pound	____ lbs.	$_____
Item 9. For Additional Structural Steel, the unit price of _____ Dollars and _____ Cents ($) per pound	____ lbs.	$_____
Item 10. For Additional Cast Iron or Ductile Iron, the unit price of _____ Dollars and _____ Cents ($) per pound	____ lbs.	$_____
Item 11. For Additional Aluminum, the unit price of _____ Dollars and _____ Cents ($) per pound	____ lbs.	$_____

Estimated Item Description	Total Quantity	(Lump Sum)
Item 12. For Additional Stainless Steel, the unit price of _____ Dollars and _____ Cents ($) per pound	____ lbs.	$_____

Item 13. For Additional Conduit, the unit prices per foot in accordance with the following schedule:

Conduit Size	Price per Foot Dollars	Cents			
3/4-inch	_____	and _____	($)	_____ ft.	$_____
1-inch	_____	and _____	($)	_____ ft.	$_____
1-1/4-inch	_____	and _____	($)	_____ ft.	$_____
1-1/2-inch	_____	and _____	($)	_____ ft.	$_____
2-inch	_____	and _____	($)	_____ ft.	$_____
2-1/1-inch	_____	and _____	($)	_____ ft.	$_____
3-inch	_____	and _____	($)	_____ ft.	$_____
4-inch	_____	and _____	($)	_____ ft.	$_____

Item 14. For Additional Cable, the unit prices per foot in accordance with the following schedule:

600 Volt Cable Size	Price per Foot Dollars	Cents			
No. 14	_____	and _____	($)	_____ ft.	$_____
No. 12	_____	and _____	($)	_____ ft.	$_____
No. 10	_____	and _____	($)	_____ ft.	$_____
No. 6	_____	and _____	($)	_____ ft.	$_____
No. 4	_____	and _____	($)	_____ ft.	$_____
No. 1/0	_____	and _____	($)	_____ ft.	$_____
350 MCM	_____	and _____	($)	_____ ft.	$_____
500 MCM	_____	and _____	($)	_____ ft.	$_____

5,000 Volt Cable Size	Price per Foot Dollars	Cents			
4/0	_____	and _____	($)	_____ ft.	$_____
350 MCM	_____	and _____	($)	_____ ft.	$_____
500 MCM	_____	and _____	($)	_____ ft.	$_____

PROJECT NO. S867026

Estimated Item Description			Total Quantity	(Lump Sum)
Two Conductor Shielded Cable	Price per Foot Dollars	Cents		
No. 16	_____ and	_____	($)	_____ ft. $_____

Total Items 1 through 16 $_____

The undersigned hereby declares that he has visited the site and has carefully examined the Contract Documents relating to the Work covered by the above bids:

Upon receipt of notice of the acceptance of this bid, we will execute the formal contract attached within ten (10) days, and will deliver a one hundred percent (100%) Performance Bond for the faithful performance of this Contract, together with a one hundred percent (100%) Labor and Materials Bond.

The bid security attached, with endorsement, in the sum of five percent (5%) of the total bid, is to become the property of the City of Glendale, Arizona, in the event the Contract and Bonds are not executed within the time set forth, as liquidated damages for the delay and additional work caused thereby.

The undersigned has checked carefully all the above figures and understands that the City of Glendale, Arizona will not be responsible for any errors or omissions on the part of the undersigned in making up this bid.

The undersigned understands that the Mayor and Council of the City of Glendale, Arizona, reserves the right to reject any or all bids or to waive any informalities in the bid.

Respectfully submitted,

_____
Contractor

By _____

_____

_____
(Complete business address)
Phone Number: _____

Bidder shall signify receipt of all Addenda here (if any):

Failure to acknowledge receipt of Addenda shall render the bid proposal non-responsive and will be rejected.

_____

By: _____
Its: _____

PROJECT NO. S867026

BID BOND

KNOW ALL MEN BY THESE PRESENTS:

That we, _____

_____, as Principal, (hereinafter called the Principal), and the _____,

a corporation duly organized under the laws of the State of _____, as Surety, (hereinafter called the Surety) are held and firmly bound unto the City of Glendale as Obligee, in the sum of five percent (5%) of the total amount of the Bid of Principal, submitted by him to the City of Glendale for the Work described below, for the payment of which sum, well and truly to be made, the said Principal and the said Surety, bind ourselves, our heirs, executors, and administrators, successors and assigns, jointly and severely, firmly by these presents, and in conformance with A.R.S.

WHEREAS, the said Principal is herewith submitting its proposal for construction of Thunderbird Paseo Wastewater Reclamation Facility, City Project No. S867026.

NOW, THEREFORE, if the City of Glendale shall accept the proposal of the Principal and the Principal shall enter into a Contract with the City of Glendale in accordance with the terms of such proposal and give such Bonds and Certificates of Insurance as specified in the Contract Documents with good and sufficient Surety for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter into such Contract and give such Bonds and Certificates of Insurance, if the Principal shall pay to the City of Glendale the sum of money set forth above as liquidated damages for failure of the Principal to enter into the Contract, then this obligation shall be null and void, otherwise to remain in full force and effect.

Signed and sealed this _____ day of _____, A.D., 19____

_____
Principal

_____
Title

Witness: _____

_____
Surety

_____
Title

Witness: _____

PROJECT NO. S867026

FIVE PERCENT PREFERENTIAL AFFIDAVIT
For Resident Bidders Only

This affidavit form is for the use of Bidders who are able to qualify under Section 34-241 of the Arizona Revised Statutes.

State of Arizona,

County of _____.

_____ being first duly sworn, upon his oath deposes and says:
That he is _____ of the _____
(Title) (Company/Corporation)
_____ and that he makes this affidavit for and on behalf of the said Company/Corporation being thereunto duly authorized; that in connection with the tender of bid to furnish labor, materials, construction equipment, transportation and services, for construction of:

Project No. S867026 - Thunderbird Paseo Wastewater Reclamation Facility

_____, for the City of Glendale, Arizona.

The affiant certifies and declares that _____
(Company/Corporation)

_____
(Address)
has fully complied with the terms and provisions of the Arizona Revised Statutes, and by virtue of such compliance is entitled to the 5% preference authorized thereunder; that he makes this affidavit in order to induce the granting of the said 5% preference in connection with the hereinbefore described bid.

Signed and dated at _____, this _____ day of _____, 19__.

_____
Contractor

By _____

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

Subscribed and sworn to by _____ before me this _____ day of _____, 19__.

_____
Notary Public

My commission expires: _____

PROJECT NO. S867026

BIDDER'S QUALIFICATION STATEMENT

(Completion of this statement is required in advance of consideration for award of contract.)

SUBMITTED TO:

City of Glendale, Arizona
5850 West Glendale Avenue
Glendale, Arizona 85301

SUBMITTED FOR:

Thunderbird Paseo
Wastewater Reclamation Facility
City Project No. S867026

SUBMITTED BY:

Name: _____
(Print or Type Name of Bidder)
(A Corporation/A Partnership/An Individual/A Joint Venture
[Bidder to strike out inapplicable terms.])

Address: _____

_____

Gentlemen:

The undersigned certifies under oath the truth and correctness of all statements and of all answers to questions made hereinafter.

(Note: Attach Separate Sheets as Required)

1.0 How many years has your organization been in business as a contractor?
_____

2.0 How many years has your organization been in business under its present name? _____

3.0 If a corporation, answer the following:

3.1 Date of incorporation:
3.2 State of incorporation:
3.3 President's name:
3.4 Vice president's name(s):
3.5 Secretary's or Clerk's name:
3.6 Treasurer's name:

4.0 If individual or partnership, answer the following:

4.1 Date of organization:
4.2 Name and address of all partners. (State whether general or limited partnership.):

5.0 If other than corporation or partnership, describe organization and name principals:

6.0 Do you plan to subcontract any part of this project? _____ If so, give details.

7.0 Has any construction contract to which you have been a party been terminated by the owner; have you ever terminated work on a project prior to its completion for any reason; has any surety which issued a performance bond on your behalf ever completed the work in its own name or financed such completion on your behalf; has any surety expended any monies in connection with a contract for which they furnished a bond on your behalf? If the answer to any portion of this question is "yes", please furnish details of all such occurrences including name of owner, architect or engineer, and surety, and name and date of project.

8.0 Has any officer or partner of your organization ever been an officer or partner of another organization that had any construction contract terminated by the owner; terminated work on a project prior to its completion for any reason; had any surety which issued a performance bond complete the work in its own name or financed such completion; or had any surety expend any monies in connection with a contract for which they furnished a bond? If the answer to any portion of this question is "yes", please furnish details of all such occurrences including name of owner, architect or engineer, and surety, and name and date of project.

9.0 List name of project, owner, architect or engineer, contract amount, percent complete and scheduled completion of the major construction projects your organization has in process on this date.

10.0 List name of project, owner, architect or engineer, contract amount, date of completion and percent of work with own forces of the major projects of the same general nature as this project which your organization has completed in the past five years.

11.0 List name, address and telephone number of a reference for each project project listed under Items 9.0 and 10.0, above.

12.0 List name and construction experience of the principal individuals of your organization.

13.0 List the states and categories of construction in which your organization is legally qualified to do business.

14.0 List name, address and telephone number of an individual who represents each of the following and whom OWNER may contact for a financial reference:

14.1 A surety:
14.2 A bank:
14.3 A major material supplier:

15.0 Attach a financial statement, prepared on an accrual basis, in a form which clearly indicates Bidder's assets, liabilities and net worth.

15.1 Date of financial statement: _____

15.2 Name of firm preparing statement: _____

16.0 Dated at _____, this _____ day of _____, 19__.

_____
(Print or Type Name of Bidder)

By _____

_____
(Title)

(Seal, if corporation)

----------(Affidavit for Individual)----------

_____ being duly sworn, deposes and says that: a) the financial statement, taken from his/her books, is a true and accurate statement of his/her financial condition as of the date thereof; and b) all of the foregoing qualification information is true, complete, and accurate.

----------(Affidavit for Partnership)----------

_____ being duly sworn, deposes and says that: a) he/she is a member of the partnership of _____; b) he/she is familiar with the books of said partnership showing its financial condition; c) the financial statement, taken from the books of said partnership, is a true and accurate statement of the financial condition of the partnership as of the date thereof; and d) all of the foregoing qualification information is true, complete, and accurate.

----------(Affidavit for Corporation)----------

_____ being duly sworn, deposes and says that: a) he/she is _____ of _____;
(Full name of Corporation)
b) he/she is familiar with the books of said corporation showing its financial condition; c) the financial statement, taken from the books of said corporation, is a true and accurate statement of the financial condition of said corporation as of the date thereof; and d) that all of the foregoing qualification information is true, complete, and accurate.

----------(Acknowledgment)----------

_____ being duly sworn, deposes and says that he/she is _____ of _____;
(Name of Bidder)
that he/she is duly authorized to make the foregoing affidavit and that he/she makes it on behalf of
( ) himself/herself; ( ) said partnership; ( ) said corporation.

Sworn to before me this _____ day of _____, 19__, in the County of _____, State of _____.

_____
(Notary Public)

My commission expires _____

(Seal)

PROJECT NO. S867026

NONCOLLUSIVE BIDDING CERTIFICATION

(STATE OF)
SS:
(COUNTY OF)

I, _____ of the City of _____, in the County of _____ and the State of _____, of full age, being duly sworn according to the law on may oath depose and say that:

I am _____ a, _____
(Name) (Title, Position, etc.)

of the firm of _____,

the Bidder making the Bid for City of Glendale, Thunderbird Paseo Wastewater Reclamation Facility, City Project No. S867026, and that I executed the said Proposal with full authority so to do; that said Bidder has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free, competitive bidding in connection with the above named Project; and that all statements contained in said Proposal and in this affidavit are true and correct, and made with full knowledge that the City of Glendale relies upon the truth of the statements contained in said Bid and in the statements contained in this affidavit in awarding the Contract for the said Project.

I further warrant that no person or selling agency has been employed or retained to solicit or secure such Contract upon an agreement or understanding, for a commission, percentage, brokerage or contingent fee, except bonafide employees or bonafide established commercial or selling agencies maintained by:

_____
(Signature of Bidder)

_____
(Printed or Typed Name of Bidder)
(Seal if Corporation)

Sworn to before me this _____ day of _____, 19__, in the County of _____, State of _____.

_____
(Notary Public)

My commission expires _____

(Seal)

PROJECT NO. S867026

CERTIFIED COPY OF RESOLUTION OF
BOARD OF DIRECTORS OF

_____
(Name of Corporation)

"RESOLVED that _____, _____
(Person Authorized to Sign) (Title)

of _____ be authorized to sign and submit the Proposal
(Name of Corporation)

or proposal of this corporation for the following project:

City of Glendale, Thunderbird Paseo Wastewater Reclamation Facility, City Project No. S867026.

The foregoing is a true and correct copy of the resolution adopted by

_____ at a meeting of its Board of
(Name of Corporation)

Directors held on the _____ day of _____, 19___.

By_____

Title_____

(SEAL)

(This form must be completed if the Bidder is a corporation.)

PROJECT NO. S867026

CONTRACT

THIS AGREEMENT, made and entered into this _____ day of _____, 19___, by and between the City of Glendale, Arizona, a municipal corporation, organized and existing under and by virtue of the laws of the State of Arizona, party of the first part, hereinafter designated the Owner, and

_____, of the City of _____, County of _____, and State of _____, party of the second part, hereinafter designated as the Contractor.

WITNESSETH: That the said Contractor has covenanted, and agreed, for and in consideration of the payments made as provided for in the proposal and specifications, to the Contractor by the said Owner, and under the penalty expressed in the bond hereto attached, at his proper cost and expense to do all the Work and furnish all materials, tools, labor, and all appliances, appurtenances and services called for by the Agreement, free from all claims, liens and charges whatsoever, in the manner, and under the conditions hereinafter specified, that are necessary for construction of:

PROJECT No. S867026 - Thunderbird Paseo Wastewater Reclamation Facility

For the sum of: _____

_____ Dollars $_____
(written words) (figures)

The Work done and materials and equipment furnished shall be strictly pursuant to and in conformity with the specifications and plans. The Specifications and Drawings furnished to the Contractor, along with the Contractor's proposal and additional drawings or prints and other information to be furnished by the Contractor in accordance with the Specifications are made a part of this Agreement when and as approved by the City of Glendale, Arizona, or its authorized agents, are intended to be complementary, and all Specifications, plans, drawings, or prints furnished by the Contractor and approved by the City of Glendale, or its authorized agents, shall be complementary therewith. Any work appearing in or upon the one and not mentioned in the others shall be executed according to the true intent and meaning of the said Specifications and Drawings, or prints the same as though the said work were contained and described in all.

The Notice to Contractors, Instructions to Bidders, General and Supplementary Conditions, Proposal, Bid Bond, Labor and Materials Bond, Performance Bond, Appendix, Specifications, Contract Drawings and Addenda thereto, are hereby understood to be a part of this Contract.

It is further covenanted and agreed that inspection of the work shall be performed by the City of Glendale, Arizona, or its properly authorized agents, on whose inspection all work shall be accepted or rejected.

The City or its authorized agents shall have full power to reject or condemn all material furnished or work performed under this contract which does not conform to the terms and conditions herein expressed.

PROJECT NO. S867026

To Provent all disputes and litigation, it is further agreed by and between the said City of Glendale, Arizona, and said Contractor, that the Public Works/Engineering Department, City of Glendale or its authorized agents, shall determine all questions in relation to the work and the construction thereof, and it shall in all cases decide all questions which may arise relative to the work under this Contract on the part of the said Contractor and its estimates and decisions shall be final and conclusive; and such estimates and decisions, in case any question may arise, shall be a condition precedent to the right of said Contractor to receive any money or compensation for anything done or furnished under this Contract.

IN WITNESS WHEREOF, four (4) identical counterparts of the Contract, each of which shall for all purposes be deemed an original thereof, have been duly executed by the parties hereinabove named, on the date and year first herein written.

ATTEST:

CITY OF GLENDALE, ARIZONA
PARTY OF THE FIRST PART (OWNER)

(SEAL)

_____
City Clerk

_____

_____
Title

APPROVED: (AS TO FORM)

_____
City Attorney

WITNESSES:

_____
PARTY OF THE SECOND PART
(CONTRACTOR)

_____

_____

_____

_____
Title

CITY OF GLENDALE
GLENDALE, ARIZONA

THUNDERBIRD PASEO
WASTEWATER RECLAMATION FACILITY

CITY PROJECT NO.

S867026

SUPPLEMENTAL CONTRACT PROVISIONS

ARTICLE 1 - WORK

1.1 CONTRACTOR shall at his own cost and expense furnish all labor, services, tools, materials, equipment and incidentals necessary to perform all Work required by the Contract Documents to construct the Thunderbird Paseo Wastewater Reclamation Facility, City Project No. S867026, in complete accordance with the Contract Documents.

1.2 The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as Construction of the Thunderbird Paseo Wastewater Reclamation Facility.

ARTICLE 2 - CONTRACT DOCUMENTS

2.1 The Contract Documents are defined in the General Conditions.

ARTICLE 3 - CONTRACT TIME

3.1 The Work will be substantially complete within 365 days after the date when the Contract Time commences to run as provided in Paragraph 2.3 of the General Conditions and completed and ready for final payment.

3.2 Failure of the CONTRACTOR to perform any convenant or condition contained in the Contract Documents within the time period specified in Paragraph 3.1 shall constitute a material breach of this Agreement entitling the OWNER to terminate the Agreement unless the CONTRACTOR applies for, and receives, an extension of time in accordance with the procedures set forth in Article 12 of the General Conditions.

3.3 Failure of the OWNER to insist upon the performance of any covenant or condition within the time period specified in Paragraph 3.1 shall not constitute a waiver of the CONTRACTOR'S duty to complete performance within the designated periods unless the waiver is in writing.

3.4 The OWNER'S agreement to waive a specific time provision or to extend the time for performance shall not constitute a waiver of any other time provisions contained in the Contract Documents. Failure of the CONTRACTOR to complete performance promptly within the additional time authorized in the waiver or extension of time agreement shall constitute a material breach of this Agreement entitling the OWNER to terminate.

ARTICLE 4 - LIQUIDATED AND SPECIAL DAMAGES

4.1 Liquidated Damages:

A. OWNER and CONTRACTOR recognize that time is of the essence as to Substantial Completion and that OWNER will suffer financial loss apart from the costs described in Paragraph 4.2, if the Work is not substantially complete within the time specified in Article 3, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. OWNER and CONTRACTOR also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by OWNER if the Work is not substantially complete on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) CONTRACTOR shall pay OWNER $225.00 for each day that expires after the time specified in Article 3 for Substantial Completion, including any extensions thereof made in accordance with Article 12 of the General Conditions, until the Work is substantially complete.

B. It is further agreed that said amount per day is a reasonable estimate of such damages, that said amount does in fact bear a reasonable relationship to the damage that would be sustained by the OWNER, and the CONTRACTOR agrees to pay such liquidated damages as herein provided.

4.2 Special Damages:

A. In addition to the amount provided for liquidated damages, CONTRACTOR shall pay OWNER the actual costs reasonably incurred by OWNER for engineering and inspection forces employed on the Work for each day that expires after the time specified in Article 3 for Substantial Completion, including any extensions thereof made in accordance with Article 12 of the General Conditions, until the Work is substantially complete.

4.3 OWNER may deduct the amount of liquidated damages and special damages from monies due CONTRACTOR under the Contract.

ARTICLE 5 - PAYMENT PROCEDURES

5.1 CONTRACTOR shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

5.2 Progress Payments:

A. OWNER shall make monthly progress payments on account of the Contract Price on the basis of CONTRACTOR'S Applications for Payment as recommended by ENGINEER. CONTRACTOR'S Applications for Payment will be due

on the tenth day of the month. All progress payments will be on the basis of the progress of the Work measured by the schedule of values provided for in Paragraph 14.1 of the General Conditions. A progress payment will not be made whenever the value of the Work is completed since the last previous progress payment is less than $5,000.00.

1. Prior to Substantial Completion, progress payments will be in the amount of 90 percent of the labor, materials and equipment incorporated into the Work, and of the materials and equipment not incorporated into the Work but suitably stored, less the aggregate of payments previously made.
2. Upon Substantial Completion, OWNER shall pay an amount sufficient to increase total payments to CONTRACTOR to 100 percent of the Contract Price, less such amounts as ENGINEER shall determine in accordance with Paragraph 14.4.D. of the General Conditions.

5.3 Final Payment:

A. Upon final completion and acceptance of the Work in accordance with Paragraph 14.9 of the General Conditions, OWNER shall pay the remainder of the Contract Price as recommended by ENGINEER as provided in said Paragraph 14.9.

ARTICLE 6 - INTEREST

6.1 All moneys not paid when due hereunder shall bear interest at the maximum rate allowed by law at the place of the Project.

ARTICLE 7 - CONTRACTOR'S REPRESENTATIONS

7.1 As part of the inducement for OWNER to enter into the Contract, CONTRACTOR makes the following representations:

A. CONTRACTOR has familiarized himself with the nature and extent of the Contract Documents, Work, locality, and with all local conditions and federal, state and local laws, ordinances, rules and regulations that in any manner may affect cost, progress or performance of the Work.

B. CONTRACTOR has studied carefully all reports of investigations and tests of subsurface and latent physical conditions at the site or those reports that otherwise may affect cost, progress or performance of the Work, which were utilized by ENGINEER in the preparation of the Drawings and Specifications and which have been identified in the Supplementary Conditions.

C. CONTRACTOR has made or caused to be made examinations, investigations and tests and studies of such reports and related data in addition to those referred to in Paragraph 7.1.B. as he deems necessary for the performance of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents; and no additional examinations, investigations, tests, reports or similar data are or will be required by CONTRACTOR for such purposes.

D. CONTRACTOR has correlated the results of all such observations, examinations, investigations, tests, reports and data with the terms and conditions of the Contract Documents.

E. CONTRACTOR has given ENGINEER written notice of all conflicts, errors or discrepancies that he has discovered in the Contract Documents and the written resolution thereof by ENGINEER is acceptable to CONTRACTOR.

ARTICLE 8 - DRAWINGS AND ADDENDA

8.1 The Drawings comprise a set entitled "City of Glendale, Arizona, Thunderbird Paseo Wastewater Reclamation Facility, dated _____, and include the following:

8.2 Addenda consisting of Numbers ____ to ____ inclusive.

ARTICLE 9 - MISCELLANEOUS

9.1 Terms used in the Contract which are defined in Article 1 of the General Conditions shall have the meanings indicated in the General Conditions.

9.2 No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

9.3 OWNER and CONTRACTOR each binds himself, his partners, successors, assigns and legal representatives to the other party hereto, and his partners, successors, assigns and legal representatives in respect to all covenants, agreements and obligations contained in the Contract Documents.

PERFORMANCE BOND

STATUTORY PERFORMANCE BOND PURSUANT TO
TITLE 34, CHAPTER 2, ARTICLE 2,
OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That, _____(hereinafter called the Principal), as Principal, and _____ a corporation organized and existing under the law of the State of _____ with its principal office in the City of _____, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of Glendale, County of Maricopa, State of Arizona, in the amount of _____ _____ Dollars ($_____), for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the City of Glendale, dated the _____ day of _____, 19__, for construction of Thunderbird Paseo Wastewater Reclamation Facility, City Project No. S867026, which Contract is hereby referred to and made a part hereof as fully and to the same extent as if copies at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall faithfully perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said Contract during the original term of said Contract and any extension thereof, with or without notice to the Surety, and during the life of any guaranty required under the Contract, and shall also perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of any and all duly authorized modifications of said Contract that may hereafter be made, notice of which modifications to the Surety being hereby waived; then the above obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2 of the Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of said Title, Chapter and Article, to the extent as if it were copied at length herein.

The prevailing party in a suit on this bond shall be entitled to such reasonable attorney's fees as may be fixed by a judge of the Court.

PROJECT NO. S867026

Witness our hands this _____ day of _____, 19____.

_____
PRINCIPAL SEAL

_____
AGENT OF RECORD

By_____

_____
SURETY SEAL

_____
AGENT ADDRESS

By_____

LABOR AND MATERIALS BOND

STATUTORY PAYMENT BOND PURSUANT TO
TITLE 34, CHAPTER 2, ARTICLE 2,
OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That, _____(hereinafter called the Principal), as Principal, and _____ a corporation organized and existing under the law of the State of _____ with its principal office in the City of _____, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of Glendale, County of Maricopa, State of Arizona (hereinafter called the Obligee), in the amount of _____

_____ Dollars ($_____), for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 19__, for construction of Thunderbird Paseo Wastewater Reclamation Facility, City Project No. S867026, which Contract is hereby referred to and made a part hereof as fully and to the same extent as if copies at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall promptly pay all moneys due to all persons supplying labor or materials to him or his Subcontractors in the prosecution of the Work provided for in said Contract, then this obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2 of the Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of said Title, Chapter and Article, to the extent as if it were copied at length herein.

The prevailing party in a suit on this bond shall be entitled to such reasonable attorney's fees as may be fixed by a judge of the Court.

PROJECT NO. S867026

Witness our hands this _____ day of _____, 19____.

_____
PRINCIPAL SEAL

_____
AGENT OF RECORD

By_____

_____
SURETY SEAL

_____
AGENT ADDRESS

By_____

PROJECT NO. S867026

CITY OF GLENDALE
GLENDALE, ARIZONA
DEPARTMENT OF PUBLIC WORKS

CONTRACTOR'S AFFIDAVIT
REGARDING
SETTLEMENT OF CLAIMS

_____, Arizona

Date _____

Project Name: _____

Project Number: _____

To the City of Glendale, Arizona

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the consideration of $_____, as set out in the final pay estimate, as full and complete payment under the terms of the contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project. The undersigned further agrees to indemnify and save harmless the City of Glendale against any and all liens, claims of liens, suits, actions, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performances and materials furnished for the performance of said installation.

Signed and dated at _____, this _____ day of _____ 19___.

_____
CONTRACTOR

By: _____

STATE OF ARIZONA)
) SS
COUNTY OF MARICOPA)

The foregoing instrument was subscribed and sworn to before me this

_____ day of _____, 19___.

_____
Notary Public

_____
My Commission Expires

GENERAL CONDITIONS

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ARTICLE 1 - DEFINITIONS

1.1 Wherever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated which are applicable to both the singular and plural thereof.

A. Defined Terms:

1. Addenda: Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change, the Bidding Documents or the Contract Documents.
2. Agreement: The written agreement between OWNER and CONTRACTOR covering the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein.
3. Application for Payment: The form accepted by ENGINEER which is to be used by CONTRACTOR in requesting progress or final payment and which is to include such supporting documentation as is required by the Contract Documents.
4. Bid: The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
5. Bidder: Any person, firm or corporation submitting a Bid for the Work.
6. Bidding Documents: Notice to bidders or advertisement, if any, instructions to bidders, other bidding information and requirements, bidding forms and attachments, contract and bond forms, and the proposed Contract Documents, including any Addenda issued prior to receipt of Bids.
7. Bonds: Bid, performance, and labor and material payment bonds and other instruments of security.
8. Change Order: A written order to CONTRACTOR signed by OWNER authorizing an addition, deletion or revision in the Work, or an

adjustment in the Contract Price or the Contract Time issued after the Effective Date of the Agreement.

9. Contract Documents: The Agreement, Addenda (which pertain to the Contract Documents), CONTRACTOR'S Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications, the Drawings as the same may be more specifically identified in the Agreement, together with all Modifications issued after execution of the Agreement.
10. Contract Price: The moneys payable by OWNER to CONTRACTOR under the Contract Documents as stated in the Agreement.
11. Contract Time: The number of days (computed as provided in Paragraph 17.2) or the date stated in the Agreement for the completion of the Work.
12. CONTRACTOR: The person, firm or corporation with whom OWNER has executed the Agreement. Whenever the Project is to be constructed under multiple direct contracts, the term "CONTRACTOR" shall mean the appropriate prime CONTRACTOR. Whenever a specific prime CONTRACTOR is referred to, terms such as "General CONTRACTOR", "Electrical CONTRACTOR", etc. will be used.
13. day: A calendar day of twenty-four hours measured from midnight to the next midnight.
14. defective: An adjective which when modifying the word Work refers to Work that is unsatisfactory, faulty or deficient, or does not conform to the Contract Documents or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to ENGINEER'S recommendation for final payment (unless responsibility for the protection thereof has been assumed by OWNER at Substantial Completion in accordance with Paragraph 14.5).
15. Drawings: The Drawings which show the character and scope of the Work to be performed and which have been prepared or approved by ENGINEER and are referred to in the Contract Documents.
16. Effective Date of the Agreement: The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.
17. ENGINEER: The person, firm or corporation named as such in the Agreement.
18. Field Order: A written order issued by ENGINEER which orders minor changes in the Work in accordance with Paragraph 10.2 but which does not involve a change in the Contract Price or the Contract Time.
19. General Requirements: Sections of Division 1 of the Specifications.
20. Modifications: (a) A written amendment of the Contract Documents signed by both parties, (b) a Change Order, or (c) a Field Order. A Modification may only be issued after the Effective Date of the Agreement.
21. Notice of Award: The written notice by OWNER to the apparent successful Bidder stating that upon compliance by the apparent successful Bidder with the conditions precedent enumerated therein, within the time specified, OWNER will sign and deliver the Agreement.
22. Notice to Proceed: A written notice given by OWNER to CONTRACTOR fixing the date on which the Contract Time will commence to run and on which CONTRACTOR shall start to perform his obligations under the Contract Documents.

23. OWNER: The public body or authority, corporation, association, partnership, or individual with whom CONTRACTOR has entered into the Agreement and for whom the Work is to be provided.
24. Project: The total construction of which the Work to be provided under the Contract Documents may be the whole or a part as indicated elsewhere in the Contract Documents.
25. Project Manual: The bound documentary information prepared for bidding and constructing the Project. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.
26. Resident Project Representative: The authorized representative of ENGINEER who is assigned to the site or any part thereof.
27. Samples: Physical examples furnished by the CONTRACTOR to illustrate materials, equipment or workmanship, and to establish standards by which some portions of the Work will be judged.
28. Shop Drawings: All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for CONTRACTOR to illustrate some portion of the Work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a manufacturer, fabricator, supplier or distributor and submitted by CONTRACTOR to illustrate material or equipment for some portion of the Work.
29. Specifications: Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.
30. Subcontractor: An individual, firm or corporation having a direct contract with CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the site.
31. Substantial Completion: The Work (or a specified part thereof) has progressed to the point where, in the opinion of ENGINEER as evidenced by ENGINEER'S definitive certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it was intended; or if there be no such certificate issued, when final payment is due in accordance with Paragraph 14.9.A. The terms "substantially complete" and "substantially completed" as applied to any Work refer to Substantial Completion thereof.
32. Supplementary Conditions: Modifications and additions to the General Conditions.
33. Work: The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

ARTICLE 2 - PRELIMINARY MATTERS

2.1 Delivery of Bonds and Insurance Certificates:

A. When CONTRACTOR executes Agreement with OWNER, CONTRACTOR shall deliver to OWNER such Bonds as CONTRACTOR may be required to furnish in accordance with Article 5.

B. When CONTRACTOR executes Agreement with OWNER, CONTRACTOR shall deliver to OWNER, with a copy to ENGINEER, certificates (and other evidence of insurance requested by OWNER) which CONTRACTOR is required to purchase and maintain in accordance with Article 5, and OWNER shall deliver to CONTRACTOR certificates (and other evidence of insurance requested by CONTRACTOR) which OWNER is required to purchase and maintain in accordance with Article 5.

2.2 Copies of Documents:

A. OWNER shall furnish to CONTRACTOR up to ten copies (unless otherwise provided in the General Requirements) of the Contract Documents as are reasonably necessary for the execution of the Work. Additional copies will be furnished, upon request, at the cost of reproduction.

2.3 Commencement of Contract Time; Notice to Proceed:

A. The Contract Time will commence to run on the thirtieth day after the Effective Date of the Agreement; or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed; but in no event shall the Contract Time commence to run later than the ninetieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement. A Notice to Proceed may be given at any time within thirty days after the Effective Date of the Agreement.

2.4 Starting the Project:

A. CONTRACTOR shall start to perform the Work on the date when the Contract Time commences to run, but no Work shall be done at the site prior to the date on which the Contract Time commences to run.

2.5 Before Starting Construction:

A. Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements. CONTRACTOR shall promptly report in writing to ENGINEER any conflict, error or discrepancy which he may discover and shall obtain a written interpretation or clarification from ENGINEER before proceeding with any Work affected thereby; however, CONTRACTOR shall not be liable to OWNER or ENGINEER for the failure to report any conflict, error or discrepancy in the Contract Documents, unless CONTRACTOR had actual knowledge thereof or should reasonably have known thereof.

B. Within ten days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), CONTRACTOR shall submit to ENGINEER for review and acceptance, an estimated progress schedule indicating the starting and completion dates of the various stages of the Work, a preliminary schedule of Shop Drawing submissions, and a preliminary schedule of values of the Work.

2.6 Preconstruction Conference:

A. Within twenty days after the Effective Date of the Agreement, but before CONTRACTOR starts the Work at the site, a conference will be held for review and acceptance of the schedules, referred to in Paragraph 2.5.B, to establish procedures for handling Shop Drawings and other submittals

and for processing Applications for Payment, and to establish a working understanding among the parties as to the Work.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AND REUSE

3.1 Intent:

A. The Contract Documents comprise the entire Agreement between OWNER and CONTRACTOR concerning the Work. They may be altered only by a Modification.

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. If, during the performance of the Work, CONTRACTOR finds a conflict, error or discrepancy in the Contract Documents, he shall report it to ENGINEER in writing at once and before proceeding with the Work affected thereby; however, CONTRACTOR shall not be liable to OWNER or ENGINEER for failure to report any conflict, error or discrepancy in the Specifications or Drawings unless CONTRACTOR had actual knowledge thereof or should reasonably have known thereof.

C. It is the intent of the Specifications and Drawings to describe a complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work that may reasonably be inferred from the Specifications or Drawings as being required to produce the intended result shall be supplied whether or not it is specifically called for, at no additional cost to OWNER.

D. The Specifications may describe or the Drawings may show the general arrangement of an item of material or equipment when the actual details of said arrangement will vary with the source of the material or equipment. In such cases, CONTRACTOR shall bear all direct and indirect costs to accommodate the item of material or equipment furnished, whether the item of material or equipment is furnished by a manufacturer named in the Specifications or is furnished as an approved substitute or "or equal" item of material or equipment.

E. When words in the Specifications or on the Drawings, which have a well-known technical or trade meaning, are used to describe Work, materials or equipment such words shall be interpreted in accordance with such meaning. Reference to standard specifications, manuals or codes of any technical society, organization or association, or to the code of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual or code in effect at the time of opening of Bids (or, on the effective date of the Agreement if there were no Bids), except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual or code (whether or not specifically incorporated by reference in the Contract Documents) shall change the duties and responsibilities of OWNER, CONTRACTOR or ENGINEER, or any of their agents or employees from those set forth in the Contract Documents. Clarifications and interpretations of the Contract Documents shall be issued by ENGINEER as provided for in Paragraph 9.3.

F. The Contract Documents will be governed by the law of the place of the Project.

3.2 Re-use of Documents:

A. Neither CONTRACTOR nor any Subcontractor, manufacturer, fabricator, supplier or distributor shall have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents (or copies of any thereof) prepared by or bearing the seal of ENGINEER; and they shall not re-use any of them on extensions of the Project or any other project without written consent of OWNER and ENGINEER and specific written verification or adaptation by ENGINEER.

ARTICLE 4 - AVAILABILITY OF LANDS; PHYSICAL CONDITIONS; REFERENCE POINTS

4.1 Availability of Lands:

A. OWNER shall furnish, as indicated in the Contract Documents the lands upon which the Work is to be performed, rights-of-way for access thereto, and such other lands which are designated for the use of CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by OWNER, unless otherwise provided in the Contract Documents. If CONTRACTOR believes that any delay in OWNER'S furnishing these lands or easements entitles CONTRACTOR to an extension of the Contract Time, CONTRACTOR may make a claim therefor as provided in Article 12. CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.2 Physical Conditions-Investigations and Reports:

A. Reference is made to the Supplementary Conditions for identification of those reports of investigations and tests of subsurface and latent physical conditions at the site or those reports that otherwise may affect cost, progress or performance of the Work which have been utilized by ENGINEER in preparation of the Drawings and Specifications. These reports are not intended to constitute any explicit or implicit representation as to the nature of the subsurface and latent physical conditions which may be encountered at the site or to constitute explicit or implicit representations as to any other matter contained in any report. Such reports are not guaranteed as to accuracy or completeness and are not part of the Contract Documents.

4.3 Unforeseen Physical Conditions:

A. CONTRACTOR shall promptly notify OWNER and ENGINEER in writing of any subsurface or latent physical conditions at the site or in an existing structure differing materially from those indicated or referred to in the Contract Documents. ENGINEER will promptly review those conditions and advise OWNER in writing if further investigations or tests are necessary. Promptly thereafter, OWNER shall obtain the necessary additional investigations and tests and furnish copies to ENGINEER and CONTRACTOR. If ENGINEER finds that the results of such investigations or tests indicate that there are subsurface or latent physical conditions which differ materially from those intended in the Contract Documents, and which could not reasonably have been anticipated by CONTRACTOR, a Change Order shall be issued incorporating the necessary revisions.

4.4 Reference Points:

A. OWNER shall provide engineering surveys for construction to establish reference points which in OWNER'S judgment are necessary to enable CONTRACTOR to proceed with the Work. CONTRACTOR shall be responsible for laying out the Work (unless otherwise specified in the General Requirements), and shall protect and preserve the established reference points and shall make no changes or relocations without the prior written approval of OWNER. CONTRACTOR shall report to ENGINEER whenever any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for replacement or relocation of such reference points by professionally qualified personnel.

ARTICLE 5 - BONDS AND INSURANCE

5.1 Performance, Payment and Other Bonds:

A. CONTRACTOR shall furnish performance and payment Bonds, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all CONTRACTOR'S obligations under the Contract Documents. These Bonds shall remain in effect at least until one year after the date of final payment, except as otherwise provided by law. CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary Conditions. All Bonds shall be in the forms prescribed by the Bidding Documents or Supplementary Conditions and be executed by such sureties as:
   1. Are licensed to conduct business in the state where the Project is located, and
   2. Are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Audit Staff Bureau of Accounts, U.S. Treasury Department.

   All Bonds signed by an agent must be accompanied by a certified copy of the authority to act.

B. If the surety on any Bond furnished by CONTRACTOR is declared a bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.1.A, CONTRACTOR shall within five days thereafter substitute another Bond and surety, both of which shall be acceptable to OWNER.

5.2 Contractor's Liability Insurance:

A. CONTRACTOR shall purchase and maintain such comprehensive general liability and other insurance as will provide protection from claims set forth below which may arise out of or result from CONTRACTOR'S performance of the Work and CONTRACTOR'S other obligations under the Contract Documents, whether such performance of the Work is by CONTRACTOR, by any Subcontractor, by anyone directly or indirectly employed by any of them, or by anyone for whose acts any any of them may be liable:
   1. Claims under workers' or workmen's compensation, disability benefits and other similar employee benefit acts;
   2. Claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR'S employees;

3. Claims for damages because of bodily injury, sickness or disease, or death of any person other than CONTRACTOR'S employees;
4. Claims for damages insured by personal injury liability coverage which are sustained (a) by any person as a result of an offense directly or indirectly related to the employment of such person by CONTRACTOR, or (b) by any other person for any other reason;
5. Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;
6. Claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle; and
7. Claims for damages because of bodily injury or death of any person arising out of operation of law.

B. The insurance required by Paragraph 5.2.A shall include the specific coverages and be written for not less than the limits of liability and coverages provided in the Supplementary Conditions, or required by law, whichever is greater. All such insurance shall remain in effect until final payment and at all times thereafter when CONTRACTOR may be correcting, removing or replacing defective Work in accordance with Paragraph 13.7. The comprehensive general liability insurance shall include completed operations insurance and shall include OWNER and ENGINEER and their agents and employees as additional insureds. CONTRACTOR shall maintain such completed operations insurance for at least two years after final payment and shall furnish OWNER with evidence of continuation of such insurance at final payment and one year thereafter.

5.3 Contractual Liability Insurance:

A. The comprehensive general liability insurance required by Paragraph 5.2.A shall include contractual liability insurance applicable to CONTRACTOR'S obligations under Paragraph 6.15.

5.4 Owner's Liability Insurance:

A. OWNER shall be responsible for purchasing and maintaining OWNER'S own liability insurance and, at OWNER'S option, may purchase and maintain such insurance as will protect OWNER against claims which may arise from operations under the Contract Documents.

5.5 Property Insurance:

A. Unless otherwise provided in the Supplementary Conditions, CONTRACTOR shall purchase and maintain property insurance upon the Work at the site to the full insurable value thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or as required by law). This insurance shall include the interests of the OWNER, CONTRACTOR, and Subcontractors in the Work; shall insure against the perils of fire and extended coverage; shall include "all risk" insurance for physical loss and damage including theft, vandalism and malicious mischief, collapse and water damage, and such other perils as may be specified in the Supplementary Conditions; shall include damages, losses and expenses arising out of or resulting from any insured loss or incurred in the repair or replacement of any insured property (including fees and charges of engineers, architects, attorneys and other professionals); and shall provide that all insurance proceeds are to be paid to OWNER "as

Trustee". If not covered under the "all risk" insurance or otherwise provided in the Supplementary Conditions, CONTRACTOR shall purchase and maintain similar property insurance on portions of the Work stored on or off the site or in transit when such portions of the Work are to be included in an Application for Payment. All such insurance required by this Paragraph 5.5.A shall remain in effect until the Work is substantially completed.

B. OWNER shall purchase and maintain such boiler and machinery insurance as may be required by the Supplementary Conditions or by law. This insurance shall include the interest of OWNER, CONTRACTOR and Subcontractors in the Work. OWNER shall file a copy of all policies required by this Paragraph with CONTRACTOR before an exposure to loss may occur.

C. The policies of insurance required under this Paragraph 5.5 shall provide that neither the OWNER nor the CONTRACTOR, nor their insurers, shall have any right of subrogation against any of the other parties enumerated in Paragraph 5.6. It is the intention of the OWNER and CONTRACTOR that the policies shall protect all of the enumerated parties and be primary coverage for any and all losses covered by the insurance described in Paragraphs 5.5.A and 5.5.B.

5.6 Waiver of Rights:

A. OWNER and CONTRACTOR waive all rights against each other and the Subcontractors and their agents and employees and against ENGINEER and separate contractors (if any) and their subcontractors', agents and employees, for damages caused by fire or other perils to the extent covered by insurance provided under Paragraph 5.5., or any other property insurance applicable to the Work, except such rights as they may have to the proceeds of such insurance held by OWNER as trustee. OWNER or CONTRACTOR, as appropriate, shall require similar waivers in writing by ENGINEER and from each separate contractor and each Subcontractor; each such waiver will be in favor of all other parties enumerated in this Paragraph 5.6.

5.7 Receipt and Application of Proceeds:

A. Any insured loss under the policies of insurance required by Paragraph 5.5 shall be adjusted with OWNER and made payable to OWNER as trustee for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.7.B. OWNER shall deposit in a separate account any money so received, and he shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof and the Work and the cost thereof covered by an appropriate Change Order.

B. OWNER as trustee shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within fifteen days after the occurrence of loss to OWNER'S exercise of this power. If such objection be made, OWNER as trustee shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If required in writing by any party in interest, OWNER as trustee shall upon the occurrence of an insured loss, give bond for the proper performance of his duties.

5.8 Partial Utilization - Property Insurance:

A. If OWNER finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all of the Work, such use or occupancy may be accomplished in accordance with Paragraph 14.6; provided that no such use or occupancy shall commence before the insurers providing the property insurance have acknowledged notice thereof and in writing effected the changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be cancelled or lapse on account of any such partial use or occupancy.

5.9 Certificates of Insurance:

A. All certificates of the insurance required to be purchased by CONTRACTOR pursuant to Article 5 shall be filed in accordance with Paragraph 2.1.B. Certificates shall be acceptable to OWNER and shall contain a provision that coverages afforded under the policies will not be cancelled, materially changed or renewal refused until at least thirty days' prior written notice has been given to OWNER and ENGINEER by certified mail.

5.10 Additional Bonds and Insurance:

A. OWNER may require CONTRACTOR to furnish such other Bonds and such additional insurance, in such form and with such sureties or insurers as OWNER may specify. If such other Bonds or such other insurance are specified in the Contract Documents, the premiums shall be paid by CONTRACTOR; if subsequent thereto, they shall be paid by OWNER except as otherwise provided in Paragraph 6.3.A.1 and Paragraph 13.8.B.

ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

6.1 Supervision and Superintendence:

A. CONTRACTOR shall supervise and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences and procedures of construction, but he shall not be solely responsible for the negligence of others in the design or selection of a specific means, method, technique, sequence or procedure of construction which is indicated in and required by the Contract Documents. CONTRACTOR shall be responsible to see that the finished Work complies accurately with the Contract Documents.

B. CONTRACTOR shall keep on the Work at all times during its progress a competent resident superintendent, who shall not be replaced without written notice to OWNER and ENGINEER except under extraordinary circumstances. The superintendent will be CONTRACTOR'S representative at the site and shall have authority to act on behalf of CONTRACTOR. All communications given to the superintendent shall be as binding as if given to CONTRACTOR.

6.2 Labor, Materials and Equipment:

A. CONTRACTOR shall provide competent, suitably qualified personnel to

survey and lay out the Work and perform construction as required by the Contract Documents. CONTRACTOR shall at all times maintain good discipline and order at the site. Except in connection with the safety or protection of persons or the Work or property at the site or adjacent thereto, and except as otherwise indicated in the Supplementary Conditions, all Work at the site shall be performed during regular working hours, and CONTRACTOR will not permit overtime work or the performance of Work on Saturday, Sunday or any legal holiday without OWNER'S written consent given after prior written notice to ENGINEER.

B. CONTRACTOR shall furnish all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances and all other facilities and incidentals necessary for the execution, testing, initial operation and completion of the Work. Except as otherwise specified in the General Requirements, CONTRACTOR shall furnish all fuel, power, light, heat, telephone, water and sanitary facilities necessary for the execution, testing, initial operation and completion of the Work.

C. All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. If required by ENGINEER, CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment.

D. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with the instructions of the applicable manufacturer, fabricator, supplier or distributor, except as otherwise provided in the Contract Documents; but no provision of any such instructions will be effective to impose on ENGINEER responsibility for the means, methods, techniques, sequences or procedures of construction or for safety precautions incident thereto.

6.3 Substitutions:

A. Whenever materials or equipment are specified or described in the Drawings or Specifications by using the name of a proprietary item or the name of a particular manufacturer, fabricator, supplier or distributor, the naming of the item is intended to establish the type, function and quality required. Unless the name is followed by words indicating that no substitution is permitted, materials or equipment of other manufacturers, fabricators, suppliers or distributors may be accepted by ENGINEER if sufficient information is submitted by CONTRACTOR to allow ENGINEER to determine that the material or equipment proposed is equivalent to that named. The procedure for review by ENGINEER will be as set forth in Paragraphs 6.3.A.1 and 6.3.A.2 below and as supplemented in the General Requirements.

1. Requests for review of substitute items of material and equipment will not be accepted by ENGINEER from anyone other than CONTRACTOR. If CONTRACTOR wishes to furnish or use a substitute item of material or equipment, CONTRACTOR shall make written application to ENGINEER for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified and be suited to the same use as that specified. The application will state that the evaluation and acceptance of the proposed substitute will not prejudice CONTRACTOR'S timely achievement of Substantial Completion, whether or not acceptance of the substitute for use in the Work will require a change in the Drawings

or Specifications to adapt the design to the substitute and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty. All variations of the proposed substitute from that specified shall be identified in the application and available maintenance, repair and replacement service will be indicated. The application will also contain a statement that CONTRACTOR agrees to pay all costs that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change. ENGINEER may require CONTRACTOR to furnish at CONTRACTOR'S expense additional data about the proposed substitute. ENGINEER will be allowed a reasonable time within which to evaluate the proposed substitute. ENGINEER will be the sole judge of acceptability and no substitute will be ordered or installed without ENGINEER'S prior written acceptance. OWNER may require CONTRACTOR to furnish at CONTRACTOR'S expense a special performance guarantee or other surety with respect to any substitute.

2. ENGINEER will record time required by ENGINEER and ENGINEER'S consultants in evaluating substitutions proposed by CONTRACTOR and in making changes in the Drawings or Specifications occasioned thereby. Whether or not ENGINEER accepts a proposed substitute, CONTRACTOR shall reimburse OWNER for the charges of ENGINEER and ENGINEER'S consultants for evaluating any proposed substitute that does not meet the requirements of the Drawings and Specifications.

6.4 Concerning Subcontractors:

A. CONTRACTOR shall not employ any Subcontractor or other person or organization (including those who are to furnish the principal items of materials or equipment), whether initially or as a substitute, against whom OWNER or ENGINEER may have reasonable objection. A Subcontractor or other person or organization identified in writing to OWNER and ENGINEER by CONTRACTOR prior to the Notice of Award and not objected to in writing by OWNER or ENGINEER prior to the Notice of Award will be deemed acceptable to OWNER and ENGINEER. If OWNER or ENGINEER after due investigation has reasonable objection to any Subcontractor, other person or organization proposed by CONTRACTOR after the Notice of Award, CONTRACTOR shall submit an acceptable substitute and the Contract Price shall be increased or decreased by the difference in cost occasioned by such substitution, and an appropriate Change Order shall be issued. CONTRACTOR shall not be required to employ any Subcontractor, other person or organization against whom CONTRACTOR has reasonable objection. Acceptance of any Subcontractor, other person or organization by OWNER or ENGINEER shall not constitute a waiver of any right of OWNER or ENGINEER to reject defective Work.

B. CONTRACTOR shall be fully responsible for all acts and omissions of his Subcontractors and of persons and organizations directly or indirectly employed by them and of persons and organizations for whose acts any of them may be liable to the same extent that CONTRACTOR is responsible for the acts and omissions of persons directly employed by CONTRACTOR. Nothing in the Contract Documents shall create any contractual relationship between OWNER or ENGINEER and any Subcontractor or other person or organization having a direct contract with CONTRACTOR, nor shall it create any obligation on the part of OWNER or ENGINEER to pay or to see to the payment of any moneys due any Subcontractor or other person or organization, except as may otherwise be required by law. OWNER or ENGINEER may furnish to any Subcontractor or other person or

organization, to the extent practicable, evidence of amounts paid to CONTRACTOR on account of specific Work done.

C. The Divisions and Sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or delineating the Work to be performed by any specific trade.

D. All Work performed for CONTRACTOR by a Subcontractor will be pursuant to an appropriate agreement between CONTRACTOR and the Subcontractor which specifically binds the Subcontractor to the applicable terms and conditions of the Contract Documents for the benefit of OWNER and the ENGINEER and contains waiver provisions as required by Paragraph 5.6. CONTRACTOR shall pay each Subcontractor a just share of any insurance moneys received by CONTRACTOR on account of losses under policies issued pursuant to Paragraph 5.5.

6.5 Patent Fees and Royalties:

A. CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of OWNER or ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by OWNER in the Contract Documents. CONTRACTOR shall indemnify and hold harmless OWNER and ENGINEER and anyone directly or indirectly employed by either of them from and against all claims, damages, losses and expenses (including attorneys' fees) arising out of any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product or device not specified in the Contract Documents, and shall defend all such claims in connection with any alleged infringement of such rights.

6.6 Permits:

A. Unless otherwise indicated in the Supplementary Conditions, CONTRACTOR shall obtain and pay for all construction permits and licenses. OWNER shall assist CONTRACTOR, when necessary, in obtaining such permits and licenses. CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable at the time of opening of Bid. CONTRACTOR shall also pay all charges of utility service companies for connections to the Work, and OWNER shall pay all charges of such companies for capital costs related thereto.

6.7 Laws and Regulations:

A. CONTRACTOR shall give all notices and comply with all laws, ordinances, rules and regulations applicable to the Work. If CONTRACTOR observes that the Specifications or Drawings are at variance therewith, CONTRACTOR shall give ENGINEER prompt written notice thereof, and any necessary changes shall be adjusted by an appropriate Modification. If CONTRACTOR performs any Work knowing or having reason to know that it is contrary to

such laws, ordinances, rules and regulations, and without such notice to ENGINEER, CONTRACTOR shall bear all costs arising therefrom; however, it shall not be CONTRACTOR'S primary responsibility to make certain that the Specifications and Drawings are in accordance with such laws, ordinances, rules and regulations.

6.8 Taxes:

A. CONTRACTOR shall pay all sales, consumer, use and other similar taxes required to be paid by him in accordance with the law of the place of the Project.

6.9 Use of Premises:

A. CONTRACTOR shall confine construction equipment, the storage of materials and equipment and the operations of workmen to areas permitted by law, ordinances, permits, or the requirements of the Contract Documents, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment.

B. During progress of the Work, CONTRACTOR shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the Work. At the completion of the Work CONTRACTOR shall remove all waste materials, rubbish and debris from and about the premises as well as all tools, appliances, construction equipment and machinery, and surplus materials, and shall leave the site clean and ready for occupancy by OWNER. CONTRACTOR shall restore to their original condition those portions of the site not designated for alteration by the Contract Documents.

C. CONTRACTOR shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall CONTRACTOR subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.10 Record Documents:

A. CONTRACTOR shall keep one record copy of all Specifications, Drawings, Addenda, Modifications, Shop Drawings and Samples at the site in good order and annotated to show all changes made during the construction process. These shall be available to ENGINEER for examination and shall be delivered to ENGINEER for OWNER upon completion of the Work.

6.11 Safety and Protection:

A. CONTRACTOR shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
   1. All employees on the Work and other persons who may be affected thereby;
   2. All the Work and all materials or equipment to be incorporated therein, whether in storage on or off the site; and
   3. Other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures and utilities

not designated for removal, relocation or replacement in the course of construction.

B. CONTRACTOR shall comply with all applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. CONTRACTOR shall notify owners of adjacent property and utilities when prosecution of the Work may affect them. CONTRACTOR shall cooperate with the utility owner in the protection, removal, relocation or replacement of such utility property. All damage, injury or loss to any property referred to in Paragraph 6.11.A.2 or 6.11.A.3 caused, directly or indirectly, in whole or in part, by CONTRACTOR, any Subcontractor or anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of OWNER or ENGINEER or anyone employed by either of them or anyone for whose acts either of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of CONTRACTOR). CONTRACTOR'S duties and responsibilities for the safety and protection of the Work shall continue until such time as all the Work is completed and ENGINEER has issued a notice to OWNER and CONTRACTOR in accordance with Paragraph 14.9 that the Work is acceptable.

C. CONTRACTOR shall designate a responsible member of his organization at the site whose duty shall be the prevention of accidents. This person shall be CONTRACTOR'S superintendent unless otherwise designated in writing by CONTRACTOR to OWNER.

6.12 Emergencies:

A. In emergencies affecting the safety or protection of persons or the Work or property at the site or adjacent thereto, CONTRACTOR, without special instruction or authorization from ENGINEER or OWNER, is obligated to act to prevent threatened damage, injury or loss. CONTRACTOR shall give ENGINEER prompt written notice of any significant changes in the Work or deviations from the Contract Documents caused thereby.

6.13 Shop Drawings and Samples:

A. After checking and verifying all field measurements, CONTRACTOR shall submit to ENGINEER for review and approval, in accordance with the accepted schedule of Shop Drawing submissions (see Paragraph 2.6) and the procedures specified in the General Requirements, copies of all Shop Drawings, which shall have been checked by and stamped with the approval of CONTRACTOR and identified as ENGINEER may require. The data shown on the Shop Drawings will be complete with respect to dimensions, design criteria, materials of construction and the like to enable ENGINEER to review the information as required.

B. CONTRACTOR shall also submit to ENGINEER for review and approval with such promptness as to cause no delay in Work, all Samples required by the Contract Documents. All Samples will have been checked by and stamped with the approval of CONTRACTOR, identified clearly as to material, manufacturer, any pertinent catalog numbers and the use for which intended.

C. At the time of each submission, CONTRACTOR shall in writing call ENGINEER'S attention to all deviations that the Shop Drawings or Samples may have from the requirements of the Contract Documents.

D. ENGINEER will review and approve with reasonable promptness Shop Drawings and Samples, but ENGINEER'S review and approval shall be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions. CONTRACTOR shall make all corrections required by ENGINEER and shall return the required number of corrected copies of Shop Drawings and resubmit new Samples for review and approval. CONTRACTOR shall direct specific attention in writing to revisions other than the corrections called for by ENGINEER on previous submittals. CONTRACTOR'S stamp of approval on any Shop Drawing or Sample shall constitute a representation to OWNER and ENGINEER that CONTRACTOR has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that CONTRACTOR has reviewed or coordinated each Shop Drawing or Sample with the requirements of the Work and the Contract Documents.

E. Where a Shop Drawing or Sample is required by the Specifications, no related Work shall be commenced until the submittal has been reviewed and approved by ENGINEER.

F. ENGINEER'S review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any deviations from the Contract Documents unless CONTRACTOR has in writing called ENGINEER'S attention to such deviation at the time of submission and ENGINEER has given written concurrence and approval to the specific deviation, nor shall any concurrence and approval by ENGINEER relieve CONTRACTOR from responsibility for errors or omissions in the Shop Drawings or Samples.

6.14 Continuing The Work:

A. CONTRACTOR shall carry on the Work and maintain the progress schedule during all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as CONTRACTOR and OWNER may otherwise agree in writing.

6.15 Indemnification:

A. To the fullest extent permitted by law, CONTRACTOR shall indemnify and hold harmless OWNER and ENGINEER and their agents, employees and consultants from and against all claims, damages, losses and expenses including, but not limited to attorneys' fees arising out of or resulting from the performance of the Work, provided that any such claim, damage, loss or expense (1) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself) including the loss of use resulting therefrom and (2) is caused in whole or in part by either (a) any negligent act or omission of CONTRACTOR, any Subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable regardless of whether or not it is caused in part by a party indemnified hereunder,

or (b) arises out of operation of law as a consequence of any act or omission of CONTRACTOR, any Subcontractor, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, regardless of whether any of them has been negligent.

B. In any and all claims against OWNER or ENGINEER or any of their agents, employees or consultants by any employee of CONTRACTOR, any Subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.15.A shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for CONTRACTOR or any Subcontractor under workers' or workmen's compensation acts, disability benefit acts or other employee benefit acts.

C. The obligations of CONTRACTOR under Paragraph 6.15.A shall not extend to the liability of ENGINEER, his agents, employees or consultants arising out of the ENGINEER's preparation or approval of maps, Drawings, opinions, reports, surveys, Change Orders, designs or Specifications.

ARTICLE 7 - WORK BY OTHERS

7.1 OWNER may perform additional work related to the Project by himself, or have additional work performed by utility service companies, or let other direct contracts therefor which shall contain General Conditions similar to these. CONTRACTOR shall afford the utility service companies and the other contractors who are parties to such direct contracts (or OWNER, if OWNER is performing the additional work with OWNER'S employees) reasonable opportunity for the introduction and storage of materials and equipment and the execution of work, and shall properly connect and coordinate his Work with theirs.

7.2 If any part of CONTRACTOR'S Work depends for proper execution or results upon the work of any such other contractor or utility service company (or OWNER), CONTRACTOR shall inspect and promptly report to ENGINEER in writing any patent or apparent defects or deficiencies in such work that render it unsuitable for such proper execution and results. CONTRACTOR'S failure to so report shall constitute an acceptance of the other work as fit and proper for integration with CONTRACTOR'S Work except for latent defects and deficiencies in the other work.

7.3 CONTRACTOR shall do all cutting, fitting and patching of his Work that may be required to make its several parts come together properly and integrate with such other work. CONTRACTOR shall not endanger any work of others by cutting, excavating or otherwise altering their work and will only cut or alter their work with the written consent of ENGINEER and the others whose work will be affected.

7.4 If the performance of additional work by other contractors or utility service companies or OWNER was not noted in the Contract Documents, written notice thereof shall be given to CONTRACTOR prior to starting any such additional work. If CONTRACTOR believes that the performance of such additional work by OWNER or others involves additional expense or requires an extension of the Contract Time, CONTRACTOR may make a claim therefor as provided in Articles 11 and 12 provided that the CONTRACTOR will make no claim which is barred by the provisions of Paragraph 12.3.

ARTICLE 8 - OWNER'S RESPONSIBILITIES

8.1 OWNER shall issue all communications to CONTRACTOR through ENGINEER.

8.2 In case of termination of the employment of ENGINEER, OWNER shall appoint an engineer whose status under the Contract Documents shall be that of the former ENGINEER.

8.3 OWNER shall furnish the data required of OWNER under the Contract Documents promptly and shall make payments to CONTRACTOR promptly after they are due as provided in Paragraphs 14.4.A and 14.9.A.

8.4 OWNER'S duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.1.A and 4.4.A. Paragraph 4.2.A refers to OWNER'S identifying and making available to CONTRACTOR copies of reports of investigations and tests of subsurface and latent physical conditions at the site or those reports that otherwise may affect performance of the Work which have been utilized by ENGINEER in preparing the Drawings and Specifications.

8.5 OWNER'S responsibilities in respect of purchasing and maintaining insurance are set forth in Article 5.

8.6 In connection with OWNER'S rights to request changes in the Work in accordance with Article 10, OWNER (especially in certain instances as provided in Paragraph 10.4) is obligated to execute Change Orders.

8.7 OWNER'S responsibility in respect of certain inspections, tests and approvals is set forth in Paragraph 13.3.

8.8 In connection with OWNER'S right to stop Work or suspend Work, see Paragraphs 13.5.A and 15.1. Paragraph 15.2.A deals with OWNER'S right to terminate services of CONTRACTOR under some circumstances.

ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION

9.1 Owner's Representative:

A. ENGINEER will be OWNER'S representative during the construction period. The duties and responsibilities and the limitations of authority of ENGINEER as OWNER'S representative during construction are set forth in the Contract Documents and shall not be extended without written consent of OWNER and ENGINEER.

9.2 Visits to Site:

A. ENGINEER will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. ENGINEER may make visits to the site at intervals appropriate to the various stages of construction to observe the progress and quality of the executed Work and to determine, in general, if the Work is proceeding in accordance with the Contract Documents. On the basis of such visits and on-site observations, ENGINEER will inform OWNER of the progress of the Work and will endeavor to guard OWNER against defects and deficiencies in the Work.

9.3 Clarifications and Interpretations:

A. ENGINEER will issue with reasonable promptness such written clarifications or interpretations of the Contract Documents (in the form of Drawings or otherwise) as ENGINEER may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents. If CONTRACTOR believes that a written clarification or interpretation justifies an increase in the Contract Price or Contract Time, CONTRACTOR may make a claim therefor as provided in Articles 11 and 12.

9.4 Rejecting Defective Work:

A. ENGINEER will have authority to disapprove or reject Work which ENGINEER believes to be defective, and will also have authority to require special inspection or testing of the Work as provided in Article 13, whether or not the Work is fabricated, installed or completed.

9.5 Project Representation:

A. If OWNER and ENGINEER agree, ENGINEER will designate a Resident Project Representative to assist ENGINEER in observing the performance of the Work. The duties, responsibilities and limitations of authority of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions. If OWNER designates another agent to represent him at the site who is not ENGINEER'S agent or employee, the duties, responsibilities and limitations of authority of such other person will be as set forth in the Supplementary Conditions.

9.6 Decisions on Disagreements:

A. ENGINEER will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. Claims, disputes and other matters relating to the acceptability of the Work or the interpretation of the requirements of the Contract Documents pertaining to the execution and progress of the Work shall be referred initially to ENGINEER in writing with a request for a formal decision in accordance with this Paragraph, which ENGINEER will render in writing within a reasonable time. Written notice of each such claim, dispute and other matter shall be delivered by the claimant to ENGINEER and the other party to the Agreement within fifteen days of the occurrence of the event giving rise thereto, and written supporting data will be submitted to ENGINEER and the other party within forty-five days of such occurrence unless ENGINEER allows an additional period of time to ascertain more accurate data. In his capacity as interpreter and judge, ENGINEER will not show partiality to OWNER or CONTRACTOR and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

B. The rendering of a decision by ENGINEER pursuant to Paragraph 9.6.A with respect to any such claim, dispute or other matter (except any which have been waived by the making or acceptance of final payment as provided in Paragraph 14.9) will be a condition precedent to any exercise by OWNER or CONTRACTOR of such rights or remedies as either may otherwise have under the Contract Documents or at law in respect of any such claim, dispute or other matter.

9.7 Limitations on Engineer's Responsibilities:

A. Neither ENGINEER'S authority to act under this Article 9 or elsewhere in the Contract Documents nor any decision made by ENGINEER in good faith either to exercise or not exercise such authority shall give rise to any duty or responsibility of ENGINEER to CONTRACTOR, any Subcontractor, any manufacturer, fabricator, supplier or distributor or any of their agents or employees or any other person performing any of the Work.

B. Whenever in the Contract Documents the terms "as ordered", "as directed", "as required", "as allowed", "as approved" or terms of like effect or import are used, or the adjectives "reasonable", "suitable", "acceptable", "proper", or "satisfactory" or adjectives of like effect or import are used to describe a requirement, direction, review or judgement of ENGINEER as to the Work, it is intended that such requirement, direction, review or judgement will be solely to evaluate the Work for compliance with the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective never indicates that ENGINEER shall have authority to supervise or direct performance of the Work or authority to undertake responsibility contrary to the provisions of Paragraphs 9.7.C and 9.7.D.

C. ENGINEER will not be responsible for CONTRACTOR'S means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, and ENGINEER will not be responsible for CONTRACTOR'S failure to perform the Work in accordance with the Contract Documents.

D. ENGINEER will not be responsible for the acts or omissions of CONTRACTOR or of any Subcontractors, or of the agents or employees of any CONTRACTOR or Subcontractor, or of any other persons at the site or otherwise performing any of the Work.

ARTICLE 10 - CHANGES IN THE WORK

10.1 Without invalidating the Agreement, OWNER may, at any time or from time to time, order additions, deletions or revisions in the Work; these will be authorized by Change Orders. Upon receipt of a Change Order, CONTRACTOR shall proceed with the Work involved. All such Work shall be executed under the applicable conditions of the Contract Documents. If any Change Order causes an increase or decrease in the Contract Price or an extension or shortening of the Contract Time, an equitable adjustment will be made as provided in Article 11 or Article 12 on the basis of a claim made by either party.

10.2 ENGINEER may authorize minor changes in the Work not involving an adjustment in the Contract Price or the Contract Time which are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order and shall be binding on OWNER, and also on CONTRACTOR who shall perform the change promptly. If CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or Contract Time, CONTRACTOR may make a claim therefor as provided in Article 11 or Article 12.

10.3 Additional Work performed without authorization of a Change Order

will not entitle CONTRACTOR to an increase in the Contract Price or an extension of the Contract Time, except as provided in Paragraphs 10.2, 13.4.B, and except in the case of an emergency as provided in Paragraph 6.12.

10.4 OWNER shall execute appropriate Change Orders prepared by ENGINEER covering changes in the Work which are required by OWNER, or required because of unforeseen physical conditions or emergencies, or because of uncovering Work found not to be defective, or as provided in Paragraphs 11.6 and 15.1, or because of any other claim of CONTRACTOR for a change in the Contract Time or the Contract Price which is recommended by ENGINEER.

10.5 If notice of any changes affecting the general scope of the Work or change in the Contract Price is required by the provisions of any Bond to be given to the surety, it will be CONTRACTOR'S responsibility to so notify the Surety, and the amount of each applicable Bond shall be adjusted accordingly. CONTRACTOR shall furnish proof of such adjustment to OWNER.

ARTICLE 11 - CHANGE OF CONTRACT PRICE

11.1 The Contract Price constitutes the total compensation (subject to authorized adjustments) payable to CONTRACTOR for performing the Work. All duties, responsibilities and obligations assigned to or undertaken by CONTRACTOR shall be at his expense without change in the Contract Price.

11.2 The Contract Price may only be changed by a Change Order. Any claim for an increase in the Contract Price shall be based on written notice delivered to OWNER and ENGINEER within fifteen days of the occurrence of the event giving rise to the claim. Notice of the amount of the claim with supporting data shall be delivered within forty-five days of such occurrence unless ENGINEER allows an additional period of time to ascertain accurate cost data. All claims for adjustment in the Contract Price shall be determined by ENGINEER if OWNER and CONTRACTOR cannot otherwise agree on the amount involved. Any change in the Contract Price resulting from any such claim shall be incorporated in a Change Order.

11.3 The value of any Work covered by a Change Order or of any claim for an increase or decrease in the Contract Price shall be determined in one of the ways listed herein.

A. Where the Work involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved.

B. By mutual acceptance of a lump sum.

C. On the basis of the Cost of the Work (determined as provided in Paragraph 11.4) plus a Contractor's Fee for overhead and profit (determined as provided in Paragraph 11.5).

D. Whenever the cost of any Work is to be determined pursuant to Paragraphs 11.4.A and 11.4.B, CONTRACTOR will submit in form acceptable to ENGINEER, an itemized cost breakdown together with supporting data.

11.4 Cost of the Work:

A. The term Cost of the Work means the sum of all costs necessarily incurred and paid by CONTRACTOR in the proper performance of the Work. Except as otherwise may be agreed to in writing by OWNER, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any of the costs itemized in Paragraph 11.4.B.

1. Payroll costs for employees in the direct employ of CONTRACTOR in the performance of the Work under schedules of job classifications agreed upon by OWNER and CONTRACTOR. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits which shall include social security contributions, unemployment, excise and payroll taxes, workers' or workmen's compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. Such employees shall include superintendents and foremen at the site. The expenses of performing Work after regular working hours, on Saturday, Sunday or legal holidays shall be included in the above to the extent authorized by OWNER.
2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and manufacturers' field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR unless OWNER deposits funds with CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to OWNER. All trade discounts, rebates and refunds, and all returns from sale of surplus materials and equipment shall accrue to OWNER, and CONTRACTOR shall make provisions so that they may be obtained.
3. Payments made by CONTRACTOR to the Subcontractors for Work performed by Subcontractors. If required by OWNER, CONTRACTOR shall obtain competitive bids from Subcontractors acceptable to CONTRACTOR and shall deliver such bids to OWNER who will then determine, with the advice of ENGINEER, which bids will be accepted. If a subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work Plus a Fee, the Subcontractor's Cost of the Work shall be determined in the same manner as CONTRACTOR'S Cost of the Work. All subcontracts shall be subject to the other provisions of the Contract Documents insofar as applicable.
4. Costs of special consultants (including, but not limited to, engineers, architects, testing laboratories, surveyors, lawyers and accountants) employed for services specifically related to the Work.
5. Supplemental costs including the following:
   a. The proportion of necessary transportation, travel and subsistence expenses of CONTRACTOR'S employees incurred in discharge of duties connected with the Work.
   b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the site and hand tools not owned by the workmen, which are consumed in the performance of the Work, and cost less market value of such items used but not consumed which remain the property of CONTRACTOR.
   c. Rentals of all construction equipment and machinery and the parts thereof whether rented from CONTRACTOR or others in accordance with rental agreements approved by OWNER with the advice of ENGINEER, and the costs of transportation, loading, unloading,

installation, dismantling and removal thereof--all in accordance with terms of said rental agreements. The rental of any such equipment, machinery or parts shall cease when the use thereof is no longer necessary for the Work.

d. Sales, use or similar taxes related to the Work, and for which CONTRACTOR is liable, imposed by any governmental authority.

e. Deposits lost for causes other than CONTRACTOR'S negligence, royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses), not compensated by insurance or otherwise, to the Work or otherwise sustained by CONTRACTOR in connection with the execution of the Work, provided they have resulted from causes other than the negligence of CONTRACTOR,any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of OWNER. No such losses, damages and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's Fee. If, however, any such loss or damage requires reconstruction and CONTRACTOR is placed in charge thereof, CONTRACTOR shall be paid for services a fee proportionate to that stated in Paragraph 11.5.

g. The cost of utilities, fuel and sanitary facilities at the site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the site, expressage and similar petty cash items in connection with the Work.

i. Cost of premiums for additional Bonds and insurance required because of changes in the Work.

B. The term Cost of the Work shall not include any of the following:

1. Payroll costs and other compensation of CONTRACTOR'S officers, executives, principals (of partnership and sole proprietorships), general managers, engineers, architects, estimators, lawyers, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks and other personnel employed by CONTRACTOR whether at the site or in his principal or a branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.4.A.1 - all of which are to be considered administrative costs covered by the CONTRACTOR'S Fee.
2. Expenses of CONTRACTOR'S principal and branch offices other than CONTRACTOR'S office at the site.
3. Any part of CONTRACTOR'S capital expenses, including interest on CONTRACTOR'S capital employed for the Work and charges against CONTRACTOR for delinquent payments.
4. Cost of premiums for all Bonds and for all insurance whether or not CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except for additional Bonds and insurance required because of changes in the Work).
5. Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied and making good any damage to property.
6. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 11.4.A.

11.5 Contractor's Fee:

A. The Contractor's Fee allowed to CONTRACTOR for overhead and profit shall be determined as follows:
   1. A mutually acceptable fixed fee; or if none can be agreed upon.
   2. A fee based on the following percentages of the various portions of the Cost of the Work:
      a. For costs incurred under Paragraphs 11.4.A.1 and 11.4.A.2, the Contractor's Fee shall not exceed a total of twenty percent (ten percent for overhead and ten percent for profit).
      b. For costs incurred under Paragraph 11.4.A.3, the Contractor's Fee shall not exceed a total of five percent; and if a subcontract is on the basis of Cost of the Work Plus a Fee, the maximum allowable to the Subcontractor as a fee for overhead and profit shall not exceed a total of twenty percent.
      c. No fee shall be payable on the basis of costs itemized under Paragraphs 11.4.A.4, 11.4.A.5 and 11.4.B.
      d. The amount of credit to be allowed by CONTRACTOR to OWNER for any such change which results in a net decrease in cost, will be the amount of the net decrease plus a deduction in Contractor's Fee by an amount equal to ten percent of the net decrease.
      e. When both additions and credits are involved in any one change, the adjustment in Contractor's Fee shall be computed on the basis of the net change in accordance with Paragraphs 11.5.A.2.a through 11.5.A.2.d, inclusive.

11.6 Cash Allowances:

A. It is understood that CONTRACTOR has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be done by such Subcontractors, manufacturers, fabricators, suppliers or distributors and for such sums within the limit of the allowances as may be acceptable to ENGINEER. Upon final payment, the Contract Price shall be adjusted as required and an appropriate Change Order issued. CONTRACTOR agrees that the original Contract Price includes such sums as CONTRACTOR deems proper for costs and profit on account of cash allowances. No demand for additional cost or profit in connection therewith will be allowed.

ARTICLE 12 - CHANGE OF THE CONTRACT TIME

12.1 The Contract Time may only be changed by a Change Order. Any claim for an extension in the Contract Time shall be based on written notice delivered to OWNER and ENGINEER within fifteen days of the occurrence of the event giving rise to the claim. Notice of the extent of the claim with supporting data shall be delivered within forty-five days of such occurrence unless ENGINEER allows an additional period of time to ascertain more accurate data. All claims for adjustment in the Contract Time shall be determined by ENGINEER if OWNER and CONTRACTOR cannot otherwise agree. Any change in the Contract Time resulting from any such claim shall be incorporated in a Change Order.

12.2 The Contract Time will be extended in an amount equal to time lost due to delays beyond the control of CONTRACTOR if a claim is made therefor as provided in Paragraph 12.1. Such delays shall include, but not be limited to, acts or neglect by OWNER or others performing additional work

as contemplated by Article 7, or to fires, floods, labor disputes, epidemics, abnormal weather conditions, or acts of God. No extension of the Contract Time will be granted where the delay is attributable to a Subcontractor, manufacturer, fabricator, supplier or distributor or any other party performing services or furnishing material or equipment on behalf of the CONTRACTOR unless such party's delay is attributable to one of the above enumerated causes.

12.3 The time limits concerning Substantial Completion and final completion as stated in the Contract Documents are of the essence. The provisions of this Article 12 shall not exclude recovery for damages (including compensation for additional professional services) for delay by either party, provided, however that CONTRACTOR shall not be entitled to damages for any delay occurring as a consequence of a delay in additional work being performed by others pursuant to Paragraph 7.1 hereof if the performance of said additional work was noted in the Contract Documents and the delay (by others) was not directly caused by the fault of OWNER.

ARTICLE 13 - WARRANTY AND GUARANTEE; TESTS AND INSPECTION; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.1 Warranty and Guarantee:

A. CONTRACTOR warrants and guarantees to OWNER and ENGINEER that all Work will be in accordance with the Contract Documents and will not be defective. Prompt notice of all defects shall be given to CONTRACTOR. All defective Work, whether or not in place, may be rejected or corrected as provided in this Article 13.

13.2 Access to Work:

A. ENGINEER and ENGINEER'S representatives, other representatives of OWNER, testing agencies and governmental agencies with jurisdictional interests will have access to the Work at reasonable times for their observation, inspection and testing. CONTRACTOR shall provide proper and safe conditions for such access.

13.3 Tests and Inspections:

A. CONTRACTOR shall give ENGINEER timely notice of readiness of the Work for all required inspections, tests or approvals.

B. If any law, ordinance, rule, regulation, code, or orders of any public body having jurisdiction requires any Work (or part thereof) to specifically be inspected, tested or approved, CONTRACTOR (unless another party is specified in the General Requirements) shall assume full responsibility therefor, pay all costs in connection therewith and furnish ENGINEER the required certificates of inspection, testing or approval. CONTRACTOR shall also be responsible for and shall pay all costs in connection with any inspection or testing required by the Specifications in connection with OWNER'S or ENGINEER'S acceptance of a manufacturer, fabricator, supplier or distributor of materials or equipment proposed to be incorporated in the Work, or of materials or equipment submitted for approval prior to CONTRACTOR'S purchase thereof for incorporation in the Work. The cost of all other inspections, tests and approvals required by the Contract Documents shall be paid by OWNER (unless otherwise specified).

C. All inspections, tests or approvals other than those required by law, ordinance, rule, regulation, code or order of any public body having jurisdiction shall be performed by organizations acceptable to OWNER (or by ENGINEER if so specified).

D. If any Work that is to be inspected, tested or approved is covered without written concurrence of ENGINEER, it must, if requested by ENGINEER, be uncovered for observation. Such uncovering shall be at CONTRACTOR'S expense unless CONTRACTOR has given ENGINEER timely notice of CONTRACTOR'S intention to cover such Work and ENGINEER has not acted with reasonable promptness in response to such notice.

E. Neither observations by ENGINEER nor inspections, tests or approvals by others shall relieve CONTRACTOR from his obligations to perform the Work in accordance with the Contract Documents.

13.4 Uncovering Work:

A. If any Work is covered contrary to the written request of ENGINEER, it must, if requested by ENGINEER, be uncovered for ENGINEER'S observation and replaced at CONTRACTOR'S expense.

B. If ENGINEER considers it necessary or advisable that covered Work be observed by ENGINEER or inspected or tested by others, CONTRACTOR, at ENGINEER'S request, shall uncover, expose or otherwise make available for observation, inspection or testing as ENGINEER may require, that portion of the Work in question, furnishing all necessary labor, material and equipment. If it is found that such Work is defective, CONTRACTOR shall bear all the expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction, including compensation for additional professional services, and an appropriate deductive Change Order shall be issued. If, however, such Work is not found to be defective, CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing and reconstruction if he makes a claim therefor as provided in Articles 11 and 12.

13.5 Owner May Stop the Work:

A. If the Work is defective, or CONTRACTOR fails to supply sufficient skilled workmen or suitable materials or equipment, OWNER may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of OWNER to stop the Work shall not give rise to any duty on the part of OWNER to exercise this right for the benefit of CONTRACTOR or any other party.

13.6 Correction or Removal of Defective Work:

A. If required by ENGINEER, CONTRACTOR shall promptly, without cost to OWNER and as specified by ENGINEER, either correct any defective Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by ENGINEER, remove it from the site and replace it with nondefective Work.

13.7 One Year Correction Period:

A. If, within one year after the date of Substantial Completion or such longer period of time as may be prescribed by law or by the terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents, any Work is found to be defective, CONTRACTOR shall promptly, without cost to OWNER and in accordance with OWNER'S written instructions, either correct such defective Work, or, if it has been rejected by OWNER, remove it from the site and replace it with nondefective Work. If CONTRACTOR does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, OWNER may have the defective Work corrected or the rejected Work removed and replaced, and all direct and indirect costs of such removal and replacement, including compensation for additional professional services, shall be paid by CONTRACTOR.

13.8 Acceptance of Defective Work:

A. If, instead of requiring correction or removal and replacement of defective Work, OWNER (and, prior to ENGINEER'S recommendation of final payment, also ENGINEER) prefers to accept it, OWNER may do so. In such case, if acceptance occurs prior to ENGINEER'S recommendation of final payment, a Change Order shall be issued incorporating the necessary revisions in the Contract Documents, including appropriate reduction in the Contract Price; or, if the acceptance occurs after such recommendation, an appropriate amount shall be paid by CONTRACTOR to OWNER.

B. OWNER may require CONTRACTOR to furnish, at CONTRACTOR'S expense, a special performance guarantee or other surety prior to acceptance of defective Work.

13.9 Owner May Correct Defective Work:

A. If CONTRACTOR fails within a reasonable time after written notice of ENGINEER to proceed to correct and to correct defective Work or to remove and replace rejected Work as required by ENGINEER in accordance with Paragraph 13.6, or if CONTRACTOR fails to perform the Work in accordance with the Contract Documents (including any requirements of the progress schedule), OWNER may, after seven days' written notice to CONTRACTOR, correct and remedy any such deficiency. In exercising his rights under this Paragraph, OWNER shall proceed expeditiously. To the extent necessary to complete corrective and remedial action, OWNER may exclude CONTRACTOR from all or part of the site, take possession of all or part of the Work, and suspend CONTRACTOR'S services related thereto, take possession of CONTRACTOR'S tools, appliances, construction equipment and machinery at the site and incorporate in the Work all materials and equipment stored at the site or for which OWNER has paid CONTRACTOR but which are stored elsewhere. CONTRACTOR shall allow OWNER, OWNER'S representatives, agents and employees such access to the site as may be necessary to enable OWNER to exercise his rights under this Paragraph. All direct and indirect costs of OWNER in exercising such rights shall be charged against CONTRACTOR in an amount verified by ENGINEER, and a Change Order shall be issued incorporating the necessary revisions in the Contract Documents and a reduction in the Contract Price. Such direct and indirect costs shall include, in particular but without limitation, compensation for additional professional services required and all costs

of repair and replacement of work of others destroyed or damaged by correction, removal or replacement of CONTRACTOR'S defective Work. CONTRACTOR shall not be allowed an extension of the Contract Time because of any delay in his performance of the Work attributable to the exercise by OWNER of OWNER'S rights hereunder.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

14.1 Schedules:

A. At least twenty days prior to submitting the first application for a progress payment, CONTRACTOR shall (except as otherwise specified in the General Requirements) submit to ENGINEER a progress schedule, a final schedule of Shop Drawings submission and where applicable, a schedule of values of the Work. These schedules shall be satisfactory in form and substance to ENGINEER. The schedule of values shall include quantities and unit prices aggregating the Contract Price, and shall subdivide the Work into component parts in sufficient detail to serve as the basis for progress payments during construction. Upon acceptance of the schedule of values by ENGINEER, it shall be incorporated into a form of Application for Payment acceptable to ENGINEER.

14.2 Application for Progress Payment:

A. At least ten days before each application for a progress payment falls due (but not more often than once a month), CONTRACTOR shall submit to ENGINEER for review an Application for Payment filled out and signed by CONTRACTOR covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents and also as ENGINEER may reasonably require. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the site or at another location agreed to in writing, the Application for Payment shall also be accompanied by such data, satisfactory to OWNER, as will establish OWNER'S title to the material and equipment and protect OWNER'S interest therein, including applicable insurance. Each subsequent Application for Payment shall include an affidavit of CONTRACTOR stating that all previous progress payments received on account of the Work have been applied to discharge in full all of CONTRACTOR'S obligations reflected in prior Applications for Payment. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

14.3 Contractor's Warranty of Title:

A. CONTRACTOR warrants and guarantees that title to all Work, materials and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to OWNER at the time of payment free and clear of all liens, claims, security interests and encumbrances (hereafter in these General Conditions referred to as "Liens").

14.4 Review of Applications for Progress Payments:

A. ENGINEER will, within ten days after receipt of each Application for Payment, either indicate in writing his recommendation of payment and present the Application to OWNER, or return the Application to CONTRACTOR indicating in writing ENGINEER'S reasons for refusing to recommend payment. In the latter case, CONTRACTOR may make the necessary cor-

rections and resubmit the Application. OWNER shall, within thirty days of presentation to him of the Application for Payment with ENGINEER's recommendation, pay CONTRACTOR the amount recommended.

B. ENGINEER'S recommendation of any payment requested in an Application for Payment will constitute a representation by ENGINEER to OWNER, based on ENGINEER'S on-site observations of the Work in progress as an experienced and qualified design professional and on ENGINEER'S review of the Application for Payment and the accompanying data and schedules that the Work has progressed to the point indicated; that, to the best of ENGINEER'S knowledge, information and belief, the quality of the Work is in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning Project upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents and any qualifications stated in the recommendation); and that CONTRACTOR is entitled to payment of the amount recommended. However, by recommending any such payment ENGINEER will not thereby be deemed to have represented that exhaustive or continuous on-site inspections have been made to check the quality or the quantity of the Work, or that the means, methods, techniques, sequences, and procedures of construction have been reviewed, or that any examination has been made to ascertain how or for what purpose CONTRACTOR has used the moneys paid or to be paid to CONTRACTOR on account of the Contract Price, or that title to any Work, materials or equipment has passed to OWNER free and clear of any Liens.

C. ENGINEER'S recommendation of final payment will constitute an additional representation by ENGINEER to OWNER that the conditions precedent to CONTRACTOR'S being entitled to final payment as set forth in Paragraph 14.9 have been fulfilled.

D. ENGINEER may refuse to recommend the whole or any part of any payment if, in ENGINEER'S opinion, it would be incorrect to make such representations to OWNER. ENGINEER may also refuse to recommend any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended, to such extent as may be necessary in ENGINEER'S opinion to protect OWNER from loss because:
   1. The Work is defective, or completed Work has been damaged requiring correction or replacement,
   2. Written claims have been made against OWNER or Liens have been filed in connection with the Work,
   3. The Contract Price has been reduced because of Modifications,
   4. OWNER has been required to correct defective Work or complete the Work in accordance with Paragraph 13.9,
   5. Of CONTRACTOR'S unsatisfactory prosecution of the Work in accordance with the Contract Documents, or
   6. CONTRACTOR'S failure to make payment to Subcontractors for labor, materials or equipment.

14.5 Substantial Completion:

A. When CONTRACTOR considers the entire Work ready for its intended use, CONTRACTOR shall, in writing to OWNER and ENGINEER, certify that the entire Work is substantially complete and request that ENGINEER issue a certificate of Substantial Completion. Within a reasonable time thereafter, OWNER, CONTRACTOR and ENGINEER shall make an inspection of the Work to determine the status of completion. If ENGINEER does not consider the

Work substantially complete, ENGINEER will notify CONTRACTOR in writing giving his reasons therefor. If ENGINEER considers the Work substantially complete, ENGINEER will prepare and deliver to OWNER a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. OWNER shall have seven days after receipt of the tentative certificate during which OWNER may make written objection to ENGINEER as to any provisions of the certificate or attached list. If, after considering such objections, ENGINEER concludes that the Work is not substantially complete, ENGINEER will within fourteen days after submission of the tentative certificate to OWNER notify CONTRACTOR in writing, stating his reasons therefor. If, after consideration of OWNER'S objections, ENGINEER considers the Work substantially complete, ENGINEER will within said fourteen days execute and deliver to OWNER and CONTRACTOR a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as ENGINEER believes justified after consideration of any objections from OWNER. At the time of delivery of the tentative certificate of Substantial Completion ENGINEER will deliver to OWNER and CONTRACTOR a written recommendation as to division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities and insurance. Unless OWNER and CONTRACTOR agree otherwise in writing and so inform ENGINEER prior to his issuing the definitive certificate of Substantial Completion ENGINEER'S aforesaid recommendation will be binding on OWNER and CONTRACTOR until final payment.

B. OWNER shall have the right to exclude CONTRACTOR from the Work after the date of Substantial Completion, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the tentative list.

14.6 Partial Utilization:

A. Use by OWNER of completed portions of the Work may be accomplished prior to Substantial Completion of all the Work subject to the following:

1. OWNER at any time may request CONTRACTOR in writing to permit OWNER to use any part of the Work which OWNER believes to be substantially complete and which may be used without significant interference with construction of the other parts of the Work. If CONTRACTOR agrees, CONTRACTOR will certify to OWNER and ENGINEER that said part of the Work is substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time thereafter OWNER, CONTRACTOR and ENGINEER shall make an inspection of that part of the Work to determine its status of completion. If ENGINEER does not consider that part of the Work to be substantially complete, ENGINEER will notify OWNER and CONTRACTOR in writing giving his reason therefor. If ENGINEER considers that part of the Work to be substantially complete, ENGINEER will execute and deliver to OWNER and CONTRACTOR a certificate to that effect, fixing the date of Substantial Completion as to that part of the Work, attaching thereto a tentative list of items to be completed or corrected before final payment. Prior to issuing a certificate of Substantial Completion as to part of the Work, ENGINEER will deliver to OWNER and CONTRACTOR a written recommendation as to the division of responsibilities pending final payment between OWNER and CONTRACTOR, with respect to security, operation, safety,

maintenance, utilities and insurance for that part of the Work which shall become binding upon OWNER and CONTRACTOR at the time of issuing the definitive certificate of Substantial Completion as to that part of the Work, unless OWNER and CONTRACTOR shall have otherwise agreed in writing and so informed ENGINEER. OWNER shall have the right to exclude CONTRACTOR from any part of the Work which ENGINEER has so certified to be substantially complete, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the tentative list.

2. In lieu of the issuance of a Certificate of Substantial Completion as to part of the Work, OWNER may take over operation of a facility constituting part of the Work whether or not it is substantially complete if such facility is functionally and separately useable; provided that prior to any such take over, OWNER and CONTRACTOR have agreed as to the division of responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, correction period, heat, utilities and insurance with respect to such facility.
3. No occupancy of part of the Work or taking over of operations of a facility will be accomplished prior to compliance with the requirements of Paragraph 5.8, in respect of property insurance.

14.7 Final Inspection:

A. Upon written notice from CONTRACTOR that the Work is complete, ENGINEER will make a final inspection with OWNER and CONTRACTOR and will notify CONTRACTOR in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. CONTRACTOR shall immediately take such measures as are necessary to remedy such deficiencies.

14.8 Final Application for Payment:

A. After CONTRACTOR has completed all such corrections to the satisfaction of ENGINEER and delivered all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, marked up record documents, and other documents -- all as required by the Contract Documents, and after ENGINEER has indicated that the Work is acceptable (subject to the provisions of Paragraph 14.10) CONTRACTOR may make application for final payment following the procedure for progress payments. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents and such other data and schedules as ENGINEER may reasonably require, together with complete and legally effective releases or waivers (satisfactory to OWNER) of all Liens arising out of or filed in connection with the Work. In lieu thereof and as approved by OWNER, CONTRACTOR may furnish receipts or releases in full; an affidavit of CONTRACTOR that the releases and receipts include all labor, services, material and equipment for which a Lien could be filed, and that all payrolls, material and equipment bills, and other indebtedness connected with the Work for which OWNER or his property might in any way be responsible, have been paid or otherwise satisfied; and consent of the Surety, if any, to final payment. If any Subcontractor, manufacturer, fabricator, supplier or distributor fails to furnish a release or receipt in full, CONTRACTOR may furnish a Bond or other collateral satisfactory to OWNER to indemnify OWNER against any Lien.

14.9 Final Payment and Acceptance:

A. If, on the basis of ENGINEER'S observation of the Work during construction and final inspection and ENGINEER'S review of the final Application for Payment and accompanying documentation -- all as required by the Contract Documents, ENGINEER is satisfied that the Work has been completed and CONTRACTOR has fulfilled all of his obligations under the Contract Documents, ENGINEER will, within ten days after receipt of the final Application for Payment, indicate in writing his recommendation of payment and present the Application to OWNER for payment. Thereupon ENGINEER will give written notice to OWNER and CONTRACTOR that the Work is acceptable subject to the provisions of Paragraph 14.11. Otherwise, ENGINEER will return the Application to CONTRACTOR indicating in writing the reasons for refusing to recommend final payment in which case CONTRACTOR shall make the necessary corrections and resubmit the Application. If the Application and accompanying documentation are appropriate as to form and substance, OWNER shall, within thirty days after receipt thereof, pay CONTRACTOR the amount recommended by ENGINEER.

B. If, through no fault of CONTRACTOR, final completion is materially delayed and if ENGINEER so confirms, OWNER shall, upon receipt of CONTRACTOR'S final Application for Payment and recommendation of ENGINEER, and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by OWNER for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required in Paragraph 5.1, the written consent of the Surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by CONTRACTOR to ENGINEER with his Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

14.10 Contractor's Continuing Obligation:

A. CONTRACTOR'S obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. Neither recommendation of any progress or final payment by ENGINEER, nor the issuance of a certificate of Substantial Completion, nor any payment by OWNER to CONTRACTOR under the Contract Documents, nor any use or occupancy of the Work or any part thereof by OWNER, nor any act of acceptance by OWNER nor any failure to do so, nor the issuance of a notice of acceptability by ENGINEER pursuant to Paragraph 14.9, nor any correction of defective Work by OWNER shall constitute an acceptance of Work not in accordance with the Contract Documents or a release of CONTRACTOR'S obligation to perform the Work in accordance with the Contract Documents.

14.11 Waiver of Claims:

A. The making and acceptance of final payment shall constitute:
   1. A waiver of all claims by OWNER against CONTRACTOR, except claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.7.A or from failure to comply with the Contract Documents or the terms of any special guarantees specified therein; however it shall not constitute a waiver by the OWNER of any rights in respect of CONTRACTOR'S continuing obligations under the Contract Documents; and
   2. A waiver of all claims by CONTRACTOR against OWNER other than those previously made in writing and still unsettled.

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

15.1 Owner May Suspend Work:

A. OWNER may, at any time and without cause, suspend the Work or any portion thereof for a period of not more than ninety days by notice in writing to CONTRACTOR and ENGINEER which shall fix the date on which Work shall be resumed. CONTRACTOR shall resume the Work on the date so fixed. CONTRACTOR will be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to any suspension if he makes a claim therefor as provided in Articles 11 and 12.

15.2 Owner May Terminate:

A. Upon the occurrence of any one or more of the following events:
1. If CONTRACTOR is adjudged a bankrupt or insolvent,
2. If CONTRACTOR makes a general assignment for the benefit of creditors,
3. If a trustee or receiver is appointed for CONTRACTOR or for any of CONTRACTOR'S property,
4. If CONTRACTOR files a petition to take advantage of any debtor's act, or to reorganize under the bankruptcy or similar laws,
5. If CONTRACTOR repeatedly fails to supply sufficient skilled workmen or suitable materials or equipment,
6. If CONTRACTOR repeatedly fails to make prompt payments to Subcontractors or for labor, materials or equipment,
7. If CONTRACTOR disregards laws, ordinances, rules, regulations or orders of any public body having jurisdiction,
8. If CONTRACTOR disregards the authority of ENGINEER, or
9. If CONTRACTOR otherwise violates in any substantial way any provisions of the Contract Documents,

OWNER may after giving CONTRACTOR and his Surety seven days' written notice, terminate the services of CONTRACTOR, exclude CONTRACTOR from the site and take possession of the Work and of all CONTRACTOR'S tools, appliances, construction equipment and machinery at the site and use the same to the full extent they could be used by CONTRACTOR (without liability to CONTRACTOR for trespass or conversion), incorporate in the Work all materials and equipment stored at the site or for which OWNER has paid CONTRACTOR but which are stored elsewhere, and finish the Work as OWNER may deem expedient. In such case CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds the direct and indirect costs of completing the Work, including compensation for additional professional services, such excess shall be paid to CONTRACTOR. If such costs exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such costs incurred by OWNER shall be verified by ENGINEER and incorporated in a Change Order, but in finishing the Work OWNER shall not be required to obtain the lowest figure for the Work performed.

B. Where CONTRACTOR'S services have been so terminated by OWNER, the termination shall not affect any rights of OWNER against CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of moneys due CONTRACTOR by OWNER will not release CONTRACTOR from liability.

C. Upon seven days' written notice to CONTRACTOR and ENGINEER, OWNER may, without cause and without prejudice to any other right or remedy, elect

to abandon the Work and terminate the Agreement. In such case, CONTRACTOR shall be paid for all Work executed and any expense sustained plus reasonable termination expenses.

15.3 Contractor May Stop Work or Terminate:

A. If, through no act or fault of CONTRACTOR, the Work is suspended for a period of more than ninety days by OWNER or under an order of court or other public authority, or ENGINEER fails to act on any Application for Payment within thirty days after it is submitted, or OWNER fails for thirty days to pay CONTRACTOR any sum finally determined to be due, then CONTRACTOR may, upon seven days' written notice to OWNER and ENGINEER, terminate the Agreement and recover from OWNER payment for all Work executed and any expense sustained plus reasonable termination expenses. In addition and in lieu of terminating the Agreement, if ENGINEER has failed to act on an Application for Payment or OWNER has failed to make any payment as aforesaid, CONTRACTOR may upon seven days' written notice to OWNER and ENGINEER stop the Work until payment of all amounts then due. The provision of this paragraph shall not relieve CONTRACTOR of his obligations under Paragraph 6.14 to carry on the Work in accordance with the progress schedule and without delay during disputes and disagreements with OWNER.

ARTICLE 16 - DISPUTE RESOLUTION

16.1 Unless otherwise provided in the Supplementary Conditions, all claims, disputes and other matters in question between OWNER and CONTRACTOR arising out of, or relating to the Contract Documents or the breach thereof, except for claims which have been waived by the making or acceptance of final payment as provided by Paragraph 14.11, shall be decided by the courts of the jurisdiction in which the Project is located.

16.2 In the case of any dispute that is required to be referred to ENGINEER initially for decision in accordance with Paragraph 9.6, no legal proceeding shall be instituted prior to the earlier of (a) the date on which ENGINEER has rendered a decision, or (b) the tenth day after the parties have presented their evidence to ENGINEER; and no proceeding with respect to such dispute shall be made later than thirty days after the date on which ENGINEER has rendered a written decision in respect thereof.

ARTICLE 17 - MISCELLANEOUS

17.1 Giving Notice:

A. Whenever any provision of the Contract Documents requires the giving of written notice it shall be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of notice.

17.2 Computation of Time:

A. When any period of time is referred to in the Contract Documents by days, it shall be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day shall be omitted from the computation.

17.3 General:

A. Should OWNER or CONTRACTOR suffer injury or damage to his person or property because of any error, omission or act of the other party or of any of the other party's employees or agents or others for whose acts the other party is legally liable, claim shall be made in writing to the other party within a reasonable time of the first observance of such injury or damage.

B. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and, in particular but without limitation, the warranties, guarantees and obligations imposed upon CONTRACTOR, by Paragraphs 6.15, 13.1, 13.6, 13.9, 14.3 and 15.2 and all of the rights and remedies available to OWNER and ENGINEER thereunder, shall be in addition to, and shall not be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by law or contract, by special warranty or guarantee or by other provisions of the Contract Documents, and the provisions of this Paragraph shall be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right and remedy to which they apply. All representations, warranties and guarantees made in the Contract Documents shall survive final payment and termination or completion of this Agreement.

17.4 Headings:

A. The Article and Paragraph headings are inserted for convenience only and do not constitute part of these General Conditions.

SUPPLEMENTARY CONDITIONS

(These Supplementary Conditions amend or supplement the General Conditions and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect.)

TABLE OF ARTICLES

1. Definitions
2. Physical Conditions; Investigations and Reports
3. Insurance
4. Concerning Subcontractors
5. Permits
6. Taxes
7. Safety and Health Regulations
8. Night, Saturday, Sunday and Holiday Work Hours
9. Conformity With Contract Documents and Allowable Deviations
10. Assignment
11. Personal Liability
12. Property Rights in Materials
13. Partial Invalidity
14. Attorneys' Fees
15. Waiver of Rights
16. No Kick-Back Certification
17. Project Representation: Duties, Responsibilities and Limitations of the Resident Project Representative

ARTICLE 1 - DEFINITIONS

1.1 The terms used in these Supplementary Conditions which are defined in the General Conditions have the meanings assigned to them in the General Conditions.

ARTICLE 2 - PHYSICAL CONDITIONS; INVESTIGATIONS AND REPORTS

2.1 In preparation of Drawings and Specifications, ENGINEER has relied upon the following report of explorations and tests of subsurface conditions at the sites of the Work.

A. Report of Soil Investigation for Malcolm Pirnie, Inc., Thunderbird Paseo Wastewater Reclamation Facility, 14910 N. 67th Avenue, Glendale, Arizona, dated November 23, 1988.

2.2 The above-named subsurface investigation reports are available at the Office of Malcolm Pirnie Inc., 4636 East University Drive, Suite No. 150, Phoenix, Arizona 85034-7408. Copies of the reports are available at the cost (non- refundable) of reproduction.

2.3 Each prospective Bidder, who examines or obtains a copy of the subsurface investigation report, will be required to sign on a sheet and give his name, and the name and address of the company, firm or corporation he represents.

ARTICLE 3 - INSURANCE

3.1 CONTRACTOR shall obtain insurance coverage of the types and amount required in this Article and keep such insurance coverage in force throughout the life of this Contract. The CONTRACTOR will provide satisfactory certificates of the required coverage to the OWNER (Management Services Department) before beginning work. All policies will contain an endorsement providing that written notice be given to the OWNER at least thirty (30) calendar days prior to termination, cancellation, or reduction in coverage in any policy. Insurance policies shall remain in force until all work has been completed and the project has been accepted by the OWNER. If a policy does expire during the life of the Contract, a renewal certificate of the required coverage must be sent to the OWNER not less than five (5) days prior to expiration date.

3.2 CONTRACTOR shall obtain insurance policies approved by the State of Arizona and acceptable to the City of Glendale. In addition, the City of Glendale shall be included as an additional insured except Workmen's Compensation and Professional Liability and the CONTRACTOR'S General, Automobile, and Excess Liability insurance policies shall be primary over any insurance available to the OWNER and as to any claims resulting from this Contract, it being the intention of the parties that the insurance policies so effected shall protect both parties and be primary coverage for any and all losses covered by the described insurance.

3.3 Insurers must be authorized to do business and have an agent for service of process in Arizona and have an "A" policyholder's rating and a financial rating of at least Class XI in accordance with the most current Best's Rating.

3.4 All certificates of insurance shall be approved by the OWNER'S Management Services Director <u>prior to the inception of any work</u>.

3.5 Each certificate shall include the job site and project number. Coverage shown on certificate of insurance must coincide with the requirements in the text of the Contract Documents.

3.6 If any of the required insurance policies are not renewed prior to expiration, payments to the CONTRACTOR will be withheld until these requirements have been met, or at the option of the OWNER, the OWNER may pay the renewal premium and withhold such payments from any monies due the CONTRACTOR.

3.7 Failure of the CONTRACTOR to take out and/or maintain or the taking out and/or maintenance of any required insurance, shall not relieve the CONTRACTOR from any liability under the Agreement, nor shall the insurance requirements be construed to conflict with or otherwise limit the obligations of the CONTRACTOR concerning indemnification.

3.8 In the event that claims in excess of the insured amounts provided herein are filed by reason of any operations under the Agreement, the amount of excess of such claims, or any portion thereof, may be withheld from payment due or to become due the CONTRACTOR until such time as the CONTRACTOR shall furnish such additional security covering such claims as may be determined by the City of Glendale.

3.9 Any and all deductibles in the insurance policies purchased by the CONTRACTOR shall be assumed by and be for the account of, and at the sole risk of the CONTRACTOR.

3.10 Nothing contained in the insurance requirements in these Contract Documents shall be construed as limiting the liability of the CONTRACTOR or the CONTRACTOR'S sureties.

ARTICLE 4 - CONCERNING SUBCONTRACTORS

4.1 Bidders shall submit with the Bid a list of all major subcontractors and other persons and organizations (including those who are to furnish the principal items of material and equipment) that the Bidder proposes to utilize on this Contract, as stated in the Instructions to Bidders.

ARTICLE 5 - PERMITS

5.1 City of Glendale permits will be required for all Work performed within the City.

5.2 Building permits and permits to perform Work within the rights-of-way will be issued by the City to the CONTRACTOR without a fee or charge.

5.3 Water, sewer and landfill permit fees will not be waived and must be paid for by the CONTRACTOR.

5.4 Any additional bonds and/or insurances required as a condition of any permit will be obtained and paid for by the CONTRACTOR.

ARTICLE 6 - TAXES

6.1 All sales and use taxes, as well as other taxes that might lawfully be assessed against the Owner in the execution and performance of the proposed Contract and work covered thereby, are to be paid by the Contractor for the work from monies obtained in satisfaction of his Contract. It is to be understood by all bidders that the bid price or prices submitted shall include the total cost of all such taxes.

ARTICLE 7 - SAFETY AND HEALTH REGULATIONS

7.1 The CONTRACTOR shall comply with the Department of Labor Safety and Health Regulations for construction promulgated under the Occupational Safety and Health Act of 1970 (PL 91-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PL 91-54), as amended.

7.2 The attention of the CONTRACTOR is directed to the provisions of Section 4(B)(4) of the Occupational Safety and Health Act of 1970, as follows:

"Nothing in this Act shall be construed to supersede or in any manner affect any workman's compensation law or to enlarge or diminish or affect in any manner the common law or statutory rights, duties, or liabilities of employers and employees under any law with respect to injuries, diseases, or death of employees arising out of, or in the course of, employment."

ARTICLE 8 - NIGHT, SATURDAY, SUNDAY AND HOLIDAY WORK HOURS

8.1 Unless otherwise permitted by the ENGINEER, no Work shall be done between the hours of 6:00 p.m. and 7:00 a.m., nor on Saturdays, Sundays or legal holidays, except as necessary for the proper care and protection of Work already performed. If it shall become absolutely necessary to perform Work at night or on Saturdays, Sundays or legal holidays, the ENGINEER shall be informed at least 24 hours in advance of the beginning of performance of such Work. Only such Work shall be done at night as can be done satisfactorily as determined by the ENGINEER and in a first-class manner. Good lighting and all other necessary facilities for carrying out and inspecting the Work shall be provided and maintained at all points where such Work is being done.

ARTICLE 9 - CONFORMITY WITH CONTRACT DOCUMENTS AND ALLOWABLE DEVIATIONS

9.1 The Work shall conform to the lines, grades, dimensions, tolerances, and material and equipment requirements shown on the Drawings or set forth in the Specifications. Although measurement, sampling, and testing may be considered evidence as to such conformity, the ENGINEER shall be the sole judge as to whether the Work or materials deviate from the Drawings and Specifications, and his decision as to any allowable deviations therefrom shall be final.

9.2 If specific lines, grades, and dimensions are not shown on Drawings, those furnished by the ENGINEER shall govern.

ARTICLE 10 - ASSIGNMENT

10.1 The performance of the Agreement may not be assigned, except upon the written consent of the OWNER. Consent will not be given to any proposed assignment which would relieve the original CONTRACTOR or his surety of their responsibilities under the Agreement, nor will the OWNER consent to any assignment of a part of the Work under the Agreement.

10.2 Upon obtaining a prior written consent of the OWNER, the CONTRACTOR may assign moneys due or to become due him under the Agreement, to the extent permitted by law, but any assignment of moneys shall be subject to all proper set-offs in favor of the OWNER and to all deductions provided for in the Agreement, and particularly all money withheld, whether assigned or not, shall be subject to being used by the OWNER for the completion of the Work in the event that the CONTRACTOR should be in default therein.

10.3 No assignment of the Agreement will be approved unless it shall contain a provision that the funds to be paid to the assignee under the assignment are subject to a prior lien for services rendered or materials supplied for performance of the Work called for under the Agreement in favor of all persons, firms, or corporations rendering such services or supplying such materials and that the OWNER may withhold funds due until all Work required by the Contract Documents is completed to the OWNER'S satisfaction.

ARTICLE 11 - PERSONAL LIABILITY

11.1 No director, officer, employee, or agent of the OWNER or ENGINEER, or their consultants shall be personally responsible for any liability arising under or by virtue of the Agreement.

ARTICLE 12 - PROPERTY RIGHTS IN MATERIALS

12.1 Nothing in the Agreement shall be construed as vesting in the CONTRACTOR any right of property in the materials used after they have been attached or affixed to the Work or the soil, or after payment has been made for materials delivered to the site of the Work, or stored subject to or under the control of the OWNER. All such materials shall become the property of the OWNER upon being so attached or affixed or upon payment for materials delivered to the site of the Work or stored subject to or under the control of the OWNER.

12.2 Soil, stone, gravel, and other materials found at the site of the Work and which conform to the Drawings and Specifications for incorporation into the Work may be used in the Work. No other use shall be made of such materials except as may be otherwise described in the Drawings and Specifications.

ARTICLE 13 - PARTIAL INVALIDITY

13.1 If any provision of the Agreement is held by a court of competent jurisdiction to be invalid, void or unenforceable, the remaining provisions shall nevertheless continue in full force without being impaired or invalidated in any way.

ARTICLE 14 - ATTORNEYS' FEES

14.1 Should either party to the Agreement bring an action to enforce any provision of the Agreement, the prevailing party shall be entitled to recover his reasonable attorneys' fees and costs in connection therewith.

ARTICLE 15 - WAIVER OF RIGHTS

15.1 Except as otherwise specifically provided in the Contract Documents, no action or failure to act by the OWNER, ENGINEER or CONTRACTOR shall constitute a waiver of any right or duty afforded any of them under the Contract Documents, nor shall any such action or failure to act constitute an approval of or acquiescence in any breach thereunder.

ARTICLE 16 - NO KICK-BACK CERTIFICATION

16.1 The CONTRACTOR warrants that no person has been employed or retained to solicit or secure the Agreement upon an agreement or understanding for a commission, percentage, brokerage or contingent fee; and that no member of the City Council or any employee of the OWNER has any interest, financially or otherwise, in the CONTRACTOR'S organization.

16.2 For breach or violation of this warranty, the OWNER shall have the right to annul the Agreement without liability, or at its discretion to deduct from the Contract Price or consideration, the full amount of such commission, percentage, brokerage or contingent fee.

ARTICLE 17 - PROJECT REPRESENTATION: DUTIES, RESPONSIBILITIES AND LIMITATIONS OF THE RESIDENT PROJECT REPRESENTATIVE

17.1 The terms Resident Project Representative and Resident Engineer shall be used interchangeably, herein.

17.2 The Resident Engineer shall maintain a force for observation of construction, which shall consist of a field staff and supporting personnel required in connection therewith. Nothing in the OWNER/ ENGINEER agreement or in the Contract Documents shall be construed to make the Resident Engineer a guarantor of the performance of the CONTRACTOR or others, nor shall any provision in this Agreement be construed as giving the Resident Engineer, on its own behalf or on behalf of the OWNER, the responsibility for or the authority to direct or supervise construction methods, techniques, procedures or safety measures. The Resident Engineer will not be responsible for the enforcement of the obligations of the CONTRACTOR or others, nor their failure to execute the Work in accordance with the Contract Documents and within the time period specified. The services furnished hereunder can be generally described as follows:

A. Schedules: The Resident Engineer shall review the CONTRACTOR'S progress schedules, schedule of Shop Drawings, and other schedules prepared by the CONTRACTOR and report to the OWNER and/or ENGINEER as to their acceptability.

B. Conferences: The Resident Engineer shall arrange, schedule and attend preconstruction conferences, progress meetings and other job conferences as may be required, and notify in advance those who are expected to attend.

C. Liaison: The Resident Engineer shall serve as the OWNER'S and/or ENGINEER'S on-site liaison with the CONTRACTOR concerning the CONTRACTOR'S performance under the terms of its Contract with the OWNER.

D. Shop Drawings and Samples: The Resident Engineer shall receive and record the date of receipt, and monitor transmission of Shop Drawings, samples, and test data submitted by the CONTRACTOR, and shall receive and record the date of receipt thereof, and monitor the transmission of the above referenced submissions which have been reviewed.

E. Observation of Materials and Equipment: The Resident Engineer shall observe and approve or reject construction materials and equipment to determine their general compliance with the Contract Documents.
   1. In the event the OWNER engages an independent testing laboratory to conduct tests on materials and equipment, then the Resident Engineer shall cooperate with said independent testing laboratory to determine general compliance with the Contract Documents.
   2. The Resident Engineer shall report to the OWNER and/or ENGINEER whenever it believes that Work is unsatisfactory, faulty, defective, has been damaged, does not conform to the Contract Documents, or does not meet the requirements of inspections, tests or approvals required to be made, and shall advise the OWNER and/or ENGINEER when it believes Work should be corrected, rejected, uncovered for observation, or requires special tests or inspections.
   3. The Resident Engineer shall verify that tests, equipment and systems start-up and operating and maintenance instructions are followed and conducted by the CONTRACTOR in the presence of the appropriate personnel, as required by the Contract Documents, and that the CONTRACTOR maintains adequate records thereof.
   4. The Resident Engineer shall observe, record, and report to the OWNER and/or ENGINEER concerning test procedures and start-ups.
   5. The Resident Engineer shall accompany the OWNER, ENGINEER and visiting inspectors representing other agencies having jurisdiction over the Project, and record and report the outcome of these inspections.

F. Change Orders and Supplemental Agreements: The Resident Engineer shall prepare all Change Orders and supplemental agreements in the form and manner approved by the OWNER, for authorized alterations to the Work as provided for under the Contract Documents.

G. Records: The Resident Engineer shall maintain at the job site orderly files for correspondence, reports or job conferences, Shop Drawing and sample submissions, reproductions of original Contract Documents including Addenda, authorized alterations to the Contract Documents, Change Orders, Field Orders, additional Drawings issued subsequent to the execution of the Contract, clarification letters, and other alterations to the Contract Documents, interpretations of the Contract Documents, progress reports, and other Project related documents.

H. CONTRACTOR'S Claims: The Resident Engineer shall investigate and furnish to the OWNER and/or ENGINEER information relating to the CONTRACTOR'S claims and make recommendations with regard to payment of such claims.

I. Reports: The Resident Engineer shall furnish the OWNER and/or ENGINEER with monthly reports as required, of the progress of the Work and of the CONTRACTOR'S compliance with the approved progress schedule, schedule of Shop Drawing submissions and other schedules.
   1. The Resident Engineer shall notify the OWNER and/or ENGINEER of permanent Work which does not conform to the results required in the Contract Documents, prepare written reports describing any apparent, nonconforming Work and make recommendations to the OWNER and/or ENGINEER for its correction and, at the request of the OWNER and/or ENGINEER, notify the CONTRACTOR of OWNER'S and/or ENGINEER'S directions for correction of nonconforming Work.

2. The Resident Engineer shall prepare completion lists when 100 percent completion of the Project is claimed by the CONTRACTOR. The Resident Engineer shall measure all pay items of Work.

J. CONTRACTOR'S Requests for Payment: The Resident Engineer shall review the CONTRACTOR'S Application for Payment and shall certify that the Work has progressed to the point indicated by the CONTRACTOR, that to the best of the Resident Engineer's knowledge, information and belief, based on its observations and review, the Work is in accordance with the Contract Documents, and that the CONTRACTOR is entitled to the payment of the amount certified.
   1. The Resident Engineer's certification shall be subject to an evaluation of the Work as a functioning project upon Substantial Completion, and to the results of any subsequent tests required by or performed under the Contract Documents, and to minor deviations from the Contract Documents, correctable prior to completion, and to any additional specific qualifications stated in the certificate.
   2. By approving an Application for Payment, the Resident Engineer will not be deemed to have represented that he has made any determination as to how or for what purpose any CONTRACTOR has used the monies paid on account of the Contract Price, or that title to any of the CONTRACTOR'S Work, materials, or equipment has passed to the OWNER free and clear of any liens, claims, security, interest or encumbrances.

K. Drawings: The Resident Engineer shall, based on documentation provided by the CONTRACTOR, and collected and reviewed by said Resident Engineer, submit same to the ENGINEER for preparation of record drawings.

L. Guarantees, Certificates, and Observations Prior to Guaranty Period: During the course of the Work, the Resident Engineer shall verify that guarantees, certificates, maintenance and operation manuals, and other data required to be assembled and furnished by the CONTRACTOR, are applicable to the items actually installed, and shall deliver these items and information to the OWNER and/or ENGINEER prior to the Final Acceptance of the Project.
   1. The Resident Engineer, as directed by the OWNER and/or ENGINEER, shall make an observation approximately 90 days prior to the expiration of the guaranty period of the Contract, and submit a written report to the OWNER and/or ENGINEER listing discrepancies between guarantees and performance.
   2. The Resident Engineer shall assist the OWNER and/or ENGINEER in their efforts to effect and expedite the correction or adjustment of CONTRACTOR'S defective Work, if any. The Resident Engineer shall conduct final inspection to verify that the defective Work has been corrected or adjusted, and shall make recommendations to the OWNER and/or ENGINEER concerning its acceptance.
   3. The Resident Engineer shall arrange for instruction by the CONTRACTOR and the manufacturers' representatives to the OWNER or its designated representatives concerning the proper operation and maintenance of the equipment furnished and installed for the Project.

PROJECT NO. S867026

CITY OF GLENDALE
GLENDALE, ARIZONA
DEPARTMENT OF PUBLIC WORKS

CONTRACTOR'S AFFIDAVIT
REGARDING
SETTLEMENT OF CLAIMS

_____, Arizona

Date_____

Project Name:_____

Project Number:_____

To the City of Glendale, Arizona

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the consideration of $_____, as set out in the final pay estimate, as full and complete payment under the terms of the contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project. The undersigned further agrees to indemnify and save harmless the City of Glendale against any and all liens, claims of liens, suits, actions, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performances and materials furnished for the performance of said installation.

Signed and dated at _____, this _____ day of _____19__.

_____
CONTRACTOR

By:_____

STATE OF ARIZONA)
) SS
COUNTY OF MARICOPA)

The foregoing instrument was subscribed and sworn to before me this

_____ day of _____, 19__.

_____
Notary Public

_____
My Commission Expires

PROJECT NO. S867026

CITY OF GLENDALE, ARIZONA
PUBLIC WORKS/ENGINEERING DEPARTMENT
CERTIFICATE OF INSURANCE

The _____
certifies that the following insurance policies have been issued on behalf of:

Name of Insured _____

Address of Insured _____

Name and Address of Additional Named Insured:

City of Glendale, Arizona
5350 West Glendale Avenue
Glendale, Arizona 85301

Type of Insurance	Policy No.	Eff. Date	Exp. Date	Limits of Liability
(1) Workmen's Compensation				Statutory
(2) Contractor(s) Protective Bodily Injury				$500,000 ea. occur.
(2) Contractor(s) Protective Property Damage				$100,000 ea. accid. $100,000 aggregate
(3) Contractual Bodily Injury				$500,000 ea. occur.
(3) Contractual Property Damage				$100,000 ea. accid. $100,000 aggregate
(4) Automobile Bodily Injury and Property Damage				$500,000 ea. occur.

When the project includes construction a new, or modification of an existing building (in addition to the above types):

(5) Fire and Extended Coverage plus Vandalism and Malicious Mischief - for the Full Amount of the Contract.

(6) Umbrella
Bodily Injury — $1,000,000 ea. occur.
Property Damage Combined — $1,000,000 aggregate

Policy No.	Eff. Date	Exp. Date

Policy Includes Coverage For:

(1) a. Damage caused by blasting.
b. Damage caused by collapse or structural injury.
c. Damage to underground utilities.

(2) Liability assumed in construction agreements and other types of contracts or agreements in effect in connection with insured operations.

(3) All owned, hired or non-owned automotive equipment used in connection with the insured operation.

PROJECT NO. S867026

It is agreed that none of these policies will be cancelled or changed so as to affect this certificate until ten (10) days written notice of such cancellation or change has been delivered to the City of Glendale.

It is further agreed that:

These policies shall not expire until all work has been completed and the project has been accepted by the City of Glendale. (If a policy does expire during the life of the Contract, a renewal Certificate of the required coverage must be sent to the City of Glendale not less than five (5) days prior to expiration date.) The Contractor hereby agrees to indemnify and save harmless the City of Glendale and any jurisdiction or agency issuing permits for any work included in the project, their officers, agents and representatives from all suits, actions, loss damage, expense, cost, or claims of any character or any nature brought on account of any injuries sustained by any person or property arising out of the work done in fulfillment of the construction of the improvement under the terms of this agreement, or on account of any act or omission by the Contractor or his agents, or from any claims or amounts arising or recovered under Workmen's Compensation laws or any other law, by-law, ordinance, or order or decree.

This Certificate is not valid unless countersigned by an authorized representative of the Insurance Company.

Countersigned by:

Date:

_____

_____

Signature

SECTION 1A1

SUMMARY OF WORK

1.1 LOCATION AND DESCRIPTION OF WORK

A. Wastewater treatment facility having a treatment capacity of 350 gpm and a hydraulic capacity of 500 gpm. Major work includes influent pump station, rotary screen, parshall flume, aeration tank, clarifiers, automatic-backwash filters, chlorine detention tank, storage reservoir, electrical, standby generator, control and administration building, and associated equipment and appurtenances for a complete facility.

B. The Project is located at the intersection of the Arizona Canal Diversion Channel and 67th Avenue, in the City of Glendale as shown on the Contract Drawings.

C. This summary of Work as described in the 1A Sections is an overall summary of the responsibilities of the Contractor and his relationship to the OWNER. It does not supersede the specific requirements of the other Contract Documents.

1.2 CONTRACTS

A. The Project shall be constructed under one prime contract.

1.3 WORK DONE BY OTHERS

A. Prior contracts as follows: None.

B. Future contracts as follows: None.

1.4 OWNER-FURNISHED PRODUCTS

A. None.

1.5 CONTRACTOR'S USE OF PREMISES

A. CONTRACTOR'S use of the premises for his storage and the operations of his workmen is described under Article 2.2 of the Supplementary Conditions.

B. Each prime contractor shall:
   1. Assume full responsibility for protection and safekeeping of products stored on and off premises.
   2. Move stored products that interfere with the operations of OWNER.
   3. Obtain and pay for all additional storage or work areas required for his operations.

+ + END OF SECTION + +

SECTION 1A3

FIELD ENGINEERING

1.1 GENERAL

A. ENGINEER will establish base lines and bench marks at the site for use by the CONTRACTOR. OWNER will furnish boundary surveys, if required.

B. The CONTRACTOR shall:
   1. Provide engineering services specified, or required to execute CONTRACTOR'S construction methods.
   2. Develop and make all detail surveys and measurements needed for construction including slope stakes, batter boards, piling layouts and all other working lines, elevations and cut sheets.
   3. Keep a transit and leveling instrument on the site at all times and a skilled instrument man employed or obtained whenever necessary for layout of the Work.
   4. Provide all material required for bench marks, control points, batter boards, grade stakes and other items.
   5. Be solely responsible for all locations, dimensions and levels. No data other than written orders of the ENGINEER shall justify departure from the dimensions and levels required by the Drawings.
   6. Safeguard all points, stakes, grade marks, monuments and bench marks made or established on the Work, re-establish same if disturbed and rectify all Work improperly installed because of not maintaining, not protecting or removing without authorization such established points, stakes, marks and monuments.
   7. When requested by the ENGINEER, provide such facilities as may be necessary for the ENGINEER to check line and grade points placed by CONTRACTOR. Where applicable, CONTRACTOR shall do no excavation or embankment work until cross-sectioning necessary for determining pay quantities has been completed and checked by ENGINEER.
   8. All computations necessary to establish the exact position of the work shall be made and preserved by CONTRACTOR. All computations, survey notes and other records necessary to accomplish the Work shall be neatly made, shall be made available to ENGINEER upon request and shall become the property of OWNER.

1.2 CONTRACTOR'S FIELD ENGINEER

A. CONTRACTOR shall employ and retain at the site of the Work a field engineer capable of performing all engineering tasks required of the CONTRACTOR. Tasks included are:
   1. Daily reports of Project activity to be submitted to the ENGINEER with all pertinent information pertaining to the Project as follows:
      a. Numbers of employees
      b. Subcontractor employees
      c. Breakdown of employees by trade
      d. Major equipment and materials installed
      e. Major construction equipment utilized
      f. Location of all areas in which construction was done
      g. Materials and equipment received

2. Provide all surveying equipment required including transit, level, stakes and required surveying accessories.
3. Furnish all required lines and grades for construction operations. Check all formwork, reinforcing, inserts, structural steel, bolts, sleeves, piping, other materials and equipment.
4. Maintain field office files and drawings, record drawings and coordinate engineering services with Subcontractors. Prepare layout and coordination drawings for construction operations.
5. Check and coordinate Work for conflicts and interferences and immediately advise ENGINEER of all discrepancies noted.
6. Cooperate with ENGINEER in field inspections as required.

1.3 QUALIFICATIONS OF SURVEYOR OR ENGINEER

A. The surveyor or CONTRACTOR'S field engineer shall be a qualified engineer or registered land surveyor, acceptable to ENGINEER and OWNER.

1.4 RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

B. On completion of foundation walls and major site improvements, prepare a certified survey showing all dimensions, locations, angles and elevations of construction.

1.5 SUBMITTALS

A. Submit name and address of surveyor or engineer to ENGINEER.

B. On request of ENGINEER, submit documentation to verify accuracy of field engineering work.

C. When requested by ENGINEER, submit certificate signed by registered engineer or surveyor certifying that elevations and locations of Work are in conformance with Contract Documents. Explain all deviations.

+ + END OF SECTION + +

SECTION 1A10

CUTTING AND PATCHING

1.1 GENERAL

A. This Section includes all cutting and patching of all Work under construction and completed Work in order to accommodate the coordination of Work, install other Work, uncover Work for access, inspection or testing, or similar purposes. Execute all cutting and patching, including excavation, backfill and fitting required to:
   1. Remove and replace defective Work or Work not conforming to requirements of the Contract Documents.
   2. Remove samples of installed Work as required for testing.
   3. Remove all constructions required to provide for specified alteration or addition to existing Work.
   4. Uncover Work to provide for the ENGINEER'S inspection of covered Work or inspection by regulatory agencies having jurisdiction.
   5. Connect to completed Work that was not accomplished in the proper sequence.
   6. Remove or relocate existing utilities and pipes which obstruct the Work to which connections must be made.
   7. Make connections or alterations to existing or new facilities.

B. Restore all existing Work to a state equal to that which it was in prior to cutting and restore new Work to the standards of these Specifications.

C. Submittals:
   1. Prior to cutting which may affect integrity and design function of Project, the OWNER'S operations, or work of another contractor, submit written notice to ENGINEER, requesting consent to proceed with cutting, including:
      a. Identification of Project.
      b. Description of affected Work of CONTRACTOR and work of others.
      c. Necessity for cutting.
      d. Effect on other work and on structural integrity of Project.
      e. Description of proposed Work. Designate:
         1) Scope of cutting and patching.
         2) CONTRACTOR, Subcontractor or trade to execute Work.
         3) Products proposed to be used.
         4) Extent of refinishing.
         5) Schedule of operations.
      f. Alternatives to cutting and patching, if any.
      g. Designation of party responsible for cost of cutting and patching.
   2. Should conditions of Work, or schedule, indicate a change of materials or methods, submit a written recommendation to the ENGINEER, including:
      a. Conditions indicating change.
      b. Recommendations for alternative materials or methods.
      c. Submittals as required for substitutions.

3. Submit written notice to the ENGINEER, designating time Work will be uncovered, to provide for observation. Do not begin cutting or patching operations until authorized by the ENGINEER.

D. Provide shoring, bracing and support as required to maintain structural integrity of Project and protect adjacent Work from damage during cutting and patching.

E. Conform to all applicable Specifications for application and installation of materials used for patching.

+ + END OF SECTION + +

SECTION 1A11

CONNECTIONS TO EXISTING FACILITIES

1.1 GENERAL

A. Perform all construction necessary to complete connections and tie-ins to existing facilities, including test pits to locate utilities which may be encountered.

B. Keep existing facilities in operation unless otherwise specifically permitted in these Specifications or approved by the OWNER.

C. Insofar as possible, perform all construction activities so as to avoid interference with operations of existing facilities and the work of others.

1.2 SEQUENCING AND OPERATIONS

A. All operations of existing valves and gates required for the Work shall be done by the CONTRACTOR. The OWNER will supervise this Work, and no valve, gate nor other item of equipment shall be operated without his knowledge. The OWNER does not guarantee the operation or water tightness of any valves or gates.

B. Insofar as possible, all equipment shall be tested and in operating condition before the final tie-ins are made to connect new equipment to the existing facility.

C. CONTRACTOR shall carefully coordinate all Work and schedules and shall provide OWNER written notice at least 14 days before shutdowns or process interruptions are required.

+ + END OF SECTION + +

SECTION 1A12

REFERENCE STANDARDS

1.1 GENERAL

A. When a reference standard is specified, comply with requirements and recommendations stated in that standard, except when they are modified by the Contract Documents, or when applicable laws, ordinances, rules, regulations or codes establish stricter standards. The latest provisions of applicable standards shall apply to the Work, unless otherwise specified. Reference standards include, but are not necessarily limited to, the following:

1. American Association of State Highway and Transportation Officials.
2. American Concrete Institute.
3. American Institute of Steel Construction.
4. American Iron and Steel Institute.
5. American National Standards Institute.
6. American Society of Heating, Refrigerating and Air Conditioning Engineers.
7. American Society of Mechanical Engineers.
8. American Society for Testing and Materials.
9. American Water Works Association.
10. American Welding Society.
11. Concrete Reinforcing Steel Institute.
12. Ductile Iron Pipe Research Association.
13. Factory Mutual Association.
14. Institute of Electrical and Electronics Engineers.
15. National Electrical Code.
16. National Electrical Manufacturers Association.
17. National Fire Protection Association.
18. Prestressed Concrete Institute.
19. Regulations and Standards of the Occupational Safety and Health Act (OSHA) of the U.S. Department of Labor and the State of Arizona.
20. Underwriters' Laboratories, Inc.
21. Uniform Building Code
22. All other applicable standards listed in the Specifications, and the standards of utility service companies, where applicable.
23. All other applicable codes, regulations, and standards of the U.S. Government, State of Arizona, and other government agencies.

+ + END OF SECTION + +

SECION 1A13

ABBREVIATIONS AND SYMBOLS

1.1 ABBREVIATIONS

A. Common abbreviations which may be found in the Specifications are:

alternating current	a-c	maximum	max
ante meridiem	a.m.	mercury	Hg
ampere	A	milligram	mg
average	avg	milligrams per liter	mg/l
		milliliter	ml
biochemical oxygen demand	BOD	millimeter	mm
		million gallon	mil
brake horsepower	bhp	million gallons per day	mgd
British thermal unit	Btu	minimum	min
Centigrade	C	net positive suction head	npsh
company	Co		
cubic inch	cu in	number	No.
cubic foot	cu ft	National Pipe Threads	NPT
cubic yard	cu yd		
cubic feet per minute	cfm		
cubic feet per second	cfs	ounce	oz
		outside diameter	OD
decibel	db	parts per million	ppm
degree Centigrade (or Celsius)	(say) 20 C	post meridiem	p.m.
		pound	lb
degree Fahrenheit	(say) 68 F	pounds per square foot	psf
diameter	diam		
direct current	d-c	pounds per square inch	psi
dollars	$		
		pounds per square inch absolute	psia
each	ea		
efficiency	eff	pounds per square inch gage	psig
Fahrenheit	F	revolutions per minute	rpm
feet	ft		
feet per hour	fph		
feet per minute	fpm	second	sec
feet per second	fps	specific gravity	sp gr
figure	Fig.	square	sq
flange	flg	square foot	sq ft
foot-pound	ft-lb	square inch	sq in
		square yard	sq yd
gallon	gal	standard	std
gallons per minute	gpm	standard cubic feet per minute	scfm
gallons per second	gps		
gram	g		

SECTION 1C

MEASUREMENT AND PAYMENT

1.1 DESCRIPTION

A. CONTRACTOR shall furnish all labor, materials, tools, equipment, appurtenances, incidentals and all services necessary to perform all Work required, at the lump sum or unit prices for the items listed herein.

B. The items listed in Article 1.4 below refer to and are the same pay items listed in the Bid Form. They constitute all of the pay items for completion of the Work in this Contract. No direct or separate payment will be made for providing miscellaneous temporary or accessory works, plant, services, CONTRACTOR'S or ENGINEER'S field offices, layout surveys, job signs, sanitary requirements, testing, photographs, safety devices, approval and record drawings, water supplies, power, heat, maintaining traffic, removal of waste, watchmen, bonds, insurance, mobilization and demobilization of equipment, environmental protection and controls, and all other requirements of the General Conditions, Supplementary Conditions and the General Requirements. Compensation for all such services, things and materials shall be included in the prices stipulated for the lump sum and unit price pay items listed herein.

1.2 ENGINEER'S ESTIMATE OF QUANTITIES

A. The ENGINEER'S estimated quantities for unit bid prices, as listed in the Bid Form, are approximate only and are included solely for the purpose of comparison of Bids. The OWNER does not expressly or by implication agree that the nature of the materials encountered below the surface of the ground or the actual quantities of material encountered or required will correspond therewith, and reserves the right to increase or decrease any quantity or to eliminate any quantity as OWNER may deem necessary. CONTRACTOR will not be entitled to any adjustment in a unit bid price as a result of any change in an estimated quantity and agrees to accept the aforesaid unit bid prices as complete and total compensation for any additions caused by a variation in quantities as a result of more accurate measurement.

1.3 RELATED PROVISIONS SPECIFIED ELSEWHERE

A. Payments to CONTRACTOR: Refer to General Conditions, Supplementary Conditions and Contract Agreement.

B. Changes in Contract Price: Refer to General Conditions.

C. Schedule of Values: Refer to Section 1E8.

1.4 CONTRACT FOR CONSTRUCTION OF THUNDERBIRD PASEO WASTEWATER RECLAMATION FACILITY - CITY PROJECT NO. S867026

A. Item 1 - Construction of Thunderbird Paseo Wastewater Reclamation Facility:

1. Measurement and Payment: The lump sum payment for Item 1 will be full compensation for providing all Work required to construct the

Thunderbird Paseo Wastewater Reclamation Facility, as shown and specified in the Contract Documents and described herein. Extra work items, which may be ordered by the ENGINEER under the Contract, are described in Items 2 through 14, below.

B. Item 2 - Additional Excavation:
   1. Measurement: This item shall include additional excavation of all materials regardless of type, character, composition, moisture content or condition thereof. Additional excavation, which will be included under Item 2, will be measured for payment on the basis of the lines and grades ordered by the ENGINEER, or as the volume within the limits described below, whichever is applicable. Additional excavation shall be for Work in addition to that shown on the Drawings or included in the Specifications and which is ordered by the ENGINEER. Additional excavation shall include site preparation; excavating; storage of materials; installation and removal of all necessary bracing, shoring, and sheeting; drainage and dewatering; satisfactory disposal of surplus and/or unacceptable materials; restoration of site; environmental protection, restoration, and erosion and sediment control; installation and removal of temporary fencing; and all miscellaneous and appurtenant work.
      a. For excavation for pipes, the trenches will be assumed to be of rectangular cross section having a width of 2 feet greater than the outside diameter of the pipe laid therein, exclusive of bells, branches, hubs, spurs or concrete cradles, and a depth from the surface of the ground, at the centerline of pipe, to the bottom of the pipe. Enlargements of trench, authorized by the ENGINEER where necessary to facilitate the support of existing structures, or for other reasons, will be measured for payment to the limits excavated in accordance with orders. The length shall be equal to the laid length of pipe, measured horizontally along the centerline.
      b. All excavation for structures or facilities other than pipe will be measured for payment to the subgrade directed for such excavation and, unless otherwise shown or directed, to vertical planes one foot outside the foundation limits of the structure to be built therein.
      c. For test pits outside the excavation or trench and for those within the prescribed limits, but necessarily refilled previous to the final excavation and for all other excavation not included above but required for the Work, excavation shall be measured to the lines ordered or approved.
      d. Measurement of the actual quantities of materials will be made by the ENGINEER. CONTRACTOR may, at his expense, verify quantities.
   2. Payment: The unit price per cubic yard for Item 2 will be full compensation for providing all additional excavation complete as shown and specified and as ordered by the ENGINEER, and not specifically included under other items.

C. Item 3 - Additional General Backfill from Off-Site Sources:
   1. Measurement: The quantity of additional general backfill from off-site sources, which will be included under Item 3, will be the computed number of cubic yards placed in addition to that shown on the Drawings or included in the Specifications and which are ordered by the ENGINEER. Additional general backfill will be measured for

payment as the compacted volume in place between the limits directed by the ENGINEER. Additional general backfill shall include supplying, placing, grading and compacting the material. Additional general backfill materials shall meet the requirements of Section 2D1.

2. Payment: The unit price per cubic yard for Item 3 will be full compensation for providing all additional general backfill complete as shown and specified and as ordered by the ENGINEER, and not specifically included under other items.

D. Item 4 - Additional Select Backfill from Off-Site Sources:

1. Measurement: The quantity of additional select backfill from off-site sources, which will be included under Item 4, will be the computed number of cubic yards placed in addition to that shown on the Drawings or included in the Specifications and which are ordered by the ENGINEER. Additional select backfill will be measured for payment as the compacted volume in place between the limits directed by the ENGINEER. Additional select backfill shall include supplying, placing, grading and compacting the material. Additional select backfill materials shall meet the requirements of Section 2D1.
2. Payment: The unit price per cubic yard for Item 4 will be full compensation for providing all additional select backfill complete as shown and specified and as ordered by the ENGINEER, and not specifically included under other items.

E. Item 5 - Additional Crushed Stone and Gravel Backfill from Off-Site Sources:

1. Measurement: The quantity of additional crushed stone and gravel backfill from off-site sources, which will be included for payment under Item 5, will be the computed number of cubic yards placed in addition to that shown on the Drawings or included in the Specifications and which are ordered by the ENGINEER. No payment will be made for crushed stone and gravel backfill which is used for refill when rock or earth excavation is carried below the grades specified or ordered, nor for crushed stone and gravel backfill which is used for controlling ground water. The total quantity of additional crushed stone and gravel backfill to be paid for under Item 5 will be the computed amounts used to replace unsuitable material, to improve pipe bedding, to increase the load carrying capacity of pipe, and to serve as foundation support for structures, less any amount credited to the OWNER where the stone and gravel base is omitted, all in accordance with the orders of the ENGINEER. Additional crushed stone and gravel backfill shall include supplying, placing, grading and compacting the material. Additional crushed stone and gravel backfill materials shall meet the requirements of Section 2D5.
2. Payment: The unit price per cubic yard for Item 5 will be full compensation for providing all additional crushed stone and gravel backfill complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

F. Item 6 - Additional Class "A" Concrete:

1. Measurement: The quantity of additional Class "A" concrete, which will be included under Item 6, will be the volume of concrete in cubic yards actually placed, which is not shown on the Drawings nor included in the Specifications and which is ordered by the ENGINEER.

No concrete placed in structures or elsewhere, which is paid for under other items, will be paid for under Item 6. Additional Class "A" concrete will be measured for payment on the basis of lines and grades ordered or as the volume in place between the limits ordered by the ENGINEER. Additional Class "A" concrete shall conform to the requirements of Section 3D. No direct payment will be made for sealants, performed expansion joints or metal or plastic waterstops. The cost for these materials will be included in the price bid.

2. Payment: The unit price per cubic yard for Item 6 will be full compensation for providing all additional Class "A" concrete complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

G. Item 7 - Additional Class "B" Concrete:

1. Measurement: The quantity of additional Class "B" concrete, which will be included under Item 7, will be the volume of concrete in cubic yards actually placed, which is not shown on the Drawings nor included in the Specifications and which is ordered by the ENGINEER. No concrete placed in structures or elsewhere, which is paid for under other items, will be paid for under Item 7. Additional Class "B" concrete will be measured for payment on the basis of lines and grades ordered or as the volume in place between the limits ordered by the ENGINEER. Additional Class "B" concrete shall conform to the requirements of Section 3D.
2. Payment: The unit price per cubic yard for Item 7 will be full compensation for providing all additional Class "B" concrete complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

H. Item 8 - Additional Reinforcing Steel;

1. Measurement:
   a. Additional reinforcing steel, which will be included under Item 8, will be measured for payment as the actual number of pounds of reinforcing steel placed in addition to the reinforcing steel shown on the Drawings or included in the Specifications and which is ordered by the ENGINEER. No reinforcing steel placed in structures or elsewhere, which is paid for under other items, will be paid for under Item 8. The weight will be determined by multiplying the length of each bar by the standard bar weight. Excessive laps will not be included for payment. Additional reinforcing steel shall conform to Section 3C.
   b. No direct payment will be made for wire, welding, chairs, supports nor any other required accessory for providing additional reinforcing steel. The cost for all such Work shall be included in the price bid.
2. Payment: The unit price per pound for Item 8 will be full compensation for providing all additional reinforcing steel complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

I. Item 9 - Additional Structural Steel:

1. Measurement:
   a. Additional structural steel, which will be included under Item 9, will be measured for payment as the actual number of pounds of material supplied and installed in addition to the structural steel shown on the Drawings or included in the

Specifications and which is ordered by the ENGINEER. No structural steel installed in structures or elsewhere which is paid for under other items, will be paid for under Item 9. Lengths, sizes and weights will be determined based on appropriate tables in the AISC Handbook. Additional structural steel shall conform to Section 5A1.

b. This item includes structural steel work required by changes in dimensions of the Work or by the addition of minor structures not shown on the Drawings or specified.

c. No direct payment will be made for clamps, "I" beam splicers, bolts, nuts, washers, screws, wire mesh, or similar items. Neither will direct payment be made for cutoffs from standard lengths of shapes, rods and pipes, and standard size of plates. The cost of all such materials and accessories shall be included in the price bid.

2. Payment: The unit price per pound for Item 9 will be full compensation for providing all additional structural steel complete as shown and specified and as ordered by the ENGINEER, and not specifically included under other items.

J. Item 10 - Additional Cast Iron or Ductile Iron:

1. Measurement:

a. The quantity of additional cast iron or ductile iron, which will be included under Item 10, will be the weight of cast iron or ductile iron in pounds actually supplied and installed which is not shown on the Drawings or included in the Specifications and which is ordered by the ENGINEER. No cast iron or ductile iron installed which is paid for under other items, will be paid for under Item 10. Measurement for payment will be on the basis of the actual weight of the material furnished. Additional cast iron or ductile iron shall conform to Section 5E11.

b. This item includes cast iron or ductile iron required by changes in dimensions of the Work or by the addition of Work not shown on the Drawings or specified.

2. Payment: The unit price per pound for Item 10 will be full compensation for providing all additional cast iron or ductile iron complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

K. Item 11 - Additional Aluminum:

1. Measurement:

a. The quantity of additional aluminum, which will be included under Item 11, will be the weight of aluminum in pounds actually supplied and installed which is not shown on the Drawings or included in the Specifications and which is ordered by the ENGINEER. No aluminum installed which is paid for under other items, will be paid for under Item 11. Measurement for payment will be on the basis of the actual weight of the material furnished. Additional aluminum shall consist of gratings, rails, structural aluminum shapes, miscellaneous fabrications, and shall conform to Section 5E3.

b. This item includes aluminum required by changes in dimensions of the Work or by the addition of Work not shown on the Drawings or specified.

2. Payment: The unit price per pound for Item 11 will be full compensation for providing all additional aluminum complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

L. Item 12 - Additional Stainless Steel:
1. Measurement:
   a. The quantity of additional stainless steel, which will be included under Item 12, will be the weight of stainless steel in pounds actually supplied and installed which is not shown on the Drawings or included in the Specifications and which is ordered by the ENGINEER. No stainless steel installed, which is paid for under other items, will be paid for under Item 12. Measurement for payment will be on the basis of the actual weight of the material furnished. Additional stainless steel shall consist of railings, structural stainless steel shapes, fasteners, anchors, miscellaneous fabrications and shall conform to Section 5E3.
   b. This item includes stainless steel required by changes in dimensions of the Work or by the addition of Work not shown on the Drawings or specified.
2. Payment: The unit price per pound for Item 12 will be full compensation for providing all additional stainless steel complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

M. Item 13 - Additional Conduit:
1. Measurement:
   a. The quantity of additional conduit, which will be included under Item 13, will be the actual length of a particular size of conduit in feet actually supplied and installed which is not shown on the Drawings or included in the Specifications and which is ordered by the ENGINEER. No conduit installed, which is paid for under other items, will be paid for under Item 13. Measurement for payment will be on the basis of the actual footage of the particular size of conduit furnished, less any amount credited to the OWNER where conduit is omitted. Additional conduit shall conform to Division 16.
   b. This item includes conduit required by changes in dimensions of the Work or by the additions of Work not shown on the Drawings or specified.
   c. No direct payment will be made for hangers, fasteners, pull boxes, junction boxes, or similar items. The cost for all such materials and accessories shall be included in the price bid.
2. Payment: The unit price per foot for Item 13 will be full compensation for providing all additional conduit complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

N. Item 14 - Additional Cable:
1. Measurement:
   a. The quantity of additional cable, which will be included under Item 14, will be the actual length of a particular size of cable in feet actually supplied and installed which is not shown on the Drawings or included in the Specifications and which is ordered by the ENGINEER. No cable installed, which is paid for

under other items, will be paid for under Item 14. Measurement for payment will be on the basis of the actual footage of the particular size of cable furnished, less any amount credited to the OWNER where cable is omitted. Additional cable shall conform to Division 16.

b. This item includes cable required by changes in dimensions of the Work or by the additions of Work not shown on the Drawings or specified.

c. No direct payment will be made for cable fasteners, splicing materials or similar accessories. The cost for all such materials and accessories shall be included in the price bid.

2. Payment: The unit price per foot for Item 14 will be full compensation for providing all additional cable complete as shown and specified and as ordered by the ENGINEER and not specifically included under other items.

+ + END OF SECTION + +

SECTION 1D1

PRECONSTRUCTION CONFERENCE

1.1 GENERAL

A. Date, Time and Location: A conference will be held after execution of the Contract and before construction is started at the site. ENGINEER will fix the date, time and location of the meeting in accordance with the requirements of the General Conditions.

B. ENGINEER shall prepare the agenda, preside at the meeting, and prepare and distribute a transcript of the proceedings to all parties.

C. The CONTRACTOR shall provide data required, distribute appropriate items for discussion, and be prepared to discuss all items on agenda.

1.2 REQUIRED ATTENDANCE

A. CONTRACTOR and major Subcontractors.

B. OWNER'S representative.

C. ENGINEER.

D. Representatives of government agencies having any degree of control or responsibility, if available.

1.3 AGENDA

A. Agenda will include, but will not necessarily be limited to, the following:
   1. Designation of responsible personnel.
   2. Subcontractors.
   3. Coordination with other contractors.
   4. Construction schedule.
   5. Processing of Shop Drawings.
   6. Processing of field decisions and Change Orders.
   7. Requirements for copies of Contract Documents.
   8. Insurance in force.
   9. Schedule of Values.
   10. Schedule of Payments.
   11. Use of premises.
   12. CONTRACTOR'S responsibility for safety and first aid procedures.
   13. Security.
   14. Housekeeping.
   15. Field Offices.
   16. Record Drawings.

+ + END OF SECTION + +

SECTION 1D2

PROGRESS MEETINGS

1.1 GENERAL

A. Date and Time:
   1. Regular Weekly Meetings: As mutually agreed upon by the ENGINEER and CONTRACTOR.
   2. Other Meetings: On call.

B. Place: CONTRACTOR'S office at the Project site or other mutually agreed upon location, or as directed by OWNER.

C. ENGINEER shall prepare the agenda, preside at meetings, and prepare and distribute a transcript of the proceedings to all parties.

D. CONTRACTOR shall provide data required and be prepared to discuss all items on agenda.

1.2 MINIMUM ATTENDANCE

A. CONTRACTOR, Subcontractors and suppliers. Representatives present for each party shall be authorized to act on their behalf.

B. ENGINEER.

C. OWNER'S representative.

D. Others as appropriate.

1.3 AGENDA

A. Agenda will include, but will not necessarily be limited to, the following:
   1. Transcript of previous meeting.
   2. Progress since last meeting.
   3. Planned progress for next period.
   4. Problems, conflicts and observations.
   5. Change Orders.
   6. Applications for payment.
   7. Quality standards and control.
   8. Schedules, including off-site fabrication and delivery schedules. Corrective measures required.
   9. Coordination between parties.
   10. Other business.

+ + END OF SECTION + +

SECTION 1E3

CONSTRUCTION SCHEDULE

1.1 GENERAL

A. In order to assure completion of the Work within the time stipulated, all activities of the CONTRACTOR will be scheduled and monitored by use of the critical path method, utilizing both activity diagram and computer printout.

B. The schedule, including the printout and arrow diagram shall be prepared by an expert having substantial experience in critical path scheduling. The qualifications of the critical path scheduling expert shall be submitted by the CONTRACTOR for approval after award of Contract but not later than the Notice to Proceed Date. As a minimum, the scheduling expert shall have a minimum of five years experience in critical path scheduling and shall have prepared critical path schedules for a minimum of two projects each having a construction cost in excess of $5,000,000.

C. The CONTRACTOR shall submit eight copies of the schedule for approval at least 20 days prior to submitting first application for a progress payment but not later than 30 days after the date when the Contract Time commences.

D. The schedule shall be detailed in nature and shall include the calendar dates of start and completion of each task on the critical path as well as dates and float times of tasks not on the critical path and of tie-ins to existing facilities, if any. The critical path diagram shall show all activities in detail, and the computer printout shall include for each activity its number, description, duration, early start, early finish, late start, late finish, and float time. Both the initial and subsequent submissions shall be time scaled.

E. In the preparation of the schedule, the CONTRACTOR shall take into considerations Shop Drawing submittal and approval time, the delivery times of equipment and materials, Subcontractors' work, availability and abilities of workmen, weather conditions, any restrictions in operation at the Work site, and all other items that may affect completion of the Work within the time requirements of the Contract Documents.

F. If the schedule as submitted by the CONTRACTOR is not sufficiently detailed, contains errors, or is unrealistic, it will be rejected in writing, and the CONTRACTOR shall submit an appropriately revised schedule within seven days of the date of the notice of rejection. The procedure will be repeated as often as may be necessary until the schedule is found acceptable and approved by the ENGINEER.

G. Pending approval of the construction schedule, no progress payment will be made, except in such amounts as may be approved by the ENGINEER for materials received at the Project site as provided in the General Conditions.

1.2 MONTHLY PROGRESS REPORTS

A. On or about the first working day of every month, the ENGINEER will meet with the CONTRACTOR. AT this meeting, the CONTRACTOR will present, in duplicate, a report of operations during the preceding month, including actual starting and ending dates on activities shown on the critical path diagram. Where such starting or ending dates were delayed beyond those required by the critical path schedule, the CONTRACTOR shall describe the action he is taking to regain lost time, and state the anticipated delays on continuing activities and outline the action he is taking to regain lost time or avoid future delay. On the basis of the reports presented at the monthly meetings, the CONTRACTOR shall, at not more than three-month intervals, develop a current computer printout of the critical path schedule, and shall furnish copies thereof to the ENGINEER not later than the tenth working of the third month. Monthly progress reports shall be submitted to the Resident Engineer and shall be accepted as "current" prior to the Resident Engineer's processing of a progress payment request.

1.3 REVISION OF CRITICAL PATH DIAGRAM

A. The critical path diagram shall be revised every three months during the project to reflect departures and changes from the previous critical path diagram. If departures and changes during the previous period are of such minor nature that no useful purpose is served by revising the critical path diagram, the ENGINEER may waive this requirement.

B. The CONTRACTOR shall furnish eight copies of the revised critical path diagram and the accompanying computer printout to the ENGINEER within 15 days from the date its preparation is directed.

+ + END OF SECTION + +

SECTION 1E4

SHOP DRAWING AND OTHER TECHNICAL INFORMATION SUBMITTAL AND CORRESPONDENCE PROCEDURE

1.1 GENERAL

A. The submittal of Shop Drawings, Specifications, Installation Instructions, and other technical information required by the Technical Specifications shall conform to requirements of the General Conditions and procedures described in this Section.

1.2 PROCEDURE

A. Submittals shall be made to: Malcolm Pirnie, Inc., Consulting Environmental Engineers, 4636 East University Drive, Suite 150, Phoenix, Arizona 85034.

B. A letter of transmittal shall accompany each submission. If data for more than one Section of the Specifications is submitted, a separate transmittal letter shall accompany the data submitted for each Section.

C. All letters of transmittal shall be sent to Malcolm Pirnie, Inc. in duplicate.

D. At the beginning of each letter of transmittal and each letter of inquiry, provide a reference heading indicating the following:
   1. OWNER'S Name _____
   2. Project Name _____
   3. Contract No. _____
   4. Transmittal No. _____
   5. Section No. _____

E. If submittals show variation from the requirements of the Contract Documents, the CONTRACTOR shall make specific mention of such variation in his letter of transmittal.

F. All Shop Drawings and other submittals for approval shall have a title block with complete identifying information satisfactory to ENGINEER.

G. All Shop Drawings submitted shall bear the stamp of approval and signature of the CONTRACTOR as evidence that they have been reviewed by the CONTRACTOR. Submittals without this stamp of approval will not be reviewed by the ENGINEER and will be returned to the CONTRACTOR. The stamp shall contain the following minimum information:

   Project Name and No.: _____

   Name of Supplier, Manufacturer or Subcontractor: _____

   _____

   CONTRACTOR'S Name: _____

   Date: _____

----------Reference----------

Item: _____

Specifications:

Section: _____

Page No.: _____

Para. No.: _____

Drawing No.: _____ of _____

Location: _____

Submittal No.: _____

Approved By: _____

H. A number shall be assigned to each submittal by the CONTRACTOR starting with No. 1 and thence numbered consecutively. Resubmittals shall be identified by the same number followed by the suffix "A" for the first resubmittal, the suffix "B" for the second resubmittal, etc.

I. The CONTRACTOR shall initially submit to the ENGINEER a minimum of 8 copies of all submittals that are 8-1/2-inch by 11-inch or smaller sheets, and one unfolded sepia and 2 prints made from that sepia for all submittals on sheets larger than 8-1/2-inch by 11-inch.

J. After the ENGINEER completes his review, the submittals will be marked with one of the following notations:
   1. Furnish as Submitted
   2. Furnish as Noted
   3. Revise and Resubmit
   4. Acceptable

K. If a submittal is acceptable, it will be marked "Furnish as Submitted" or "Furnish as Noted". Four prints or copies of the submittal will be returned to the CONTRACTOR.

L. Upon return of a submittal marked "Furnish as Submitted" or "Furnish as Noted", the CONTRACTOR may order, ship or fabricate the materials included on the submittal, provided it is in accordance with the corrections indicated.

M. If a submittal marked "Furnish as Noted" has extensive corrections or corrections affecting other drawings or Work, the ENGINEER may require that the CONTRACTOR make the corrections indicated thereon and resubmit it for record purposes. Such drawings will have the notation, "Furnish as Noted - Resubmit".

N. If a submittal is unacceptable, 2 copies will be returned to the CONTRACTOR with one of the following notations:
   1. "Revise and Resubmit"
   2. "Not Acceptable"

O. Upon return of a submittal marked "Revise and Resubmit", the CONTRACTOR shall make the corrections indicated and repeat the initial submittal procedure. The "Not Acceptable" notation is used to indicate material or equipment that is not acceptable. Upon return of a submittal so marked, the CONTRACTOR shall repeat the initial procedure utilizing acceptable material or equipment.

P. Any related Work performed or equipment installed without a "Furnish as Submitted" or "Furnish as Noted" Shop Drawing will be at the sole responsibility of the CONTRACTOR.

Q. Shop Drawings and other submittals shall be submitted well in advance of the need for the material or equipment for construction and with ample allowance for time required to make delivery of material or equipment after data covering such is approved. The CONTRACTOR shall assume the risk for all materials or equipment which are fabricated or delivered prior to the acceptance of Shop Drawings. No materials or equipment shall be incorporated into the Work nor will such be included in periodic progress payments until acceptance thereof has been obtained in the specified manner.

R. The ENGINEER will review and process all submittals promptly (average of 10 working days), but a reasonable time should be allowed for this, for the Shop Drawings being revised and resubmitted, and for time required to return the accepted Shop Drawings to the CONTRACTOR.

S. It is the CONTRACTOR'S responsibility to review submittals made by his suppliers and Subcontractors before transmitting them to the ENGINEER, to assure proper coordination of the Work and to determine that each submittal is in accordance with his desires, and that there is sufficient information about materials and equipment for the ENGINEER to determine compliance with the Drawings and Specifications. Incomplete or inadequate submittals will be returned for revision without review.

T. CONTRACTOR shall furnish required submittals with complete information and accuracy in order to achieve required acceptance of an item within three submittals. All costs to ENGINEER involved with subsequent submittals of Shop Drawings, Samples, or other items requiring acceptance, will be backcharged to CONTRACTOR, at the rate of 3.0 times direct technical labor cost, by deducting such costs from payments due CONTRACTOR for Work completed. In the event that CONTRACTOR requests a substitution for a previously acceptable item, all of ENGINEER'S costs in the reviewing and acceptance of the substitution will be backcharged to CONTRACTOR unless the need for such substitution is beyond the control of CONTRACTOR.

+ + END OF SECTION + +

SECTION 1E5

SAMPLES

1.1 GENERAL

A. The submittal of Samples shall conform to the requirements of the General Conditions and to procedures described in this Section.

B. Samples and Shop Drawings which are related to the same unit of Work or Specification Section shall be submitted at the same time. If related Shop Drawings and Samples are submitted at different times, they cannot be reviewed until both are furnished to the ENGINEER.

1.2 PROCEDURE

A. CONTRACTOR shall review, approve, and submit all Samples promptly. Samples shall be identified with correct reference to Specification Section, page, article and paragraph number, and Drawing No. when applicable. Samples shall clearly illustrate functional characteristics of the product and all related parts and attachments, and full range of color, texture, pattern and material. Samples shall be furnished so as not to delay fabrication, allowing the ENGINEER reasonable time for the consideration of the Samples submitted.

B. CONTRACTOR shall submit at least three Samples of each item required for the ENGINEER'S approval. Submission of Samples shall conform to all applicable provisions under Shop Drawing Submittal and Correspondence Procedure. Two of the Samples shall be delivered to the ENGINEER'S home office unless otherwise authorized by the ENGINEER. One Sample shall be delivered to the ENGINEER'S field office. If the CONTRACTOR requires a Sample for his use he shall notify the ENGINEER in writing.

C. CONTRACTOR shall make all corrections required and shall resubmit the required number of new Samples until approved.

1.3 JOB MOCK-UPS

A. Job mock-ups (sample panels) shall be constructed on site by the CONTRACTOR and only one of each type will be required. Mock-ups shall be constructed only after the individual samples and components used in the mock-up have been approved by the ENGINEER. If a mock-up is not approved, CONTRACTOR shall construct additional ones until approval is received.

1.4 SAMPLES FOR TESTS

A. The CONTRACTOR shall furnish such Samples of material as may be required for examination and test. All Samples of materials for tests shall be taken according to standard methods and as required by the Contract Documents.

+ + END OF SECTION + +

SECTION 1E6

INSTALLATION DATA

1.1 GENERAL

A. Installation data are defined as written instructions; drawings; illustrative, wiring and schematic diagrams; diagrams identifying external connections, terminal block numbers and internal wiring; and all other such information pertaining to installation of materials and equipment that is not furnished with Shop Drawings. Included are all manufacturers printed installation instructions, including those that may be attached to equipment and for which approval by the ENGINEER is not required.

1.2 SUBMITTAL

A. CONTRACTOR shall submit two copies of all such data to the ENGINEER for each piece of equipment which he furnishes and for all other construction products for which such information is available from manufacturer. Data shall be acceptably identified and accompanied with a letter of transmittal.

+ + END OF SECTION + +

SECTION 1E7

SURVEY DATA

1.1 GENERAL

A. CONTRACTOR shall keep neat legible notes of all measurements and calculations made by him while surveying and laying out the Work.

1.2 SUBMITTAL

A. One copy of all notes shall be furnished to the ENGINEER and one copy furnished to the OWNER with other records upon final completion.

+ + END OF SECTION + +

SECTION 1E8

SCHEDULE OF VALUES

1.1 GENERAL

A. The Schedule of Values is an itemized list that establishes the value or cost of each part of the Work. It shall be used as the basis for preparing progress payments and may be used as a basis for negotiations concerning additional work or credits which may arise during the construction. Quantities and unit prices may be included in the schedule when approved by or required by the ENGINEER.

1.2 PREPARATION

A. Schedule shall show breakdown of labor, materials, equipment and other costs used in preparation of the Bid.

B. Costs shall be in sufficient detail to indicate separate amounts for each Section of the Specifications.

C. CONTRACTOR may include an item for bonds, insurances, temporary facilities and job mobilization. This item shall be included for payment at a rate of 25 percent per month for the first four months.

D. The Schedule of Values shall be prepared on 8-1/2-inch by 11-inch white paper.

E. Use Table of Contents of the Specifications as basis for Schedule format and identify each item with number and title in the Table of Contents. List sub-items of major products or systems as appropriate or when requested by ENGINEER.

F. When requested by the ENGINEER, support values with data that will substantiate their correctness.

G. The sum of the individual values shown on the Schedule of Values must equal the total Contract Price.

H. Each item shall include a directly proportional amount of the CONTRACTOR'S overhead and profit.

I. Schedule shall show the purchase and delivery costs for materials and equipment that the CONTRACTOR anticipates he shall request payment for prior to their installation.

1.3 SUBMITTAL

A. Submit two copies of Schedule to the ENGINEER for approval at least 20 days prior to submitting first application for a progress payment. After review by ENGINEER, revise and resubmit Schedule as required until it is approved.

+ + END OF SECTION + +

SECTION 1E9

CONSTRUCTION PHOTOGRAPHS

1.1 GENERAL

A. CONTRACTOR shall retain a professional photographer to perform the services specified below.

B. Obtain ENGINEER'S approval of the photographer selected prior to taking first photographs. Submit qualifications and experience record of the photographer to ENGINEER.

1.2 PHOTOGRAPHS

A. Take a minimum of 200 color photographs during the construction period. The maximum number of color photographs required will be 500.

B. Take 200 color photographs of the completed or substantially completed Work.

C. Photographs shall be taken approximately twice each month.

D. The ENGINEER will approve the views to be taken and select the time at which they will be taken.

E. A minimum of 5 photographs shall be taken each time the photographer is at the site.

1.3 PRINTS

A. Furnish three prints of each photograph to the ENGINEER as soon as they are available from the photographer.

B. Furnish additional photographs or prints requested by the ENGINEER at cost.

C. Provide high quality 5-inch by 7-inch standard weight prints with a matte finish.

D. Place the following information on the back of each print:
   1. Date photograph was taken.
   2. Title of Project.
   3. Description of view shown in photograph.
   4. Name and address of photographer.
   5. Photographer's numbered identification of exposure.

1.4 PRECONSTRUCTION PHOTOGRAPHS

A. General
   1. It is the CONTRACTOR'S responsibility to take a sufficient number of preconstruction photographs so as to resolve any disputes which may arise regarding the conditions prior to and subsequent to construction.

2. If a dispute arises where no preconstruction photographs were taken, the disputed area shall be restored to the extent directed by the ENGINEER and to the complete satisfaction of the ENGINEER.
3. The CONTRACTOR must furnish one set of color prints of the preconstruction photographs to the ENGINEER, and must make others available for review in settling any disputes.
4. The ENGINEER may, at his option, take additional preconstruction photographs which may be used to settle disputes, but he will not be required to make these photographs available to the CONTRACTOR.
5. Preconstruction photographs taken by the CONTRACTOR will not be considered as part of the required number of construction photographs required in Paragraph 1.2 above.

+ + END OF SECTION + +

SECTION 1F1

TESTING LABORATORY SERVICES

1.1 GENERAL

A. The OWNER will employ and pay for an independent testing laboratory to perform the specified services.

B. Inspection, sampling and testing shall be as specified in the individual Sections. These include:
   1. Soils Compaction, Section 2D1.
   2. Crushed Stone and Gravel, Section 2D5.
   3. Bituminous Paving, Section 2I2.
   4. Concrete, Section 3D. Testing for concrete design mix is included under Section 3D and is at the expense of the CONTRACTOR.
   5. Mortar, Section 4A.
   6. Concrete Unit Masonry, Section 4C3.
   7. Welding Tests, Section 5A1.
   8. Filter Media, Section 13U2.

C. The OWNER will pay for the testing listed above except for repeat testing which results from the CONTRACTOR'S negligence or his repeated failure to meet Specification requirements.

D. CONTRACTOR shall pay for:
   1. Tests not listed above.
   2. Tests made for the CONTRACTOR'S convenience.
   3. Repeat tests required because of the CONTRACTOR'S negligence or repeated failure to meet Specification requirements.
   4. Tests specified to be the CONTRACTOR'S responsibility.

E. The testing laboratory is not authorized to approve or accept any portion of the Work; rescind, alter or augment the requirements of the Contract Documents; or perform any duties of the CONTRACTOR.

1.2 QUALIFICATIONS OF LABORATORY

A. Where applicable, the testing laboratory will meet "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories and the basic requirements of ASTM E329 "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction."

B. Testing equipment used by the laboratory will be calibrated at maximum 12-month intervals by devices of accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.

1.3 LABORATORY DUTIES

A. The testing laboratory will:
   1. Cooperate with ENGINEER and CONTRACTOR and provide qualified personnel promptly on notice.
   2. Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; ascertain compliance with requirements of Contract Documents.

3. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies of Work which are observed during performance of services.
4. Promptly submit 5 copies of reports of inspections and tests to ENGINEER, including:
   a. Date issued.
   b. Contract number.
   c. Project title and number.
   d. Testing laboratory name and address.
   e. Date of inspection or sampling.
   f. Record of temperature and weather.
   g. Date of test.
   h. Identification of product and Specification Section.
   i. Location in Project.
   j. Type of inspection or test.
   k. Results of tests and observations regarding compliance with Contract Documents.
5. Perform additional tests and services as required by OWNER.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. The CONTRACTOR shall:
   1. Cooperate with laboratory personnel, provide access to Work and to manufacturer's operations.
   2. Provide and deliver to laboratory, preliminary representative samples of materials, cylinders, etc., to be tested, in required quantities.
   3. Furnish copies of product test reports.
   4. Provide to the laboratory the preliminary design mix proposed for concrete, and other material mixes that require testing by the testing laboratory.
   5. Furnish labor and facilities:
      a. To provide access to Work to be tested.
      b. To obtain and handle samples at the site.
      c. To facilitate inspections and tests.
      d. For laboratory's exclusive use for storage and curing of test samples.
      e. For forms for preparing concrete test beams and cylinders.
   6. Notify laboratory and ENGINEER sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.
   7. Arrange with laboratory and pay for, additional samples and tests required for CONTRACTOR'S convenience.

+ + END OF SECTION + +

SECTION 1F3

SPECIAL INSPECTIONS

1.1 GENERAL

A. The following types of Work will be subject to Special Inspections, which may be performed by the ENGINEER or the Resident Project Representative, or by such other special inspector as the OWNER may employ. All references to "Code" or "Building Code" in the Section refer to the _____ Edition of the Uniform Building Code as amended and adopted by the City of Glendale.

1. CONCRETE: During the taking of test specimens and placing of all reinforced concrete and pneumatically placed concrete.
   a. EXCEPTIONS:
      1) Concrete for foundations conforming to the minimum requirements of Table No. 29-A of this code (Uniform Building Code) and for Group R, Division 3 and Group M, Division 1 Occupancies, provided the building official finds no special hazards exist.
      2) For foundation concrete when the structural design is based on a f'c no greater than 2000 psi.
      3) Nonstructural slabs on grade, including prestressed slabs on grade when effective prestress in concrete is less than 150 pounds per square inch.
      4) Site work concrete full-supported on earth and concrete where no special hazard exists.
2. DUCTILE MOMENT-RESISTING CONCRETE FRAME: As required by Section 2625(j) of the Uniform Building Code.
   a. During all stressing and grouting of prestressed concrete.
   b. During placing of reinforcing steel, placing of tendons and prestressing steel for all concrete required to have special inspection by Item No. 1.
   c. EXCEPTION: The special inspector need not be present during entire reinforcing steel and prestressing steel-placing operations, provided he has inspected for conformance with the approved plans prior to the closing of forms or the delivery of concrete to the job site.
4. WELDING:
   a. Ductile moment-resisting steel frames. As required by Section 2722(f) of the Uniform Building Code.
   b. All structural welding, including welding of reinforcing steel.
   c. EXCEPTIONS:
      1) When welding is done in an approved fabricator's shop.
      2) When approved by the building official, single-pass fillet welds when stressed to less than 50 percent of allowable stresses and floor and roof deck welding and welding studs when used for structural diaphragm or composite systems may have periodic inspections as defined in Section 306(e) of the Uniform Building Code. For periodic inspection, the inspector shall check qualifications of welders at start of work and then make final inspection of all welds for compliance prior to completion of welding.

5. HIGH-STRENGTH BOLTING: During all bolt installations and tightening operations.
   a. EXCEPTIONS:
      1) The special inspector need not be present during the entire installation and tightening operation, provided he has:
         (i) Inspected the surfaces and bolt type for conformance to plans and specifications prior to start of bolting, and
         (ii) Will, upon completion of all bolting, verify the minimum specified bolt tension for 10 percent of the bolts for each connection, with a minimum of two bolts per connection.
      2) In bearing-type connections when threads are not required by design to be excluded from the shear plane, inspection prior to or during installation will not be required.
6. STRUCTURAL MASONRY: During preparation of masonry wall prisms, sampling and placing of all masonry units, placement of reinforcement, inspection of grout space, immediately prior to closing of cleanouts and during all grouting operations. Where the f'm is less than 2600 psi and special inspection stresses are used, test specimens may consist of either one prism test for each 5000 square feet of wall area or a series of tests based on both grout and mortar for the first three consecutive days and each third day thereafter.
   a. EXCEPTION: Special inspection will not be required for structures designed in accordance with the values in appropriate tables for non-continuous inspection.
7. REINFORCED GYPSUM CONCRETE: When cast-in-place Class "B" gypsum concrete is being mixed and placed.
8. INSULATING CONCRETE FILL: During the application of insulating concrete fill when used as part of a structural system.
   a. EXCEPTION: The special inspections may be limited to an initial inspection to check the deck surface and placement of reinforcing. The special inspector shall supervise the preparation of compression test specimens during this initial inspection.
9. SPRAYED-ON FIRE-PROOFING: As required by Uniform Building Code Standard No. 43-8.
10. PILING, DRILLED PIERS AND CAISSONS: During driving and testing of piles and construction of cast-in-place drilled piles or caissons. See Items Nos. 1 and 3 for concrete and reinforcing steel inspection.
11. SPECIAL GRADING, EXCAVATION AND FILLING: During earthwork excavations, grading and filling operations inspection to satisfy the requirements of Chapter 29 and Chapter 70 (Appendix) of the Uniform Building Code.
12. SPECIAL CASES: Work which, in the opinion of the building official, involves unusual hazards.
13. APPROVED FABRICATORS: Special inspections required by this section and elsewhere in this code shall not be required where the work is done on the premises of a fabricator registered and approved by the building official to perform such work without special inspection. The certificate of registration shall be subject to revocation by the building official if it is found that any work done pursuant to the approval is in violation of this code. The approved fabricator shall submit a Certificate of Compliance that the work was performed in accordance with the approved plans and specifications to the building official and to the engineer or architect of record. The approved fabricator's qualifications shall be contingent on compliance with the following:

a. The fabricator has developed and submitted a detailed fabrication procedural manual reflecting key quality control procedures which will provide a basis for inspection control of workmanship and the fabricator plant.
b. Verification of the fabricator's quality control capabilities, plant and personnel as outlined in the fabrication procedural manual shall be by an approved inspection or quality control agency.
c. Periodic plant inspections shall be conducted by an approved inspection or quality control agency to monitor the effectiveness of the quality control program.
d. It shall be the responsibility of the inspection or quality control agency to notify the approving authority in writing of any change to the procedural manual. Any fabricator approval may be revoked for just cause. Re-approval of the fabricator shall be contingent on compliance with quality control procedures during the past year.

1.2 SPECIAL INSPECTOR

A. The special inspector shall be a qualified person who shall demonstrate his competence to the satisfaction of the regulatory authorities for inspection of the particular type of construction or operation requiring special inspection.

1.3 DUTIES AND RESPONSIBILITIES OF SPECIAL INSPECTOR

A. The special inspector shall observe the Work assigned to be certain it conforms to the approved design drawings and Specifications.

B. The special inspector shall furnish inspection reports to the regulatory authorities, the ENGINEER and other designated persons. All discrepancies shall be brought to the immediate attention of the CONTRACTOR for correction, then, if uncorrected, to the ENGINEER and regulatory authorities.

C. The special inspector shall submit a final signed report stating whether the Work requiring special inspection was, to the best of his knowledge, in conformance with the approved plans and specifications and the applicable workmanship provision of these codes.

1.4 PERIODIC SPECIAL INSPECTIONS

A. Some inspections may be made on a periodic basis and satisfy the requirements of continuous inspection, provided this periodic scheduled inspection is performed as outlined in the project plans and specifications and approved by the regulatory authorities.

+ + END OF SECTION + +

SECTION 1G2

TEMPORARY ELECTRICITY

1.1 GENERAL

A. Temporary electrical service shall be provided by the CONTRACTOR until Substantial Completion of the Project unless otherwise agreed by ENGINEER.

B. All costs, including the charge for power consumed shall be assumed by the CONTRACTOR.

C. The temporary service shall conform to applicable provisions of Division 16.

D. Materials and equipment may be new or used; however, they shall be in first-class, fully serviceable condition and must not create unsafe conditions or violate requirements of applicable codes.

E. Service is required only for lighting, power tools, and similar usages. Electric space heaters and large welding machines are not included herein.

F. All temporary service required beyond the specified locations shall be the responsibility of the CONTRACTOR, who shall furnish his own portable generator or other means.

1.2 POWER SOURCE AND SERVICE REQUIRED

A. Temporary service shall originate from Arizona Public Service.

B. System shall be 240/120 volt, single phase, 60 Hz with sufficient capacity to provide service for construction use by all trades and with the following minimum facilities:
   1. 255 ampere frame with 200 ampere trip main circuit breaker.
   2. 2 pole safety switch, and a 240/120 volt, single phase, 3 wire distribution panel.

C. Service shall be provided and maintained so that power can be secured at any desired point with no more than a 50-foot extension.

D. One power center minimum shall be provided on each floor.

E. Provide each outlet with circuit breaker protection and comply with ground fault protective requirements of NEC Article 210-8.

F. Provide continuous power for all construction site offices 24 hours per day, 7 days per week.

G. Provide power for testing and checking equipment.

H. If OWNER occupies part of facility before final acceptance, cost of electricity for that portion will be shared proportionately.

1.3 INSTALLATION

A. Install temporary work in a neat orderly manner, and make structurally and electrically sound throughout.

B. Maintain installation throughout construction period to give continuous service and to provide safe working conditions.

C. Modify service and rearrange wiring as Work progress requires.

D. Locate all facilities to avoid interference with hoisting, materials handling, storage, traffic areas, existing operable facilities and work under other contracts.

E. Assume responsibility for and return to original condition any part of the permanent electrical system which is used for construction purposes.

1.4 REMOVAL

A. Completely remove temporary materials and equipment after permanent installation is in use.

B. Repair damage caused by the temporary service or its removal and restore to specified or original condition.

+ + END OF SECTION + +

SECTION 1G3

TEMPORARY LIGHTING

1.1 GENERAL

A. Temporary lighting shall be provided by the CONTRACTOR.

1.2 DEFINITIONS

A. Work Lighting: That required to provide adequate illumination for Work being performed.

B. Safety Lighting: That required to provide:
   1. Adequate illumination for safe movement of authorized persons throughout Project.
   2. Adequate illumination for public safety.
   3. Special warning lighting for hazardous conditions.

C. Security Lighting: That required in protection of Project from unauthorized entry.

1.3 DESCRIPTION OF SYSTEM

A. Furnish and install temporary lighting which is required for:
   1. Construction needs.
   2. Safe and adequate working conditions throughout Project.
   3. Public safety.
   4. Security lighting.
   5. Lighting for temporary office, storage and construction buildings.

B. Lighting Intervals:
   1. Minimum Work Lighting:
      a. General: 5-foot candles.
      b. Construction Plant and Shops: 10-foot candles.
      c. For Detail and Finishing Work: 20-foot candles.
      d. For Detailed Testing and Inspection: 30-foot candles.
      e. For First Aid Stations and Infirmaries: 30-foot candles.
   2. Minimum Safety Lighting:
      a. General: 5-foot candles, minimum.
      b. For Hazardous Conditions: As required by applicable codes.
   3. Minimum Security Lighting: 1 foot candle.

C. Periods of Service:
   1. Work Lighting: Continuous from 15 minutes prior to 15 minutes past scheduled work hours on scheduled workdays.
   2. Safety Lighting:
      a. Within Project Site: At all times authorized personnel are present.
      b. Public Areas: At all times.
   3. Security Lighting: All hours of darkness.

D. Maintain strict supervision of use of temporary lighting. Enforce conformance with applicable standards and safe practices, and prevent abuse of services.

1.4 POWER

A. As specified in Section 1G2, Temporary Electricity.

1.5 COSTS OF INSTALLATION AND OPERATION

A. Electrical CONTRACTOR shall pay all costs for temporary lighting, including costs of installation, maintenance and removal.

B. Power Costs: As specified in Section 1G2, Temporary Electricity.

1.6 REQUIREMENTS OF REGULATORY AGENCIES

A. Comply with National Electrical Code, federal, state and local codes, and utility service company regulations.

1.7 USE OF OWNER'S EXISTING SYSTEM

A. Existing systems cannot be used for temporary lighting.

1.8 USE OF PERMANENT SYSTEM

A. Secure OWNER'S written permission for use of system, indicating conditions of use.

B. Furnish and install temporary lamps for temporary lighting.

1.9 MATERIALS

A. Comply with applicable provisions of Division 16.

B. Materials and equipment may be new or used, but must be adequate for purposes intended, and must not create unsafe conditions or violate requirements of applicable codes.

C. Provide all required facilities, including wiring, switches, accessories and supports.

D. At CONTRACTOR'S option, patented specialty products may be used if UL approved.

1.10 RECEPTACLES, FIXTURES

A. Standard products, meeting UL requirements.

B. Provide heavy-duty guards on fixtures.

C. Provide appropriate types of fixtures for environment in which used, in accordance with NEC and NEMA standards.

1.11 INSTALLATION

A. Install temporary work in neat and orderly manner and make structurally and electrically sound throughout.

B. Maintain throughout construction period to give continuous service and to provide safe working conditions.

C. Modify and extend lighting as Work progress requires.

D. Locate to avoid interference with or hazards to:
   1. Work or movement of personnel.
   2. Traffic areas.
   3. Materials handling.
   4. Storage areas.

E. Install lighting switches at entrance to each area, or successive areas, so that progress to all areas of Project may be made through lighted areas.

F. Install exterior security lighting.
   1. Illuminate entire Project site.
   2. Control lighting by photo-electric cell.

1.12 REMOVAL

A. Completely remove temporary materials and equipment, after permanent lighting is in use.

B. Repair damage caused by temporary service, and restore surfaces to specified, or original condition.

C. Immediately prior to completion of Project, remove temporary lamps, install new lamps throughout.

+ + END OF SECTION + +

SECTION 1G4

TEMPORARY HEAT, VENTILATION AND ENCLOSURE

1.1 DEFINITIONS

A. Temporary Enclosure: Sufficient preliminary enclosure of a portion of a structure, or of an entire building, to prevent entrance or infiltration of rainwater, wind or other elements, and to prevent undue heat loss from within the enclosed area.

B. Permanent Enclosure: State of construction at which all moisture and weather-protection elements of construction have been installed in accordance with Contract Documents, either for a portion of structure, or for entire building.

1.2 DESCRIPTION OF SYSTEM

A. Provide temporary heat and ventilation in enclosed areas throughout construction period required to:
   1. Facilitate progress of Work.
   2. Protect Work and all products from rain, snow, dampness and cold.
   3. Prevent moisture condensation on surfaces.
   4. Thaw out and raise temperature of ground or materials for proper execution of Work.
   5. Provide suitable ambient temperatures and humidity levels for installations and curing of materials.
   6. Provide adequate ventilation to meet health regulations for safe working environment.
   7. Allow beneficial occupancy of Work, or portion of Work, prior to final completion, including air conditioning, if applicable.

B. Temperatures Required:
   1. Except where specified otherwise, the limits of the temperatures which shall be maintained during the time of temporary heating are a minimum of 50 F to a maximum of the design temperature of the facility.
   2. During a normal working day, minimum temporary heat for the types of activities indicated shall be as follows:
      a. Placing, setting and curing of concrete, and the erection of masonry units: 50 F.
      b. Application of masonry units: 55 F.
      c. Ten days prior to, during and until completion of the placing of interior woodwork and interior finishes such as varnishing and painting: 70 F.
      d. After application of interior finishes and until substantial completion: 70 F.
   3. Twenty-four hours per day during placing, setting and curing of cementitious materials: As required by Specification Section for each product.
   4. Storage Areas: As required by Specification Section for each product.
   5. Provide temporary enclosures as required to maintain conditions described above.

C. Ventilation Required:
   1. General: Prevent hazardous accumulations of dusts, fumes, mists, vapors or gases in areas occupied during construction.
      a. Provide local exhaust ventilation to prevent harmful dispersal of hazardous substances into atmosphere of occupied areas.
      b. Dispose of exhaust in a manner that will not result in harmful exposure to persons.
      c. Ventilate storage spaces containing hazardous or volatile materials.
   2. Provide adequate ventilation for:
      a. Curing installed materials.
      b. Humidity dispersal as needed to provide suitable ambient conditions for Work.

D. Maintain strict supervision of operation of temporary heating and ventilating equipment:
   1. Enforce conformance with all applicable codes and standards.
   2. Enforce safe practices.
   3. Prevent abuse of services.
   4. Prevent damage to finishes.
   5. Ensure that temporary facilities and equipment do not interrupt the continuous progress of construction operations.

1.3 COSTS OF INSTALLATION AND OPERATION

A. CONTRACTOR shall pay all costs for temporary heat, ventilation, and enclosures required during construction, including cost of installation, fuel, operation, maintenance and removal.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Obtain and pay for permits as required by governing authorities.

B. Comply with federal, state and local laws, ordinances, rules and regulations, and with utility service company regulations.

1.5 USE OF PERMANENT SYSTEM

A. When completed, the permanent heating system may be used to provide temporary heat if the OWNER'S written permission for use of the system is obtained.

B. The following are the conditions for using the permanent heating system:
   1. Building must be sufficiently complete so it can fulfill the requirements as a "Permanent Enclosure."
   2. The permanent system must be substantially complete including the installation and functionability of the systems' operating and safety controls. All heating equipment, piping systems, strainers, filters and associated items should be flushed, cleaned, and prepared for proper operation.
   3. ENGINEER shall approve the time when the permanent system may be operated.

1.6 MATERIALS AND EQUIPMENT

A. Materials may be new or used, but must be adequate for purposes intended, and must not create unsafe conditions nor violate requirements of applicable codes.

B. Provide all required facilities, including piping, wiring and controls.

C. Portable units shall be space heaters which burn gas or oil. They shall be units which meet code requirements and have the following:
   1. Safety controls against explosion, overheating, and carbon monoxide buildup.
   2. Except where otherwise permitted by applicable codes, vent direct-fired units to outside.
   3. Adequate combustion air.

D. Electrical heaters for temporary heat shall not be used.

E. Provide covers or temporary enclosures to protect Work and materials.

1.7 INSTALLATION

A. Install all temporary work in neat, orderly manner and make structurally, mechanically and electrically sound throughout.

B. Maintain to give safe, continuous service at required times, and to provide safe working conditions.

C. Modify and extend system as Work progress requires.

D. Locate units to provide uniform distribution of heat and air movement. When feasible, temporary units shall be located as near as possible to permanent piping.

E. If air conditioning or ventilating duct systems are to be used for drying purposes, provide and maintain temporary filters until permanent filters are installed.

F. Permanently-installed direct radiation units, such as convectors or finned pipes, shall be protected with temporary sheet metal enclosures.

G. Locate to avoid interference with or hazards to:
   1. Work or movement of personnel.
   2. Traffic areas.
   3. Materials handling.
   4. Storage areas.
   5. Finishes.

1.8 REMOVAL

A. Completely remove temporary materials and equipment upon completion of construction.

B. Clean and repair damage caused by temporary installation, and restore all materials and equipment to specified or to original condition.

C. Install new replaceable type filters, or clean permanent filters, if permanent HVAC facilities were used for temporary heat.

+ + END OF SECTION + +

SECTION 1G5

TEMPORARY WATER

1.1 DESCRIPTION OF SYSTEM

A. Furnish and install temporary water service for entire Project for use throughout construction period.

B. Users shall provide water hoses from hose bibbs to point of operations.

C. Provide water for sanitary facilities, first-aid facilities, fire protection, field offices, cleaning, disinfection and testing.

D. Maintain adequate volume of water for all purposes.

E. Potable Water Source:
   1. Supplier: CONTRACTOR shall provide water source by connecting to existing utility mains.

   2. Provide minimum 6-inch supply service and supply and install meter satisfactory to water utility.

F. Maintain strict supervision of use of temporary services:
   1. Enforce conformance with applicable codes and standards.
   2. Enforce sanitary practices.
   3. Prevent abuse of services.
   4. Prevent wasteful use of water.
   5. Protect system from freezing.

1.2 COSTS OF INSTALLATION AND OPERATION

A. CONTRACTOR shall pay all costs, except as specified herein, for temporary water service, including costs of supply, installation, maintenance and removal of pipe and equipment.

B. CONTRACTOR shall pay costs for water used by all trades.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

A. Obtain and pay for permits, fees, and deposits required by governing authorities.

B. Comply with federal, state and local laws, ordinances, rules and regulations, and with utility service company regulations.

1.4 USE OF OWNER'S EXISTING SYSTEM

A. Use existing system for temporary water for construction.

B. Modify and extend system as necsaary to meet temporary water requirements.

C. Upon completion of Work, restore existing system to specified, or original condition.

1.5 MATERIALS

A. Comply with applicable provisions of Division 15.

B. Materials may be new or used, but must be adequate for purpose required, must be sanitary, and must not violate requirements of applicable codes.

C. Provide all required facilities, including piping, valves, pumps, pressure regulators, tanks and other appurtenances.

1.6 INSTALLATION

A. Install Work in a neat and orderly manner and make structurally and mechanically sound throughout.

B. Maintain to provide continuous service.

C. Modify and extend service as Work progress requires.

D. Locate piping and outlets to provide service convenient to work stations and to avoid interference with traffic and work areas, materials handling equipment, and storage areas.

E. Do not run piping on floor or on ground.

F. Provide drip pan under each hose bibb located within buildings and connect drain to sewer.

G. Provide insulation, or other means as required, to prevent pipes from freezing.

H. When necessary to maintain pressure, provide temporary pumps, tanks and compressors.

1.7 REMOVAL

A. Completely remove temporary materials and equipment upon completion of construction.

B. Clean, and repair damage caused by installation, and restore to specified, or original condition.

+ + END OF SECTION + +

SECTION 1G6

TEMPORARY SANITARY AND FIRST-AID FACILITIES

1.1 GENERAL

A. The CONTRACTOR shall provide temporary sanitary and first-aid facilities for use throughout the construction period including:
   1. Potable water and sanitary drinking cups.
   2. Sanitary drinking fountains where feasible.
   3. Enclosed toilet facilities.
   4. Suitable general employee washing facilities.
   5. First aid stations at or immediately adjacent to all major work areas and in the temporary field offices.
   6. Posting telephone numbers of physicians, hospitals and ambulance services by each telephone at the Project site.
   7. At least one person thoroughly trained in first-aid procedures shall be present on the site whenever Work is in progress. This person must have a certificate indicating that he has completed a first-aid training course conducted by the American Red Cross or other approved agency.

B. Provide facilities and fixtures in compliance with OSHA and all other applicable federal, state and local laws and regulations.

C. Maintain strict supervision of use of facilities.

D. Maintain, service and clean facilities and keep them supplied continuously with soap, towels, paper and all other required supplies.

E. Enforce proper use of sanitary facilities, including preventing the committing of nuisances in buildings on the site.

F. Dispose of all wastes in conformance with applicable regulations.

1.2 COSTS OF INSTALLATION AND OPERATION

A. The CONTRACTOR shall pay all costs including installation, maintenance and removal.

1.3 USE OF PERMANENT FACILITIES

A. Permanent facilities shall not be used by construction personnel.

1.4 INSTALLATION AND REMOVAL

A. Temporary flush toilets or portable toilets may be used.

B. Comply with all applicable provisions of Division 15.

C. Completely remove temporary materials and equipment upon completion of construction and restore all damaged facilities to original condition.

+ + END OF SECTION + +

SECTION 1G7

TEMPORARY FIRE PROTECTION

1.1 GENERAL

A. CONTRACTOR shall conform to the fire protection and prevention requirements specified herein as well as those which may be established by federal, state or local governmental agencies.

B. CONTRACTOR shall comply with all applicable provisions of NFPA Standard No. 241, Safeguarding Building Construction and Demolition Operations.

1.2 REQUIRED FIRE FIGHTING EQUIPMENT

A. Provide portable fire extinguishers, rated not less than 2A or 5B in accordance with NFPA Standard No. 10, Portable Fire Extinguishers, for each temporary building and for every 3000 square feet of floor area under construction.

B. Locate portable fire extinguishers 50 feet maximum from any point in the protection area.

1.3 FIRE PREVENTION AND SAFETY MEASURES

A. Prohibit smoking in hazardous areas. Post suitable warning signs in areas which are continuously or intermittently hazardous.

B. Use metal safety containers for storage and handling of flammable and combustible liquids.

C. Do not store flammable or combustible liquids in or near stairways or exits.

D. Maintain clear exits from all points in the Work.

1.4 COSTS OF INSTALLATION

A. CONTRACTOR shall pay all costs including installation, maintenance, and removal.

+ + END OF SECTION + +

SECTION 1G9

PROTECTION OF THE WORK AND PROPERTY

1.1 GENERAL

A. The CONTRACTOR shall be responsible for providing all precautions, and programs, and taking all actions necessary to protect the Work and all public and private property and facilities from damage, loss or vandalism, as specified in the General Conditions and herein.

B. In order to prevent damage, injury or loss, the CONTRACTOR'S actions shall include, but not be limited to, the following:
   1. Store apparatus, materials, supplies, and equipment in an orderly, safe manner that will not unduly interfere with the progress of the Work or utility service company.
   2. Provide suitable storage facilities for all materials which are liable to injury by exposure to weather, theft, breakage, or otherwise.
   3. Place upon the Work or any part thereof only such loads as are consistent with the safety of that portion of the Work.
   4. Clean up frequently all refuse, rubbish, scrap materials, and debris caused by his operations, to the end that at all times the site of the Work shall present a safe, orderly and workmanlike appearance.
   5. Provide barricades and guard rails around openings, for scaffolding, for temporary stairs and ramps, around excavations, elevated walkways and other hazardous areas.

C. CONTRACTOR shall not, except after written consent from proper parties, enter or occupy with men, tools, materials or equipment, privately-owned land except on easements provided herein.

D. CONTRACTOR shall assume full responsibility for the preservation of all public and private property or facility on or adjacent to the site. If any direct or indirect damage is done by or on account of any act, omission, neglect or misconduct in the execution of the Work by the CONTRACTOR, it shall be restored by the CONTRACTOR, at his expense, to a condition equal to that existing before the damage was done.

E. Where necessary to protect the Work or materials from damage, the CONTRACTOR shall at his expense provide suitable drainage and erect such temporary structures as are necessary to protect the Work or materials from damage. The suspension of the Work or the granting of an extension of time for any cause whatever shall not relieve the CONTRACTOR of his responsibility for the Work and materials.

F. Whenever any notice is required to be given by the OWNER or the CONTRACTOR to any adjacent or adjoining landowner or other party before commencement of any Work, such notice shall be given by the CONTRACTOR.

1.2 BARRICADES AND WARNING SIGNALS

A. Where Work is performed on or adjacent to any roadway, right-of-way, or public place, CONTRACTOR shall furnish and erect barricades, fences, lights, warning signs, and danger signals, shall provide watchmen, and shall take other precautionary measures for the protection of persons or

property and of the Work. Barricades shall be painted to be visible at night. From sunset to sunrise, the CONTRACTOR shall furnish and maintain at least one light at each barricade. Sufficient barricades shall be erected to keep vehicles from being driven on or into Work under construction. CONTRACTOR shall furnish watchmen in sufficient numbers to protect the Work. The CONTRACTOR'S responsibility for the maintenance of barricades, signs, lights, and for providing watchmen shall continue until the Project is accepted by the OWNER.

1.3 PROTECTION OF EXISTING STRUCTURES

A. Underground Structures:

1. Underground structures are defined to include, but not be limited to, all sewer, water, gas, and other piping, cable television, and manholes, chambers, electrical conduits, tunnels and other existing subsurface work located within or adjacent to the limits of the Work.
2. All underground structures known to ENGINEER except water, cable television, sewers, electric and telephone service connections are shown on the Drawings. This information is shown for the assistance of CONTRACTOR in accordance with the best information available, but is not guaranteed to be correct or complete.
3. CONTRACTOR shall explore ahead of his trenching and excavation work and shall uncover all obstructing underground structures sufficiently to determine their location, to prevent damage to them and to prevent interruption to the services which such structures provide. If CONTRACTOR damages an underground structure, he shall restore it to original condition at his expense.
4. Necessary changes in the location of the Work may be made by ENGINEER, to avoid unanticipated underground structures.
5. If the CONTRACTOR discovers utility facilities not identified in the Contract Documents or in a position different from that shown in the Contract Documents, he shall immediately notify in writing the ENGINEER and the owner of the utility facility. In case it should be necessary to remove, relocate, protect or temporarily maintain an underground structure or other subsurface facility, and it is not otherwise provided for the Contract Documents, the Work on such underground structure or facility shall be performed and paid for as follows:
   a. When it is necessary to remove, relocate, protect, or temporarily maintain an existing underground structure or other subsurface facility not indicated in the Contract Documents with reasonable accuracy, the OWNER will compensate the CONTRACTOR for the costs of locating, for the costs of repairing damage not due to the failure of the CONTRACTOR to exercise reasonable care, for the costs of removing, relocating, protecting, or temporarily maintaining such underground structures and facilities, and for the costs of equipment on the site necessarily idled during such Work. These costs, the Work to be done by the CONTRACTOR In locating, removing, relocating, protecting, or temporarily maintaining such underground structures and facilities shall be covered by a written Change Order conforming to the provisions of Articles 10, 11 and 12 of the General Conditions. The OWNER may make changes in the alignment and grade of the Work to obviate the necessity to remove, relocate,

protect, or temporarily maintain such underground structures or facilities or to reduce the costs of the Work involved in removing, relocating, protecting or temporarily maintain such underground structures and facilities. Changes in alignment and grade will be ordered in accordance with the provisions of Article 10 of the General Conditions.

6. Except as otherwise specifically provided in the Contract Documents, the OWNER, the ENGINEER and their consultants and representatives shall not be liable for any loss sustained by the CONTRACTOR as a result of any variance of such conditions as shown on the Drawings and the actual conditions revealed during the progress of the Work or otherwise.
7. Notwithstanding anything stated herein, the CONTRACTOR shall strictly comply with all requirements set forth in Arizona Revised Statutes 40-350.21-29 relating to underground structures and facilities.

B. Surface Structures:
1. Surface structures are defined as all existing buildings, structures and other facilities above the ground surface. Included with such structures are their foundations or any extension below the surface. Surface structures include, but are not limited to, buildings, tanks, walls, bridges, roads, dams, channels, open drainage, piping, poles, wires, posts, signs, markers, curbs, walks and all other facilities that are visible above the ground surface.

C. Protection of Underground and Surface Structures:
1. CONTRACTOR shall sustain in their places and protect from direct or indirect injury all underground and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure. Before proceeding with the Work of sustaining and supporting such structure, CONTRACTOR shall satisfy the ENGINEER that the methods and procedures to be used have been approved by the party owning same.
2. CONTRACTOR shall assume all risks attending the presence or proximity of all underground and surface structures within or adjacent to the Work area. CONTRACTOR shall be responsible for all damage and expense for direct or indirect injury caused by his Work to any structure. CONTRACTOR shall repair immediately all damage caused by his Work, to the satisfaction of the owner of the damaged structure.

D. All other existing surface facilities, including but not limited to, guard rails, posts, guard cables, signs, poles, markers, and curbs, which are temporarily removed to facilitate installation of the Work, shall be replaced and restored in their original condition at CONTRACTOR'S expense.

E. When any survey monument or property marker, whether of stone, concrete, wood or metal, is in the line of any trench or other Work and may have to be removed, the CONTRACTOR shall notify the ENGINEER in advance of removal. Under no circumstances shall any monument or marker be removed or disturbed by the CONTRACTOR or by any of his subcontractors, employees or agents, without permission of the ENGINEER. The CONTRACTOR shall furnish the necessary labor and materials required to re-establish any survey monument or property marker under the direction of the ENGINEER.

Should any monuments or markers be destroyed through accident, neglect, or as a result of the Work under this Contract, the CONTRACTOR shall, at his own expense, employ a land surveyor licensed in the State of Arizona to re-establish the monument or marker.

1.4 PROTECTION OF FLOORS AND ROOFS

A. CONTRACTOR shall protect floors and roofs during entire construction period.

B. Proper protective covering shall be used when moving heavy equipment, handling materials or other loads, when painting, handling mortar and grout and when cleaning walls and ceilings.

C. Use metal pans to collect all oil and cuttings from pipe, conduit, or rod threading machines and under all metal cutting machines.

D. Concrete floors less than 28 days old shall not be loaded without written permission of the ENGINEER. No floor, roof or slab shall be loaded in excess of its design loading.

E. Roofs shall not be loaded without written permission of the ENGINEER.

F. CONTRACTOR shall restrict access to roofs and keep clear of existing roofs except as required by the new Work.

G. If access to roofs is required, roofing, parapets, openings and all other construction on or adjacent to roof shall be protected with suitable plywood or other approved means.

1.5 PROTECTION OF INSTALLED PRODUCTS

A. Provide protection of installed products to prevent damage from subsequent operations. Remove protection facilities when no longer needed, prior to completion of Work.

B. Control traffic to prevent damage to equipment, materials and surfaces.

C. Provide coverings to protect equipment and materials from damage.
   1. Cover projections and wall corners of openings in areas used for traffic and for passage of products in subsequent Work.

+ + END OF SECTION + +

SECTION 1G10

SECURITY

1.1 GENERAL

A. CONTRACTOR shall safely guard all Work, materials, equipment and property from loss, theft, damage and vandalism. CONTRACTOR'S duty to safely guard property shall include the OWNER'S property and other private property from injury or loss in connection with the performance of the Contract.

B. He shall employ watchmen as needed to provide the required security and prevent unauthorized entry.

C. CONTRACTOR may make no claim against the OWNER for damage resulting from trespass.

D. CONTRACTOR shall make good all damage to property of OWNER and others arising from failure to provide adequate security.

E. If fencing or barriers are breached or removed for purposes of construction, CONTRACTOR shall provide and maintain temporary security fencing equal to the existing in a manner satisfactory to the ENGINEER and OWNER.

F. Security measures taken by the CONTRACTOR shall be at least equal to those usually provided by OWNER to protect his existing facilities during normal operation.

G. Maintain security program throughout construction until OWNER's acceptance and occupancy precludes need for CONTRACTOR'S security program.

+ + END OF SECTION + +

SECTION 1G11

ACCESS ROADS AND PARKING AREAS

1.1 GENERAL

A. CONTRACTOR shall provide all temporary construction roads, walks, storage areas, and parking areas required during construction and for use of emergency vehicles. Temporary roads, walks, storage areas, and parking areas shall be designed and maintained by the CONTRACTOR so as to be fully usable in all weather conditions.

B. The location and method of constructing temporary roads, walks, storage areas, and parking areas shall be presented to the ENGINEER for approval before any Work is begun.

C. CONTRACTOR shall prevent interference with traffic and the OWNER'S operations on existing roads. CONTRACTOR shall indemnify and save harmless the OWNER form any expenses caused by CONTRACTOR"S operations over these roads.

D. Roads, walks, storage areas, and parking areas damaged by CONTRACTOR shall be restored to their original condition by the CONTRACTOR, subject to approval of the OWNER or ENGINEER.

E. Temporary roads, walks, storage areas, and parking areas shall be removed by the CONTRACTOR prior to final acceptance and the surface returned to its original condition, unless otherwise required by the Contract Drawings.

+ + END OF SECTION + +

F. Four electric wall outlets.

G. Private telephone service and installation charges. In addition pay all local and long distance charges up to an average of $200 per month over the duration of the Contract. Telephone shall be connected to an audible bell on outside wall of office. Telephone service shall include a minimum of four telephones - one in each office and two in the remaining area.

H. Chilled and hot drinking water with cups.

I. Private sanitary facilities with one water closet and one lavatory and medicine cabinet.

J. All plumbing facilities and sewers required. Protect from freezing.

1.5 MINIMUM FURNISHINGS

A. Three 5-drawer desks.

B. Three swivel desk chairs.

C. Five side chairs.

D. One drafting table with built-in drawer, drafting stool and light.

E. One plan rack to hold twelve racks of drawings.

F. Four 4-drawer file cabinets with minimum fire resistance rating of one hour.

G. One 2-door storage cabinet.

H. Book shelving and bookcase.

I. Two waste baskets.

J. One tack board 30 inches by 36 inches.

K. Fire extinguishers.

L. Identifying exterior sign at least 24 inches by 36 inches with wording acceptable to ENGINEER.

M. Two First-aid kits.

N. One printing-type calculating machine, 10-digit minimum.

O. Outdoor thermometer mounted in shade, but visible for easy reading from inside office.

P. Electric clock.

Q. Ten protective helmets for use by ENGINEER, OWNER, and visitors.

R. One refrigerator, 10 cubic feet capacity.

S. One FAX machine with separate telephone line.

T. One Xerox copying machine.

1.6 MAINTENANCE

A. Continuous maintenance of office and services. Cleaned not less than once per week.

B. Provide soap, paper towels, cleansers, janitorial service and implements.

C. Repair immediately any damage, leaks or defective service.

1.7 REMOVAL

A. Remove office upon final acceptance or when directed by ENGINEER.

B. The office, together with the equipment and facilities thereof, except miscellaneous small supplies, shall become the property of the CONTRACTOR and shall be removed by him from the site of the Work.

+ + END OF SECTION + +

SECTION 1G16

CONTRACTOR'S FIELD OFFICE AND SHEDS

1.1 GENERAL

A. The CONTRACTOR shall provide a CONTRACTOR'S field office with the minimum facilities specified. Provide all required storage and work sheds.

B. Field Office and Furnishings:
   1. As required by the CONTRACTOR but with sufficient room for project meetings.
   2. Include conference table and chairs sufficient for 12 persons.
   3. Telephone service.
   4. Light and temperature as specified under ENGINEER'S Field Office.
   5. Six protective helmets for visitor's use.
   6. Exterior identifying sign.
   7. Other furnishings at the CONTRACTOR'S option.

C. Provide one set of all Contract Documents in the office for ready reference at all times by interested parties.

D. Remove office and sheds upon Final Acceptance unless otherwise approved by the ENGINEER.

+ + END OF SECTION + +

SECTION 1G17

STORAGE OF MATERIAL

1.1 GENERAL

A. Store and protect materials in accordance with manufacturer's recommendations and requirements of these Specifications.

B. CONTRACTOR shall make all arrangements and provisions necessary for the storage of materials and equipment. All excavated materials, construction equipment, and materials and equipment to be incorporated into the Work shall be placed so as not to damage any part of the Work or existing facilities and so that free access can be had at all times to all parts of the Work and to all public utility installations in the vicinity of the Work. Materials and equipment shall be kept neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants and occupants. Arrange storage in a manner to provide easy access for inspection.

C. Areas available on the construction site for storage of material and equipment shall be as shown or approved by the ENGINEER.

D. Materials and equipment which are to become the property of the OWNER shall be stored to facilitate their inspection and insure preservation of the quality and fitness of the Work, including proper protection against damage by freezing and moisture. They shall be placed in inside storage areas unless otherwise acceptable to OWNER.

E. Lawns, grass plots or other private property shall not be used for storage purposes without written permission of the OWNER or other person in possession or control of such premises.

F. CONTRACTOR shall be fully responsible for loss or damage to stored materials and equipment.

G. Do not open manufacturers containers until time of installation unless recommended by the manufacturer or otherwise specified.

H. Do not store products in the structures being constructed unless approved in writing by the ENGINEER.

1.2 UNCOVERED STORAGE

A. The following types of materials may be stored out-of-doors without cover:
   1. Masonry units.
   2. Reinforcing steel.
   3. Structural steel.
   4. Piping.
   5. Precast concrete items.
   6. Castings.
   7. Concrete aggregates.

B. Store the above materials on wood blocking (except concrete aggregates) so there is no contact with the ground.

1.3 COVERED STORAGE

A. The following types of materials may be stored out-of-doors if covered with material impervious to water:
   1. Rough lumber.
   2. Fiberglass items.
   3. Equipment, except electrical and electronic equipment, control panels, and similar equipment.
   4. Mortar and grout materials for masonary work, except cement.

B. Tie down covers with rope and slope to prevent accumulation of water on covers.

C. Store materials on wood blocking.

1.4 FULLY PROTECTED STORAGE

A. Store all electrical and electronic equipment, control panels, and like equipment and materials in climate controlled and cooled buildings which have a concrete or wooden floor, a roof, and fully closed walls on all sides.

B. Store calking and sealants, paint products, and pipe insulation indoors, in a cool and dry location.

C. Cement shall be stored in weathertight buildings, bins or silos which will provide protection from dampness and contamination.

D. Protect mechanical and electrical equipment from being contaminated by dust, dirt and moisture.

E. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

1.5 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on scheduled basis to assure that:
   1. State of storage facilities is adequate to provide required conditions.
   2. Required environmental conditions are maintained on a continuous basis.
   3. Products exposed to elements are not adversely affected.

B. Mechanical and electrical equipment which requires long term storage shall have complete manufacturer's instructions for servicing accompanying each item, with notice of enclosed instructions shown on exterior of package.
   1. Comply with manufacturer's instructions on scheduled basis.
   2. Space heaters which are part of electrical equipment shall be connected and operated continuously until equipment is placed in service.

+ + END OF SECTION + +

SECTION 1G18

ON-SITE FACILITIES FOR TESTING LABORATORY

1.1 GENERAL

A. CONTRACTOR shall provide on-site facilities for the sole use of the testing laboratory.

B. Facilities furnished include:
   1. One heated, weathertight room, minimum 10 feet square.
   2. One large, tightly constructed, firmly braced, insulated, wooden or steel box which will hold 40 concrete cylinders minimum under conditions as described in ASTM C 31, Making and Curing Concrete Test Specimens in the Field.
   3. Maintain the following:
      a. Minimum Temperature 40°F.
      b. Maximum Temperature 100°F.
      c. Relative Humidity 90%.

C. At the completion of the Project, CONTRACTOR shall remove the facilities provided for the testing laboratory from the site.

+ + END OF SECTION + +

SECTION 1G19

ENVIRONMENTAL CONTROLS

1.1 GENERAL

A. The CONTRACTOR shall provide and maintain methods, equipment, and temporary construction, as necessary to provide controls over environmental conditions at the construction site and adjacent areas and shall remove physical evidence of the temporary facilities at the completion of Work.

B. The CONTRACTOR shall, at his own expense, obtain all required permits for temporary controls unless otherwise specified.

1.2 NOISE CONTROL

A. The CONTRACTOR'S vehicles and equipment shall be such as to minimize noise to the greatest degree practicable. Noise levels shall conform to the latest OSHA standards and in no case will noise levels be permitted which interfere with the work of the OWNER or others.

1.3 DUST CONTROL

A. The CONTRACTOR shall be responsible for controlling objectionable dust caused by his operation of vehicles and equipment, clearing or for any reason whatever. The CONTRACTOR shall apply water and calcium chlorine or use other methods subject to the ENGINEER'S approval which will keep dust in the air to a minimum.

B. Dust control measures shall be maintained at all times to the satisfaction of the ENGINEER, in accordance with the requirements of the Maricopa County Bureau of Air Pollution Control Rules and Regulations.

1.4 PEST AND RODENT CONTROL

A. The CONTRACTOR shall provide rodent and pest control as necessary to prevent infestation of construction or storage areas.
   1. Employ methods and use materials which will not adversely affect conditions at the site or on adjoining properties.

+ + END OF SECTION + +

SECTION 1H1

TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

1.1 GENERAL

A. CONTRACTOR shall make all arrangements for transportation, delivery and handling of equipment, and materials required for prosecution and completion of the Work. Before starting any Work, CONTRACTOR shall arrange with city, municipal, county or state officials, having jurisdiction for the use of routes of travel for hauling equipment and materials including earth and rock, that will result in minimum inconvenience to the traveling public. Routes of travel so scheduled shall be adhered to throughout the course of the Work, unless otherwise approved. If permission of city, municipal, county or state authorities is required for operation of the CONTRACTOR'S equipment on streets and highways, he shall obtain such permission and pay all costs pertaining thereto.

B. Shipments of materials to CONTRACTOR or Subcontractors shall be delivered to the site only during regular working hours. Shipments shall be addressed and consigned to the proper party giving name of Project, street number and city. Shipments shall not be delivered to OWNER except where otherwise directed and any expense incurred by the OWNER in handling materials or equipment will be charged directly to the responsible CONTRACTOR.

C. If necessary to move stored materials and equipment during construction, CONTRACTOR shall move or cause to be moved materials and equipment without any additional compensation.

1.2 DELIVERY

A. Arrange deliveries of products in accord with construction schedules and in ample time to facilitate inspection prior to installation.

B. Coordinate deliveries to avoid conflict with Work and conditions at site and to accommodate the following:
   1. Work of other contractors, or OWNER.
   2. Limitations of storage space.
   3. Availability of equipment and personnel for handling products.
   4. OWNER'S use of premises.

C. Do not have products delivered to Project site until related Shop Drawings have been approved by the ENGINEER.

D. Do not have products delivered to site until required storage facilities have been provided.

E. Have products delivered to site in manufacturer's original, unopened, labeled containers. Keep ENGINEER informed of delivery of all equipment to be incorporated in the Work.

F. Partial deliveries of component parts of equipment shall be clearly marked to identify the equipment, to permit easy accumulation of parts and to facilitate assembly.

G. Immediately on delivery, inspect shipment to assure:
   1. Product complies with requirements of Contract Documents and reviewed submittals.
   2. Quantities are correct.
   3. Containers and packages are intact, labels are legible.
   4. Products are properly protected and undamaged.

1.3 PRODUCT AND EQUIPMENT HANDLING AND UNLOADING

A. Provide facilities and personnel necessary to unload and handle products, equipment, and spare parts by methods to prevent soiling or damage to products or packaging.

B. Provide additional protection during handling as necessary to prevent scraping, marring or otherwise damaging products or surrounding surfaces.

C. Handle products, equipment, and spare parts by methods to prevent bending or overstressing.

D. Lift heavy components only at designated lifting points.

E. Materials and equipment shall at all times be handled in a safe manner and as recommended by the manufacturer or supplier so that no damage will occur to them. Do not drop, roll or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

F. All equipment and spare parts that arrive at the job site during normal working hours shall be unloaded as soon as practicable. The CONTRACTOR will be responsible for all demurrage and similar costs.

+ + END OF SECTION + +

SECTION 1H2

SUBSTITUTIONS

1.1 GENERAL

A. Requests for review of a substitution shall conform to the requirements of Article 6.3 of the General Conditions and shall contain complete data substantiating compliance of proposed substitution with Contract Documents.

1.2 CONTRACTOR'S OPTIONS

A. For materials or equipment (hereinafter products) specified only by reference standard, select product meeting that standard, by any manufacturer, fabricator, supplier or distributor (hereinafter manufacturer). To the maximum extent possible, provide products of the same generic kind from a single source.

B. For products specified by naming several products or manufacturers, select any one of the products or manufacturers named which complies with Specifications.

C. For products specified by naming one or more products or manufacturers and stating "or equal", submit a request for a substitution for any product or manufacturer which is not specifically named.

D. For products specified by naming only one product or manufacturer and followed by words indicating that no substitution is permitted, there is no option and no substitution will be allowed.

E. Where more than one choice is available as a CONTRACTOR'S option, select product which is compatible with other products already selected or specified.

1.3 SUBSTITUTIONS

A. During a period of 30 days after date of commencement of Contract Time, the ENGINEER will consider written requests from CONTRACTOR for substitution of products or manufacturers, and construction methods (if specified).
   1. After end of specified period, requests will be considered only in case of unavailability of product or other conditions beyond the control of CONTRACTOR.

B. Submit five copies of request for substitution. Submit separate request for each substitution. In addition to requirements set forth in Article 6.3 of the General Conditions, include in the request the following:
   1. For products or manufacturers:
      a. Product identification, including manufacturer's name and address.
      b. Manufacturer's literature with product description, performance and test data, and reference standards.
      c. Samples, if appropriate.

d. Name and address of similar projects on which product was used, and date of installation.

2. For construction methods (if specified):
   a. Detailed description of proposed method.
   b. Drawings illustrating method.
3. Such other data as the ENGINEER may require to establish that the proposed substitution is equal to the product, manufacturer or method specified.
4. Cost comparison with products or method specified, and amount of Project cost reduction to the OWNER, where applicable.

C. In making request for substitution, CONTRACTOR represents that:
   1. CONTRACTOR has investigated proposed substitution, and determined that it is equal to or superior in all respects to the product, manufacturer or method specified.
   2. CONTRACTOR will provide the same or better warranties or bonds for proposed substitution as for product, manufacturer or method specified.
   3. The CONTRACTOR waives all claims for additional costs or extension of time related to proposed substitution that subsequently may become apparent.

D. Proposed substitutions will not be accepted if:
   1. Acceptance will require substantial revision of Contract Documents.
   2. They will change design concepts or Specifications.
   3. They will delay completion of the Work, or the work of other contractors.
   4. They are indicated or implied on a Shop Drawing and are not accompanied by a formal request for substitution from the CONTRACTOR.

E. If the ENGINEER determines that a proposed substitute is not equal to that specified, the CONTRACTOR shall furnish the product, manufacturer or method specified at no additional cost to the OWNER.

F. Approval of a substitution will not relieve the CONTRACTOR from the requirement for submission of Shop Drawings as set forth in the Contract Documents.

+ + END OF SECTION + +

SECTION 1H3

STARTING AND PLACING EQUIPMENT IN OPERATION

1.1 GENERAL

A. CONTRACTOR shall initially start-up and place all equipment installed by him into successful operation according to manufacturer's written instructions and as instructed by manufacturer's field representative. Provide all material, labor, tools, equipment, and expendables required.

B. Equipment start-up period, to initiate the training of plant personnel, shall begin after satisfactory completion and acceptance of the field tests and coincidentally with the certified date of substantial completion for the part of the Work for which the equipment is included. If the equipment is not covered by a certificate of substantial completion for a part of the Work, the period shall begin upon substantial completion of the Project.

C. General Activities Include:
   1. Cleaning.
   2. Removing temporary protective coatings.
   3. Flushing and replacing greases and lubricants, where required by manufacturer.
   4. Lubrication.
   5. Check shaft and coupling alignments and reset where needed.
   6. Check and set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
   7. Check and correct if necessary levelling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping which may put stress on pumping equipment connected to it.
   8. All adjustments required.

D. Provide initial filling of lubricants and all other required operating fluids.

E. Also provide fuel, electricity, water, filters, and other expendables required for initial start-up of equipment unless otherwise specified.

1.2 MINIMUM START-UP PROCEDURES

A. Bearings and Shafting:
   1. Inspect for cleanliness, clean and remove foreign materials.
   2. Verify alignment.
   3. Replace defective bearings, and those which run rough or noisy.
   4. Grease as necessary, and in accord with manufacturer's recommendations.

B. Drives:
   1. Adjust tension in V-belt drives, and adjust varipitch sheaves and drives for proper equipment speed.
   2. Adjust drives for alignment of sheaves and V-belts.
   3. Clean and remove foreign materials before starting operation.

C. Motors:
   1. Check each motor for comparison to amperage nameplate value.

2. Correct conditions which produce excessive current flow, and which exist due to equipment malfunction.

D. Pumps:
1. Check glands and seals for cleanliness and adjustment before running pump.
2. Inspect shaft sleeves for scoring.
3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
4. Verify that piping system is free of dirt and scale before circulating liquid through the pump.

E. Valves:
1. Inspect both hand and automatic control valves, clean bonnets and stems.
2. Tighten packing glands to assure no leakage, but permit valve stems to operate without galling.
3. Replace packing in valves to retain maximum adjustment after system is judged complete.
4. Replace packing on any valve which continues to leak.
5. Remove and repair bonnets which leak.
6. Coat packing gland threads and valve stems with a surface preparation of "Moly-Cote" or "Fel-Pro," after cleaning.

F. Verify that control valve seats are free from foreign material, and are properly positioned for intended service.

G. Tighten flanges and all other pipe joints after system has been placed in operation.
1. Replace gaskets which show any sign of leakage after tightening.

H. Inspect all joints for leakage.
1. Promptly remake each joint which appears to be faulty, do not wait for rust to form.
2. Clean threads on both parts, apply compound and remake joints.

I. After system has been placed in operation, clean strainers, dirt pockets, orifices, valve seats and headers in fluid system, to assure freedom from foreign materials.

J. Open steam traps and air vents where used, remove operating elements.
1. Clean thoroughly, replace internal parts and put back into operation.

K. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.

L. Set and calibrate draft gages of air filters and other equipment.

M. Inspect fan wheels for clearance and balance.
1. Provide factory-authorized personnel for adjustment when needed.

N. Check each electrical control circuit to assure that operation complies with Specifications and requirements to provide desired performance.

O. Inspect each pressure gage and thermometer for calibration.
1. Replace items which are defaced, broken, or which read incorrectly.

P. Repair damaged insulation.

Q. Vent gasses trapped in any part of systems.
   1. Verify that liquids are drained from all parts of gas or air systems.

1.3 RESPONSIBILITIES

A. During the equipment start-up period the Contractor shall furnish, at no additional cost to the City, the services of factory-trained representatives of the equipment manufacturers for the equipment designated in the Specifications to:
   1. Assist in the start-up and operations of the equipment.
   2. Conduct training of plant personnel in the proper operation and maintenance of the equipment.

B. The City shall:
   1. Provide the necessary plant personnel for training in the operation and maintenance of the equipment. The City's personnel shall operate all equipment.

C. The Contractor shall pay for all chemicals consumed up to the date of "certified substantial completion."

D. Contractor shall be available to promptly repair all Work during the start-up period so as to cause minimum disruption to the total plant operation.

+ + END OF SECTION + +

SECTION 1H4

FIELD TESTS OF EQUIPMENT

1.1 PRELIMINARY TESTS

A. CONTRACTOR shall make preliminary field tests of all equipment as soon as conditions permit.

B. Purpose of tests is to determine if equipment is:
   1. Properly installed.
   2. Complies with operating cycles.
   3. Operational and free from overheating, overloading, vibration or other operating problems.

C. CONTRACTOR shall furnish all labor, materials, instruments, fuel, incidentals, and expendables required, unless otherwise provided.

D. CONTRACTOR shall make all changes, adjustments and replacements required to place equipment in service and test it.

E. ENGINEER and OWNER shall be given sufficient prior notice to witness tests.

1.2 FINAL TESTS

A. Upon completion of the Work but prior to final acceptance, CONTRACTOR shall give all equipment final field tests.

B. Purpose of the tests is to demonstrate that equipment is:
   1. Properly installed.
   2. Completely ready for operation by the OWNER.
   3. In compliance with design conditions, material specifications and all other requirements of the Contract Documents.

C. If applicable facilities have been substantially completed and occupied by the OWNER, he will supply energy, fuel, water and lighting. Otherwise, these will be responsibility of CONTRACTOR.

D. CONTRACTOR shall furnish all labor, materials, instruments, lubricants and expendables required for the tests.

E. Until final field tests are completed and approved, CONTRACTOR shall make all necessary changes, adjustments and replacements.

F. CONTRACTOR shall notify ENGINEER at least 24 hours prior to beginning of tests. CONTRACTOR shall keep notes and data on tests and submit copy to the ENGINEER. ENGINEER and OWNER'S operating personnel shall witness all tests.

+ + END OF SECTION + +

SECTION 1H5

INSTRUCTION OF OPERATING PERSONNEL

1.1 GENERAL

A. Manufacturer shall provide the services of a factory trained maintenance specialist to instruct the OWNER'S operations and maintenance personnel in the recommended corrective and preventive maintenance procedures for equipment as specified in the respective equipment section.

B. The qualifications of the specialist shall be subject to approval by the OWNER'S representative.

C. Manufacturer shall be responsible for coordinating these services at times acceptable to the ENGINEER, with a minimum of 30 days prior notice.

D. Manufacturer shall provide a combination of classroom and field/training. All training shall be conducted at the project site. Class sizes shall be limited to no more than seven (7) trainees.

E. Manufacturer shall conduct a separate training session to be video taped by the OWNER following the instruction of OWNER'S operations and maintenance personnel. Manufacturer shall participate in a one-day planning and script preparation meeting at least one week prior to the video taping sessions.

1.2 SUBMITTALS

A. Manufacturer shall submit for approval a proposed Lesson Plan for the instruction 30 days prior to commencement of scheduled training.

B. Manufacturer shall submit for approval credentials of their designated maintenance instructor. Credentials will include a brief resume and specific details of the instructor's experience with maintenance of and training on the equipment specified.

1.3 INSTRUCTION LESSON PLAN

A. Manufacturer's proposed Lesson Plan shall include the elements presented in the Outline of Instruction Lesson Plan in Section 1.3.D. Specific components and procedures shall be identified in the proposed Lesson Plan.

B. Manufacturer's proposed Lesson Plan shall detail specific instruction topics. Training aids to be utilized in the instruction shall be referenced and attached where applicable to the proposed Lesson Plan. "Hands-On" demonstrations planned for the instruction shall be described in the Lesson Plan.

C. The manufacturer shall indicate the estimated duration of each segment of the training Lesson Plan.

D. Outline of Instruction Lesson Plan:
   1. Equipment Operation:
      a. Describe equipment's operating (process) function.
      b. Describe equipment's fundamental operating principals and dynamics.
      c. Identify equipment's mechanical, electrical and electronic components and features.
      d. Identify all support equipment associated with the operation of subject equipment (i.e., air intake filters, valve accuators, motors).
   2. Detailed Component Description:
      a. Identify and describe in detail each component's function.
      b. Where applicable, group related components into subsystem. Describe subsystem functions and their interaction with other subsystems.
      c. Identify and describe in detail equipment safeties and control interlocks.
   3. Equipment Preventive Maintenance (PM):
      a. Describe PM inspection procedures required to:
         1) Perform an inspection of the equipment in operation.
         2) Spot potential trouble symptoms (anticipate breakdowns).
         3) Forecast maintenance requirements (predictive maintenance).
      b. Define the recommended PM intervals for each component.
      c. Provide lubricant and replacement part recommendations and limitations.
      d. Describe appropriate cleaning practices and recommended intervals.
   4. Equipment Troubleshooting:
      a. Define recommended systematic troubleshooting procedures.
      b. Provide component specific troubleshooting checklists.
      c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.
   5. Equipment Corrective Maintenance:
      a. Describe recommended equipment preparation requirements.
      b. Identify and describe the use of any special tools required for maintenance of the equipment.
      c. Describe component removal/installation and disassembly/assembly procedures.
      d. Perform at least two "hand-on" demonstrations of common corrective maintenance repairs.
      e. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
      f. Define recommended torquing, mounting, calibration and/or alignment procedures and settings, as appropriate.
      g. Describe recommended procedures to check/test equipment following a corrective repair.

1.4 TRAINING AIDS

A. The manufacturer's instructor shall incorporate training aids as appropriate to assist in the instruction. At a minimum, the training aids shall include text and figure handouts. Other appropriate training aids are:
   1. Audio-Visual Aids (e.g., films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, catalogue sheets).

2. Equipment Cutaways and Samples (e.g., spare parts, damaged equipment).
3. Tools (e.g., repair tools, customized tools, measuring and calibrating instruments).

B. The manufacturer's instructor shall utilize descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts should accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are encouraged. Handouts planned for the instruction shall be attached with the manufacturer's proposed Lesson Plan.

1.5 "HANDS-ON" DEMONSTRATIONS

A. The manufacturer's instructor shall present at least two "hands-on" demonstrations of common corrective maintenance repairs for each scheduled group. The manufacturer shall provide the tools and equipment to conduct the demonstrations. Requests for supplemental assistance and facilities should be submitted with the manufacturer's proposed Lesson Plan. The proposed "hands-on" demonstrations should be described in the manufacturer's proposed Lesson Plan.

B. In any hands-on training situation where OWNER's operations or maintenance personnel participate in disassembly or assembly equipment components, the manufacturer shall be responsible for such disassembly or assembly and shall provide written certification of proper equipment operation to the ENGINEER.

1.6 RESPONSIBILITIES

A. Manufacturer's Instructors shall be fully prepared for the training sessions. Training delivery shall be communicative, clear and proceed according to the approved lesson plan. If training delivery is found by the City or Engineer to be not to Standards or requirements, the training shall be postponed and rescheduled at a cost to be born by the Contractor.

1.7 TRAINING SCHEDULE

A. In order to provide the City with adequate time requirements for manufacturer's training, minimum training times for various pieces of equipment and systems are listed below:

Section Specification	Equipment Description	Minimum Training Time
11A1	Centrifugal Return/Waste Sludge Pumps	1 day
11A2	Vertical Turbine Pumps	2 days
11A11	Centrifugal Influent Pumps	2 days
11C4	Rotary Screening Equipment	2 days

Section Specification	Equipment Description	Minimum Training Time
11C6	Sewage Grinders	2 days
11E6	Flocculator-Clarifier Mechanism	1 day
11F7	Process Air Diffusion Equipment	1 day
11F10	Air Blowers and Appurtenances	2 days
11L1	Chlorination Equipment	2 days
13A	Instrumentation	3 days
13E7	Wet Scrubber Odor Control System	3 days
13E10	Carbon Adsorber Odor Control System	2 days
13T	Automatic Backwash Filter	2 days
15H	Heating, Ventilating, Air Conditioning, Fans	2 days
16H1	Motor Control Center	1 day
16I1	Standby Power Generator	3 days

+ + END OF SECTION + +

SECTION 1I1

CLEANING

1.1 GENERAL

A. The CONTRACTOR shall execute cleaning during progress of the Work, including periods when Work is suspended, at completion of the Work, and as required by General Conditions.

B. Requirements of Regulatory Agencies:
   1. In addition to the requirements herein, maintain the cleanliness of the Work and surrounding premises within the Work limits so as to comply with federal, state, and local fire and safety laws, ordinances, codes and regulations.
   2. Comply with all federal, state and local antipollution laws, ordinances, codes and regulations when disposing of waste materials, debris and rubbish.
   3. Disposal of surplus excavated material within the City of Glendale County limits or Planning Area requires the approval of the City Engineer.

C. The CONTRACTOR shall schedule cleaning and disposal operations:
   1. So that dust, wash water or other contaminants generated during such operations do not damage or mar painted or finished surfaces.
   2. To prevent accumulation of dust, dirt, debris, rubbish and waste materials on or within the Work or on the premises surrounding the Work.

D. Waste Disposal:
   1. Dispose of all waste materials, surplus materials, debris and rubbish off the plant site.
   2. Do not burn or bury rubbish and waste materials on the plant site.
   3. Do not dispose of volatile or hazardous wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
   4. Do not discharge wastes into streams or waterways.

E. Cleaning Materials:
   1. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
   2. Use each type of cleaning material on only those surfaces recommended by the cleaning material manufacturer.
   3. Use only materials which will not create hazards to health or property.

F. During Construction:
   1. Keep the Work and surrounding premises within work limits free of accumulations of dirt, dust, waste materials, debris and rubbish.
   2. Keep dust generating areas wetted down.
   3. Provide suitable containers for storage of waste materials, debris and rubbish until time of disposal.
   4. Dispose of waste, debris and rubbish off site at legal disposal areas.

G. When the project is completed the CONTRACTOR shall:
   1. Remove and dispose of all excess or waste materials, debris, rubbish, and temporary facilities from the site, structures and all facilities.
   2. Repair pavement, roads, sod, and all other areas affected by construction operations and restore them to original condition or to minimum condition specified.
   3. Remove spatter, grease, stains, fingerprints, dirt, dust, labels, tags, packing materials and other foreign items or substances from interior and exterior surfaces, equipment, signs and lettering.
   4. Repair, patch and touch up chipped, scratched, dented or otherwise marred surfaces to match specified finish.
   5. Remove paint, clean and restore all equipment and material nameplates, labels and other identification markings.
   6. Wash and shine mirrors, glazing and polished surfaces.
   7. Clean all floors, slabs, pavements, and ground surfaces.
   8. Maintain cleaning until acceptance and occupation by OWNER.

+ + END OF SECTION + +

SECTION 1I2

RECORD DOCUMENTS

1.1 GENERAL

A. The CONTRACTOR shall maintain and provide the ENGINEER with record documents as specified below except where otherwise specified or modified in Divisions 2-16.

B. Maintenance of Documents:
   1. Maintain in the CONTRACTOR'S field office in clean, dry, legible condition complete sets of the following: Drawings, Specifications, Addenda, approved Shop Drawings, Samples, photographs, Change Orders, other Modifications of Contract, test records, survey data, Field Orders and all other documents pertinent to the CONTRACTOR'S Work.
   2. Provide files and racks for proper storage and easy access. File in accordance with filing format of Construction Specification Institute (CSI) unless otherwise approved by ENGINEER.
   3. Make documents available at all times for inspection by ENGINEER and OWNER.
   4. Record documents shall not be used for any other purpose and shall not be removed from the office without ENGINEER'S approval.

1.2 FINAL SUBMISSION OF RECORD DOCUMENTS

A. Record Drawings:
   1. At the completion of the installation of all grading, structures, equipment, piping, and duct work the CONTRACTOR shall furnish to the ENGINEER reproducible mylar tracings showing the actual in-place installation of these items installed under this Contract. The drawings shall show the Work in plan and sections as required for clarity with reference dimensions and elevations for complete record drawings. The tracings shall be furnished not later than 30 days after completion of the Work and prior to final payment.
   2. At the completion of all electrical work under the Contract, the CONTRACTOR shall furnish to the ENGINEER, reproducible mylar tracings showing a one line diagram of the distribution system and the actual in-place grounding system, lighting arrangement, motor control centers, equipment and conduit and cable plans. The tracings shall be furnished not later than 30 days after completion of the Work and prior to final payment.
   3. The Contract Drawings may be used as a starting point in developing these drawings. Subcontractor and manufacturer drawings may be included in this drawing package. The drawing package must be fully integrated and include the necessary cross references between drawings. The drawing package shall include interconnection and termination details to equipment furnished under this Contract.
   4. All drawings must be submitted for approval of the ENGINEER. This shall include the following composite drawings for the system being furnished:
      a. Schematic (Elementary) Diagrams: This shall include but not be limited to complete schematics including items furnished by others for the following:

1) Motor Control Circuits for Starters furnished under this Contract.
2) Substation Controls.
3) HVAC Control Panels furnished under this Contract.

b. Wiring (Connection) Diagrams: These shall be included for all pre-wired equipment furnished under this Contract.
c. Interconnection Diagrams: These shall include all interconnections to be furnished under this Contract.
d. Conduit and Cable Schedules: These shall include all conduit and cable furnished under this Contract.
e. Dimension of Outline Drawings: These shall include all equipment furnished under this Contract.
f. Power and Lighting Layout Drawings: These shall include all conduits and wiring furnished under this Contract.

5. Reproducible mylar tracings shall be minimum 5 mil erasable type.

B. Submittal:
1. At completion of Project, deliver record documents to ENGINEER.
2. Accompany submittal with transmittal letter containing:
   a. Date.
   b. Project title and number.
   c. Contract title and number.
   d. CONTRACTOR'S name and address.
   e. Title and number of each record document.
   f. Certification that each document as submitted is complete and accurate.
   g. Signature of CONTRACTOR, or his authorized representative.

C. Recording:
1. Label each document "PROJECT RECORD" in 2-inch high printed letters.
2. Keep record documents current.
3. Do not permanently conceal any Work until required information has been recorded.
4. Drawings: Legibly mark to record actual construction including:
   a. Depths of various elements of foundation in relation to datum.
   b. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
   d. Field changes of dimensions and details.
   e. Changes made by Change Order or Field Order.
   f. Details not on original Drawings.
5. Specifications and Addenda: Legibly mark up each Section to record:
   a. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed.
   b. Changes made by Change Order or Field Order.
   c. Other matters not originally specified.
6. Shop Drawings: Maintain as record documents and legibly annotate drawings to record changes made after review.

+ + END OF SECTION + +

SECTION 1I3

OPERATION AND MAINTENANCE DATA

1.1 GENERAL

A. CONTRACTOR shall provide operation and maintenance data in the form of instructional manuals for use by the OWNER'S personnel for:
   1. All equipment and systems.
   2. All valves, gates and related accessories.
   3. All instruments and control devices.
   4. All electrical gear.

B. Definitions:
   1. Operation and Maintenance Data:
      a. The term "operation and maintenance data" includes all product related information and documents which are required for preparation of the plant operation and maintenance manual. It also includes all data which must accompany said manual as directed by current regulations of any participating government agency.
      b. Required operation and maintenance data includes, but is not limited to, the following:
         1) Complete, detailed written operating instructions for each product or piece of equipment including: equipment function; operating characteristics; limiting conditions; operating instructions for startup, normal and emergency conditions; regulation and control; and shutdown.
         2) Complete, detailed written preventive maintenance instructions as defined below.
         3) Recommended spare parts lists and local sources of supply for parts.
         4) Written explanations of all safety considerations relating to operation and maintenance procedures.
         5) Name, address and phone number of manufacturer, manufacturer's local service representative, and Subcontractor or installer.
         6) Copy of all approved Shop Drawings, all required test reports and a copy of warranty bond and service contract as applicable.
   2. Preventive Maintenance Instructions:
      a. The term "preventive maintenance instructions" includes all information and instructions required to keep a product or piece of equipment properly lubricated, adjusted and maintained so that the item functions economically throughout its full design life.
      b. Preventive maintenance instructions include, but are not limited to, the following:
         1) A written explanation with illustrations for each preventive maintenance task.
         2) Recommended schedule for execution of preventive maintenance tasks.
         3) Lubrication charts.
         4) Table of alternative lubricants.
         5) Trouble shooting instructions.
         6) List of required maintenance tools and equipment.

C. Submittals:
   1. General: Submit operations and maintenance data to the ENGINEER within 90 days after approval of Shop Drawings.
   2. Number of Copies: Six of each item.
   3. Letter of Transmittal: Provide a letter of transmittal with each submittal and include the following in the letter:
      a. Date of submittal.
      b. Project title and number.
      c. CONTRACTOR'S name and address.
      d. A list of the attachments and the Specification Sections to which they relate.
      e. Reference to or explanation of related submittals already made or to be made at a future date.
   4. Format Requirements:
      a. Use 8-1/2 inch by 11 inch paper of high rag content and quality. Larger drawings or illustrations are acceptable if neatly folded to the specified size in a manner which will permit easy unfolding without removal from the binder. Provide reinforced punched binder tab. Or provide fly-leaf for each product.
      b. All text must be legibly typewritten or machine printed originals or high quality copies of same.
      c. Each page shall have a binding margin of approximately 1-1/2 inches and be punched for placement in a three ring looseleaf or triple post binder. Provide binders. Identify each binder with the following:
         1) Title "OPERATING AND MAINTENANCE INSTRUCTIONS".
         2) Project title and number.
         3) Identity of building or structure as applicable.
         4) Identity of general subject matter covered.
      d. Use dividers and indexed tabs between major categories of information such as operating instructions, preventive maintenance instructions, or other. When necessary, place each major category in a separate binder.
      e. Provide a table of contents for each binder.
      f. Identify products by their functional names in the table of contents and at least once in each chapter or Section. Thereafter, abbreviations and acronyms may be used if their meaning is explained in a table in the back of each binder. Use of model or catalog numbers or letters for identification is not acceptable.

+ + END OF SECTION + +

SECTION 1I4

SPARE PARTS AND MAINTENANCE MATERIALS

1.1 GENERAL

A. CONTRACTOR shall furnish spare parts and maintenance materials as specified in the individual Sections and as recommended in the individual manufacturer's operation and maintenance manuals.

B. Parts and materials shall be furnished in manufacturer's unopened cartons, boxes, crates or other protective covering suitable for preventing corrosion or deterioration for the maximum length of storage which may be normally anticipated. They shall be clearly marked and identified.

C. During construction, store parts in buildings or trailers with floor, roof and closed sides and in accordance with manufacturer's recommendations. Protect from weather, condensation and humidity.

D. Parts and materials shall be delivered to the OWNER upon completion of the Work or when the OWNER assumes beneficial occupancy. CONTRACTOR shall then place them in permanent storage rooms or areas approved by the OWNER.

E. Provide a letter of transmittal including the following:
   1. Date of letter and transfer of parts and material.
   2. Contract title.
   3. CONTRACTOR'S name and address.
   4. A complete inventory of the parts and material, listing the applicable Specification Section for each.
   5. A place for the OWNER to sign and signify receipt of the parts and materials.

F. CONTRACTOR shall be fully responsible for loss or damage to parts and materials until they are transmitted to the OWNER.

+ + END OF SECTION + +

SECTION 2B

CLEARING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to perform all clearing and grubbing as shown and specified.

B. Related Work Specified Elsewhere:
   1. Section 2C, Demolition.
   2. Section 2D1, Excavation and Backfill.
   3. Section 2K, Landscaping

1.2 QUALITY ASSURANCE

A. Codes and Standards: State and local laws and code requirements shall govern the hauling and disposal of trees, shrubs, stumps, roots, rubbish, debris and other matter.

B. CONTRACTOR shall conform to all applicable requirements of Section 201 of the Uniform Standard Specifications for Public Works Construction by Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and these Specifications, the provisions of these Specifications shall govern.

1.3 JOB CONDITIONS

A. Protection:
   1. Streets, roads, adjacent property and other works and structures shall be protected throughout the entire project. CONTRACTOR shall return to original condition, satisfactory to the ENGINEER, damaged facilities caused by the CONTRACTOR'S operations.
   2. Trees, shrubs and grassed areas which are to remain shall be protected by fences, barricades, wrapping or other methods as shown, specified or approved by the ENGINEER. Equipment, stockpiles, etc. shall not be permitted within tree branch spread. Trees shall not be removed without approval of the ENGINEER unless shown or specified.

B. Salvageable Improvements:
   1. Unless specified elsewhere carefully remove items to be salvaged and store on premises in approved location, all in accordance with recommendations of specialists recognized in the Work involved.

1.4 GUARANTEE

A. CONTRACTOR shall guarantee that Work performed under this Section will not permanently damage trees, shrubs, turf or plants designated to remain, or other adjacent work or facilities. If damage resulting from CONTRACTOR'S operations appears during the period up to 18 months after completion of the project he shall replace damaged items at no expense to OWNER.

PART 2 - PRODUCTS

(Part 2 omitted this Section)

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING

A. Limits of clearing shall be all areas within the Contract limit lines except as otherwise shown. Damage outside these limits caused by the CONTRACTOR'S operations shall be corrected at the CONTRACTOR'S expense.

B. Except as noted below, CONTRACTOR shall remove from the site and satisfactorily dispose of all trees, shrubs, stumps, roots, brush, masonry, rubbish, scrap, debris, pavement, curbs, fences and miscellaneous other structures not covered under other Sections as shown, specified or otherwise required to permit construction of the proposed Work.

C. Trees, stumps and other cleared and grubbed material shall not be disposed on site. All cleared and grubbed material shall be disposed of off-site in accordance with local and state ordinances. No cleared or grubbed material may be used in backfills or structural embankments.

D. Burning on site shall not be done unless approved by authorities having jurisdiction.

E. All burning, on or off the site, if approved, shall be in complete accordance with rules and regulations of local authorities having jurisdiction.

F. Trees and shrubs shall be trimmed when doing so will avoid removal or damage. Trimmed or damaged trees shall be treated and repaired by persons with experience in this specialty and who are approved by ENGINEER. Trees and shrubs intended to remain which are damaged beyond repair or removed, shall be replaced by the CONTRACTOR.

G. Control air pollution caused by dust and dirt, and comply with governing regulations.

+ + END OF SECTION + +

SECTION 2C

DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals required for demolition, removal and disposal of work shown and specified.
2. Included, but not limited to, are demolition and removal of existing materials, equipment, or work necessary to install the new Work as shown and specified and to connect same with existing work in an approved manner. Demolition includes concrete irrigation ditches, structural concrete, foundations, walls, doors, windows, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical equipment, paving, curbs, walks, fencing, and similar existing facilities.
3. Demolition and removals which may be specified under other Sections shall conform to requirements of this Section.

B. Related Work Specified Elsewhere:
1. Section 1A, Summary of Work.
2. Section 2B, Clearing.
3. Section 2D1, Excavation and Backfill.

1.2 JOB CONDITIONS

A. Protection:
1. CONTRACTOR shall execute the demolition and removal work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.
2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways.
3. CONTRACTOR shall erect and maintain barriers, lights, sidewalk sheds, and other required protective devices as required by local regulatory authorities.

B. Scheduling:
1. CONTRACTOR shall carry out his operations so as to avoid interference with operations and work in the existing facilities.

C. Notification:
1. At least 48 hours prior to commencement of a demolition or removal, CONTRACTOR shall notify the ENGINEER in writing of his proposed schedule therefor. OWNER shall inspect the existing equipment and to identify and mark those items which are to remain the property of the OWNER. No removals shall be started without the permission of the ENGINEER.

PART 2 - PRODUCTS

(Part 2 omitted this Section)

PART 3 - EXECUTION

3.1 GENERAL

A. All materials and equipment removed from existing work, shall become the property of the CONTRACTOR, except for those which the OWNER has identified and marked for his use. All materials and equipment marked by the OWNER to remain his shall be carefully removed by the CONTRACTOR, so as not to be damaged, cleaned and stored on or adjacent to the site in a protected place specified by the ENGINEER or loaded onto trucks provided by the OWNER.

B. CONTRACTOR shall dispose of all demolition materials, equipment, debris, and all other items not marked by the OWNER to remain as his, off the site and in conformance with all existing applicable laws and regulations.

C. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
   1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
   2. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the Work.

D. Building Demolition:
   1. Unless otherwise approved by ENGINEER, proceed with demolition from the top of the structure to the ground. Complete demolition work above each floor or tier before disturbing supporting members of lower levels.
   2. Demolish concrete and masonry in small sections.
   3. Remove structural framing members and lower to ground by means of hoists, derricks, or other suitable methods.
   4. Break up and remove foundations and slabs-on-grade, unless otherwise shown to remain.
   5. Locate demolition equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls, floors or framing.

3.2 STRUCTURAL REMOVALS

A. CONTRACTOR shall remove structures to the lines and grades shown unless otherwise directed by the ENGINEER. Where no limits are shown, the limits shall be 4 inches outside the item to be installed. The removal of masonry beyond these limits shall be at the CONTRACTOR'S expense and these excess removals shall be reconstructed to the satisfaction of the ENGINEER with no additional compensation to the CONTRACTOR.

B. All concrete, brick, tile, concrete block, roofing materials, reinforcement, structural or miscellaneous metals, plaster, wire mesh and other items contained in or upon the structure shall be removed and taken from the site, unless otherwise approved by the ENGINEER. Demolished items shall not be used in backfill adjacent to structures or in pipe line trenches.

C. After removal of parts or all of masonry walls, slabs and like work which tie into new Work or existing work, the point of junction shall be neatly repaired so as to leave only finished edges and surface exposed.

3.3 MECHANICAL REMOVALS

A. Mechanical removals shall consist of dismantling and removing of existing septic systems, piping, pumps, motors, equipment and other appurtenances as specified, shown, or required for the completion of the Work. It shall include cutting, capping, and plugging as required, except that the cutting of existing piping for the purpose of making connections thereto will be included under Division 15.

B. Existing process, water, chemical, gas, fuel oil and other piping shall be removed where shown. Piping not indicated to be removed shall be removed to the nearest solid support, capped and left in place. Where piping that is to be removed passes through existing walls, it shall be cut off and properly capped on each side of the wall.

C. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping may be left in place unless it interferes with new Work is shown or specified to be removed or indicated by the ENGINEER to be removed.

D. Waste and vent piping shall be removed to points shown. Pipe shall be plugged with cleanouts and plugs. Where vent stacks pass through an existing roof that is to remain, they shall be removed and the hole in the roof properly patched and made watertight.

E. Any changes to potable water piping and other plumbing and heating system work shall be made in conformance with all applicable codes and under the same requirements as other underground piping. All portions of the potable water system that have been altered or opened shall be pressure tested and disinfected in accordance with Section 15I and local codes. Other plumbing piping and heating piping shall be pressure tested only.

3.4 ELECTRICAL REMOVALS

A. Electrical removals shall consist of the removal of existing transformers, distribution switchboards, control panels, motors, conduits and wires, poles and overhead wiring, panelboards, lighting fixtures, and miscellaneous electrical equipment all as shown, specified, or required to perform the Work.

B. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.

C. Conduits and wires shall be abandoned or removed where shown. All wires in abandoned conduits shall be removed, salvaged, and stored. Abandoned conduits concealed in floor or ceiling slabs, or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitably plugged and the area repaired in a flush, smooth, approved manner. Exposed conduits and their supports shall be disassembled and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.

D. Where shown or otherwise required, wiring in the underground duct system shall be removed. All such wiring shall be salvaged and stored as specified. CONTRACTOR shall verify the function of all wiring before disconnecting and removing it. Ducts which are not to be reused shall be plugged where they enter buildings and made watertight.

E. Where shown, direct-burial cable shall be abandoned. Such cable shall be disconnected at both ends of the run. Where it enters a building or structure the cable shall be cut back to the point of entrance. All openings in buildings for entrance of abandoned direct-burial cable shall be patched and made watertight.

F. Poles and overhead wiring shall be abandoned as shown and specified. Existing substation and poles owned by the power company will be removed by the power company. Poles not owned by the power company shall be completely removed from the site by the CONTRACTOR. The overhead wires shall be salvaged and stored as previously specified in Paragraph 3.1.A. CONTRACTOR shall perform this work after the proposed service has been completed and energized, and in accordance with the approved schedule.

G. Lighting fixtures shall be removed or relocated as shown. Fixtures not relocated shall be removed from the site. Relocated fixtures shall be carefully removed from their present location and rehung where shown.

H. Wall switches, receptacles, starters and other miscellaneous electrical equipment, shall be removed and disposed of off the site as required. Care shall be taken in removing all equipment so as to minimize damage to architectural and structural members. Any damage incurred shall be repaired.

3.5 CLEAN-UP

A. CONTRACTOR shall remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the Work, all materials, equipment, waste, and debris of every sort shall be removed and premises shall be left, clean, neat and orderly.

+ + END OF SECTION + +

SECTION 2D1

EXCAVATION AND BACKFILL

Part 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to perform all excavation and backfilling as shown, specified, and required for the purpose of constructing structures, conduits, pipelines, roads, grading, and other facilities required to complete the Work in every respect. Included are erosion control, dewatering, surface drainage, compacted fills, installation and removal of sheeting and bracing, all necessary preparation of subgrades for slabs and pavement, and the satisfactory disposal of surplus and unacceptable materials.
2. All temporary means required to prevent discharge of sediment to water courses which results from surface water control or erosion control are also included.
3. No classification of excavated materials will be made. Excavation includes removal of all materials between existing ground surface and the required subgrade elevations regardless of type, character, composition, moisture content, or condition thereof.

B. Related Work Specified Elsewhere:
1. Section 1F1, Testing Laboratory Services.
2. Section 2B, Clearing.
3. Section 2C, Demolition.
4. Section 2D5, Crushed Stone and Gravel.
5. Section 2I2, Pavement
6. Section 2K, Landscaping
7. Section 15A1, Buried Piping Installation.
8. Sections 15G1 through 15I16, HVAC and Plumbing Work.
9. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Standard Specification and Details:
1. The CONTRACTOR shall conform to all applicable requirements of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as follows:
   a. Section 205, Roadway Excavation
   b. Section 206, Structure Excavation and Backfill
   c. Section 211, Fill Construction
   d. Section 225, Watering
   e. Section 702, Base Materials
2. If there is a conflict between the MAG Standard Specifications and these Specifications, the provisions of these Specifications shall govern.

B. Testing Services:
1. General: Testing of materials, testing for moisture content during placement and compaction of fill materials, and testing of com-

paction results for compliance with technical requirements of the Specifications shall be performed by a testing laboratory as designated in Section 1F1.

2. Testing Services Include:
   a. Testing the CONTRACTOR'S proposed materials in the laboratory and/or field for compliance with the Specifications.
   b. Performing field moisture content and density tests to assure that the specified compaction of backfill materials has been obtained.
   c. Reporting all test results to the ENGINEER and the CONTRACTOR.
3. Authority and Duties of Testing Agency: Technicians representing the testing laboratory shall inspect the materials in the field and perform tests, and shall report their findings to the ENGINEER and the CONTRACTOR. When the materials furnished or Work performed fails to fulfill Specification requirements, the technician will direct the attention of the ENGINEER and the CONTRACTOR to such failure.
   a. The technician shall not act as foreman or perform other duties for the CONTRACTOR. Work will be checked as it progresses, but failure to detect any defective work or materials shall in no way prevent later rejection when such defect is discovered, nor shall it obligate the ENGINEER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Specifications, nor to approve or accept any portion of the Work.
4. Responsibilities and Duties of CONTRACTOR: The use of testing services shall in no way relieve the CONTRACTOR of his responsibility to furnish materials and construction in full compliance with the Drawings and Specifications.
   To facilitate testing services, the CONTRACTOR shall:
   a. Secure and deliver to the ENGINEER or to the testing agency preliminary representative samples of the materials he proposes to use and which are required to be tested.
   b. Furnish casual labor as is necessary to obtain and handle samples at the Project or at other sources of material.
   c. Advise the testing agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.

B. Reference Standards: CONTRACTOR shall comply with applicable provisions and recommendations of the following:
   1. ASTM A 36, Structural Steel.
   2. ASTM A 328, Steel Sheet Piling.
   3. ASTM D 422, Particle-Size Analysis of Soils.
   4. ASTM D 4318, Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   5. ASTM D 427, Shrinkage Factors of Soils.
   6. ASTM D 698, Moisture-Density Relations of Soils, using 5.5 lb (2.5 Kg) Rammer and 12-in. (304.8 mm Drop).
   7. ASTM D 1140, Amount of Material in Soils Finer than the No. 200 Sieve.
   8. ASTM D 1556, Density of Soil in Place by the Sand-Cone Method.
   9. ASTM D 2166, Unconfined Compressive Strength of Cohesive Soil.

1.3 SUBMITTALS

A. Wherever, under Paragraph 3.3.A.4., sheeting and shoring is necessary, the CONTRACTOR shall prepare drawings for the following: Sheeting and bracing for excavations over six feet deep. The drawings shall be prepared by a professional engineer licensed in the State of Arizona. The drawings shall be submitted to the ENGINEER for record purposes and to establish that the terms of the Specifications are complied with. Calculations shall not be submitted. Drawing submissions will not be checked and will not imply approval by the ENGINEER of the work involved. The CONTRACTOR shall be wholly responsible for designing, installing and operating whatever system is necessary to accomplish satisfactory sheeting, bracing, dewatering and protection.

B. Test Reports: Submit copies of the following reports directly to ENGINEER from the testing service, with copy to the CONTRACTOR:
   1. Field density and moisture tests.
   2. Optimum moisture - maximum density curve for each soil used for backfill.

C. Samples of all select backfill, general backfill, granular and aggregate base material shall be submitted to the ENGINEER and the testing service. Samples of the proposed material shall be submitted at least 14 days in advance of its anticipated use.

1.4 SITE CONDITIONS

A. Refer to the Supplementary Conditions and Instruction to Bidders for information pertaining to subsurface investigations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill and Fill Materials - Walls, Foundations and Piping:
   1. Materials acceptable for use as backfill against walls, foundations and above piping shall be stockpiled native silty sand soils obtained from on-site excavations and which are uniformly mixed, contain no organic matter, nor contain rocks or fragments greater than 6 inches in size and whose Plasticity Index is less than eight.
   2. Backfill and fill materials from on-site excavation or off-site sources shall consist of silty or clayey sand soils which are uniformly mixed, contain no organic matter, vegetation debris and which have a Plasticity Index less than eight. The maximum particle size of imported soils shall be 6 inches or less if required to satisfy trenching, or other requirements. The maximum expansion of off-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at 2 percent below optimum moisture content under a 100 psf surcharge pressure. Maximum percent passing No. 200 sieve is 30.
   3. All materials for use as backfill and fill material shall be tested by the laboratory and approved by the ENGINEER.

B. Select Backfill:
   1. Select backfill for use beneath concrete slabs shall be well graded sand and gravel materials conforming to the requirements of:

Sieve Size (U.S. Std.)	Percent Passing	
	Crushed Aggregate	Processed Natural Material
3"	100	
1 1/2"		100
No. 4	30-75	30-70
No. 8	20-60	20-60
No. 30	10-40	10-40
No. 200	0-12	0-12
P.I. Max.	5	5

C. Crushed Stone and Gravel:
   1. Crushed stone shall be crushed rock or gravel conforming to the requirements of Section 2D5.

D. Aggregate Base Material:
   1. Aggregate base material shall consist of crushed aggregate conforming to the following gradation:

Sieve Size (U.S. Std)	Percent Passing
1-1/8"	100
#4	38-65
#8	25-60
#30	10-40
#200	3-12
P.I. Max.	5

E. Pipe Bedding:
   1. For PVC pipe, bedding material shall be clean well graded sand.

F. Sand:
   1. Sand for sand bedding material and backfill shall be clean and free from deleterious substances, with not more than 50 percent of it being retained on a No. 4 sieve and not more than 7 percent passing a No. 200 sieve, and shall have an effective size between 0.001 mm and 0.003 mm.
   2. All sand backfill material must be tested and approved prior to delivery to the site. Samples of sand proposed for use as sand backfill shall be submitted by the CONTRACTOR to the ENGINEER and to the testing agency. Samples of the proposed material must be submitted at least ten days in advance of its anticipated use.
   3. No sand backfill shall be placed without the ENGINEER'S approval of the samples.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. The portions of the site on which the Work is to be constructed shall be cleared in accordance with Section 2B.

B. Remove and dispose of existing structures and facilities that interfere with the Work.

3.2 EROSION CONTROL AND DEWATERING

A. Erosion Control:
   1. As a minimum, the construction procedures outlined herein shall be implemented to assure minimum damage to the environment during construction. CONTRACTOR shall take any and all additional measures required to conform to the requirements of applicable codes and regulations.
   2. Whenever possible, access and temporary roads shall be located and constructed to avoid environmental damage. Provisions shall be made to regulate drainage, avoid erosion and minimize damage to vegetation.
   3. Where areas must be cleared for storage of materials or temporary structures, provisions shall be made for regulating drainage and controlling erosion, subject to the ENGINEER'S approval.
   4. Temporary measures shall be applied to control erosion and to minimize the siltation of the existing waterways, and natural ponding areas. Such measures shall include, but not be limited to, the use of berms, baled straw silt barriers, gravel or crushed stone, mulch, slope drains and other methods. These temporary measures shall be applied to erodible materials exposed by any activities associated with the construction of this Project.
      a. Special care shall be taken to eliminate depressions that could serve as mosquito pools.
      b. Temporary measures shall be coordinated with the construction of permanent drainage facilities and other work to the extent practicable to assure economical, effective, and continuous erosion and siltation control.
      c. CONTRACTOR shall provide special care in areas with steep slopes. Disturbance of vegetation shall be kept to a minimum to maintain stability.
   5. Remove only those shrubs and grasses that must be removed for construction. Protect the remainder to preserve their erosion-control value.
   6. Install erosion and sediment control practices where shown and according to applicable standards, codes and specifications. The practices shall be maintained in effective working condition during construction and until the drainage area has been permanently stabilized.
   7. Mulching to be used for temporary stabilization.
      a. Suitable Materials for Mulching:
         1) Unrotted straw or salt hay - 1-1/2 to 2 tons/acre.
         2) Asphalt emulsion or cutback asphalt - 600 to 1200 gal./acre.
         3) Wood-fiber or paper-fiber (hydroseeding) - 1500 lbs./acre.
         4) Mulch netting (paper, jute, excelsior, cotton or plastic).

b. Straw or salt hay mulches should be immediately anchored using peg and twine netting or a mulch anchoring tool or liquid mulch binders.

8. After stabilization, remove all straw bale dikes, debris, etc., from the site.
9. In the event of any temporary work stoppage, the CONTRACTOR shall take steps to prevent any temporary or permanent environmental damage to the area undergoing construction.
10. In the event the CONTRACTOR repeatedly fails to satisfactorily control erosion and siltation, the OWNER reserves the right to employ outside assistance or to use its own forces to provide the corrective measure indicated. The cost of such work, plus engineering costs, will be deducted from monies due the CONTRACTOR.
11. CONTRACTOR shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on and off-site damage and health hazards. Control may be effected by irrigation in which the site shall be sprinkled with water until the surface is moist. The process shall be repeated as needed.

B. Dewatering:

1. CONTRACTOR shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the Work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein is inspected by the ENGINEER and backfill operations have been completed and approved.
   a. The different working areas on the site shall be kept free of surface water at all times. CONTRACTOR shall install drainage ditches and dikes and shall perform all pumping and other work necessary to divert or remove rainfall and all other accumulations of surface water from the excavations and fill areas. The diversion and removal of surface water shall be performed in a manner that will prevent the accumulation of water behind temporary structures or at any other locations within the construction area where it may be detrimental.
   b. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the water downstream of the point of discharge shall not be directly discharged. Such waters shall be diverted through a settling basin or filter before being discharged.
   c. CONTRACTOR will maintain pipe, conduit or channel used for drainage purposes and all such pipes, conduits or channels shall be left clean and free of sediment.
2. CONTRACTOR shall provide, install and operate sufficient trenches, sumps, pumps, hose, piping, wellpoints, deep wells, etc., necessary to depress and maintain the ground water level below the base of the excavations during all stages of construction operations. The ground water table shall be lowered in advance of excavation and maintained two feet below the lowest subgrade excavation made until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural ground water. Dewatering shall be maintained on a 24-hour basis and standby pumping facilities and personnel shall be available onsite.
   a. Elements of the system shall be located so as to allow a continuous dewatering operation without interfering with the

construction of the permanent work. Where portions of the dewatering system are located in the area of permanent construction, CONTRACTOR shall submit details of the methods he proposes to construct the permanent work in this location for the approval of the ENGINEER. Controls of ground water shall continue until the permanent construction provides sufficient dead load to withstand the hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, until all waterproofing work has been completed and until pipelines are properly jointed. Dispose of all water removed from the excavation in such a manner so as not to endanger any portion of the Work under construction or completed. Convey water from the excavations in a closed conduit. Do not use trench excavations as temporary drainage ditches.

3.3 EXCAVATION

A. General:

1. CONTRACTOR shall excavate and backfill, in advance of the construction, test pits to determine conditions or location of the existing piping and facilities. Test pits shall be as specified in Paragraph 3.8. CONTRACTOR shall repair damage to structures, piping, or utility caused by his work.
2. During excavation Work CONTRACTOR shall separate, classify and stockpile materials as required for backfill and embankment Work.
3. Although blasting is not contemplated, in the event it is required, CONTRACTOR shall comply with all laws, ordinances, applicable safety code requirements and regulations relative to the handling, storage and use of explosives and the protection of life and property. CONTRACTOR shall be responsible for all damage caused by his blasting operations. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench.
   a. All rock which cannot be handled and compacted as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials except as specified or directed.
4. Sheeting and shoring shall be provided where shown and as necessary for the protection of existing facilities, the Work and for the safety of personnel. Sheeting, shoring and bracing shall be as specified in Paragraph 3.6 below.
5. Excavation of every description and of whatever substances encountered within the grading limits of the Project shall be performed to the lines and grades shown.
   a. Excavation Work shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.
   b. Slope sides of open excavations to a maximum slope of one horizontal to one vertical.
   c. Subgrades for roadways and trench bottoms shall be firm, dense, and thoroughly compacted. The finished elevation or stabilized

subgrades shall not be above the subgrade elevations shown on the Drawings.

d. Exposed soil after excavations have been made shall be protected against detrimental damage and change in condition from physical disturbance and rain. Wherever possible, concrete footings shall be cast the same day the excavation is made. If this is not done, the footing excavations shall be properly protected.

6. All excavated materials that meet the requirements for backfill and embankment shall be stockpiled within the site.
7. No heavy construction equipment or stockpiled soil shall be located within 25 feet of the surface borders of any excavation.
8. All excavated materials which are not considered suitable for fill or other use, and any surplus (including but not limited to excess clean dirt, concrete and asphalt rubble, and trash) or excavated material which is not required for fill or embankment shall be disposed of off the site by the CONTRACTOR. Upon completion of the Work all on-site waste and disposal areas shall be cleaned and the debris removed from the site. Disposal of surplus excavated material shall be in accordance with Section 205.6 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) with the following additions:
   a. Disposal of material within the City limits or Planning Area must be approved by the City Engineer.
   b. Stockpiling of excavated material shall not exceed a height of six (6) feet above the natural ground elevation.
   c. The slopes on all sides of stockpiled excavated material shall not exceed a 1 to 4 ratio of height to length.
   d. Use permit is required for stockpiling in residential areas.
   e. No surplus or unacceptable excavated materials of any kind shall be deposited in any stream or water course or dumped on public property.
9. The various work areas on the site shall be maintained free of surface water at all times.

B. Excavations for Structures:
1. Excavations for the construction of structures, piping or other facilities shall be carefully made to the depths indicated or required. Bottoms for footings, slabs and grade beams shall be level, clean and clear of loose materials and the lower sections true to size. Footings, slab, and grade beam bottoms shall be approved by the ENGINEER before any concrete is placed thereon.
2. Structures with foundations less than four feet below existing grade:
   a. In areas where shallow footing or mat foundations are to be constructed on compact fill, excavate the existing soil to a minimum depth of two feet below the bottom of the footing or mat, or to a minimum depth of two feet below existing ground surface, whichever is greater.
   b. In building areas at existing grade, including pavement areas, scarify the natural soil to a minimum depth of 8 inches, or to the depth of disturbance caused by previous plowing, whichever is greater, prior to compaction.
3. Structures with foundations greater than four feet below existing grade:

a. Excavate the existing soil to the required subgrade elevation of the footing or mat and selectively stockpile low pasticity soils for reuse as fill or backfill.

4. All excavations below existing grade shall be extended laterally a minimum of two feet beyond the outside edges of the foundations.
5. When the excavation has reached the design subgrade elevation, soft or unconsolidated zones or areas shall be undercut until a stable condition has been achieved and approved by the ENGINEER. The undercut subgrade shall be compacted and backfilled with select backfill compacted to the design subgrade elevation. The final subgrade shall be inspected and approved by the ENGINEER.
6. In excavations where the subgrade is spongy, soft, disturbed or otherwise unsuitable for the proposed foundation, the CONTRACTOR shall remove the unsuitable material and replace it with compacted select backfill.
7. Excavations for structures which have been carried below the required subgrade elevation shall be refilled to the proper grade with compacted select backfill.
8. All excavations for structures shall be hand trimmed to permit placing full widths and lengths of footings on horizontal beds. Rounded and undercut edges will not be permitted.

C. Roadway Excavations:
1. Roadway excavation shall consist of excavation in conformity with lines, grades, cross sections and dimensions shown and shall include the excavation of all unsuitable material from the subgrade.

D. Trench Excavations:
1. Trenches shall be excavated to a width which will provide adequate working space and clearances for proper pipe installation, jointing, and embedment.
   a. Where pipe elevations are not shown, trenches shall be excavated to a depth sufficient to provide a minimum cover over the top of the pipe of 3.0 feet.
2. Where necessary to reduce earth load on pipe trench banks to prevent sliding or caving, banks may be cut back on slopes which shall not extend lower than 12 inches above the top of the pipe.
3. Unless otherwise shown, pipe trenches shall be excavated 6 inches below the underside of the pipe for 24-inch and smaller size pipe to provide for the installation of crushed stone or gravel foundation material.
4. Over-depths in trench excavation shall be backfilled with select backfill material properly compacted. Whenever unsuitable material that is incapable of properly supporting the pipe is encountered in the undercut required for bedding material, the unsuitable material shall be removed to the depth required and the trench backfilled to the proper grade with select backfill material properly compacted.
5. Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls or granular embedment when the pipe is jointed.
6. Where existing piping, ductbanks or utilities cross the new trench excavation, they shall be adequately supported and protected from damage due to construction. All methods for supporting and maintaining these facilities shall be subject to approval of the party owning or controlling the facility. Care shall be taken to assure

that the existing grades and alignment are maintained and that joints are not disturbed. Backfill shall be carefully placed and tamped to prevent damage or future settlement. Any damage or misalignment of existing facilities due to construction or settlement shall be repaired by the CONTRACTOR to the satisfaction of the party owning or controlling the facility.

3.4 UNAUTHORIZED EXCAVATION

A. All excavation outside the lines and grades shown, and which is not approved by the ENGINEER, together with the removal and disposal of the associated material, shall be at the CONTRACTOR'S expense. The unauthorized excavation shall be filled and compacted with approved backfill by the CONTRACTOR at his expense.

3.5 PLACEMENT OF FILL AND BACKFILL

A. General:
   1. All select backfill, embankment and backfill required for structures and trenches and required to provide the finished grades shown and as described herein shall be furnished, placed and compacted by the CONTRACTOR.
   2. Backfill excavations as promptly as work permits, but not until completion of the following:
      a. Acceptance by the ENGINEER of construction below finish grade.
      b. Inspection, testing, approval and recording of locations of underground piping, utilities and ductbanks.
      c. Removal of concrete formwork.
      d. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
      e. Removal of trash and debris.
   3. Fill containing organic materials or other unacceptable material shall be removed and replaced with approved fill material.
   4. A layer of compacted clayey soil, not less than 12 inches thick, shall be placed at the top of granular backfills adjacent to walls.

B. Placement of Select Backfill, Backfill and Fill:
   1. Select backfill shall be placed to the grades shown and/or specified. The lift thickness and compaction moisture content ranges stated herein are nominal values. The final values will be determined from the laboratory test results on the fill material.
   2. All select backfill shall be placed in horizontal loose lifts not exceeding 8 inches in thickness and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Each lift shall be compacted by a minimum of two complete coverages of a specified or approved type of compactor. When ordered in writing by the ENGINEER, a minimum of 4 inches of select backfill shall be placed beneath all concrete mat foundations. The material shall extend a minimum of two feet outside the face of each structure. The maximum slope of select backfill to the subgrade shall be one vertical to one horizontal. Select backfill shall be compacted to the density specified below.
   3. Backfill and fill against walls and foundations, and over select backfill shall be placed in horizontal loose lifts not exceeding 8 inches and mechanically compacted. Compaction of backfill and fill by inundation with water will not be permitted. All materials shall be placed as specified herein and/or as shown.

4. Compaction of low plasticity soils (Plasticity Index less than 8) from on-site excavations or imported from off-site sources shall be accomplished at a moisture content that is within plus or minus three percent of the optimum moisture content as determined by laboratory testing. The material shall be compacted to the density specified below.
5. Compaction of high plasticity soils (Plasticity Index greater than 8) from on-site sources shall be accomplished at a uniform moisture content within the range of optimum and plus three percent of the optimum moisture content as determined by laboratory testing. The material shall be compacted to the density specified below.
6. The CONTRACTOR shall provide equipment capable of adding measured amounts of water to the backfill and/or select backfill material to bring it to a condition within the range of the required moisture content. CONTRACTOR shall provide equipment capable of discing, aerating, and mixing the soil to insure reasonable uniformity of moisture content throughout the fill material and to reduce the moisture content of the material by air drying if necessary. If the subgrade or lift of earth material must be moisture conditioned before compaction, the fill material shall be sufficiently mixed or worked on the subgrade to insure a uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of the specified limit shall be dried by aeration or stockpiled for drying.
7. No backfill or fill material shall be placed when free water is on the surface of the area where the fill is to be placed. No compaction of fill will be permitted with free water on any portion of the fill to be compacted. Any fill containing organic materials or other unacceptable material previously described shall be removed and replaced with approved fill material prior to compaction.
8. Compaction shall be performed with equipment suitable for the type of fill material being placed. The CONTRACTOR shall select equipment which is capable of providing the minimum density required by these Specifications. The gross weight of compacting equipment shall not exceed 7,000 pounds within a distance of 10 feet from the wall of any completed structure. Equipment shall be provided that is capable of compacting in restricted areas, next to structures and around piping. The effectiveness of the equipment selected by the CONTRACTOR shall be tested at the commencement of compacted fill work by construction of a small section of fill within the area where fill is to be placed. If tests on this section of fill show that the specified compaction is not obtained, the CONTRACTOR shall increase the amount of coverages, decrease the lift thicknesses or use a different type of compactor.
9. Levels of backfill against concrete walls shall not differ by more than two feet on either side of walls unless the walls are adequately braced or all floor framing is in place up to and including grade level slabs. Particular care shall be taken to compact structure backfill which will be beneath pipes, roads or other surface construction or structures. In addition, wherever a trench passes through structure backfill, the structure backfill shall be placed and compacted to an elevation 12 inches above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

10. The compaction requirements specified below are predicated on the use of normal materials and compaction equipment. In order to establish criteria for the placement of a controlled fill so that it will have compressibility and strength characteristics compatible with the proposed structural loadings, a series of laboratory compaction tests will be performed on the samples of materials submitted by the CONTRACTOR. From the results of the laboratory tests, the final values of the required degree of compaction, the acceptable compaction moisture content range and the maximum permissible lift thickness will be established for the fill material and construction equipment proposed.

C. Backfill in Pipe Trenches:
1. Prior to placing pipe bedding the bottom of all trenches shall be mechanically compacted.
2. Pipeline trenches may be backfilled prior to pressure testing, but no structure shall be constructed over any pipeline until it has been tested.
3. Except where a greater thickness is specified, pipe shall be placed on not less than 6 inches of granular embedment material.
4. Embedment materials both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment materials shall conform to the following requirements:
   a. Granular embedment shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle. After each pipe has been graded, aligned, placed in final position on the bedding material and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations. Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.
   b. Compacted backfill will be required for the full depth of the trench above the granular pipe embedment material. Where the trench for one pipe passes beneath the trench for another pipe or electrical ductbank, the lower trench shall be compacted to the level of the bottom of the upper trench.
   c. Each layer of embedment material shall be compacted by at least two complete coverages of all portions of the surface of each lift using approved compaction equipment. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of the compacting surface of the compactor.
   d. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.
   e. The degree of compaction required for granular embedment is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 698, Method A.
   f. All buried PVC piping shall be encased from 12 inches below the pipe to 12 inches above the pipe in a granular fill. The granular fill material shall be a clean well graded sand. The

material shall be loosely placed and then compacted with a sled type vibrator. Backfill above 12 inches above the top of the pipe shall be the same material as used in the general fill or select fill.

D. Compaction Density Requirements:

1. Exposed subgrade soils, select fill, general backfill and fill shall be compacted to the densities indicated under Paragraph (2.). Material shall be moistened or aerated as required to provide the moisture content that will facilitate obtaining the specified densities.
2. The degree of compaction required for the clay liner material is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557. The degree of compaction required for fill and backfill is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 698. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction. Compaction requirements shall be as specified below:

Location	Required Density	Test Frequency	Maximum Permissible Lift Thickness as Compacted
Backfill under structures	100	1 test/2500 S.F./lift and not less than 1 test/ lift per structure	6 inches
Backfill around structures	95 Min.	1 test/50 L.F./lift	8 inches
Roadway subgrade	95 Min.	1 test/500 L.F./lift	9 inches
Roadway base material	100	1 test/500 L.F./lift	6 inches
Aggregate base material	100	1 test/2500 S.F./lift and not less than 1 test/ lift per location	6 inches
Pipe trenches clear of structures	95 Min.	1 test/300 L.F./lift	12 inches
Pipe trenches in proximity (within 25' of structures)	95 Min.	1 test/50 L.F./lift	12 inches
Clay reservoir liner & subgrade	95 Min.	1 test/2500 S.F./lift	6 inches

3. The required densities specified above are expressed as a percent of maximum density obtained in the laboratory in accordance with the test procedure presented in ASTM D 698, Method A.
4. The testing laboratory shall perform tests necessary to provide data for selection of fill material and control of placement water content.

5. Field density tests to insure that the specified density is being obtained will be performed by testing laboratory during each day of compaction work. The number of tests shall be designated by ENGINEER.
6. If the tests indicate unsatisfactory compaction, the CONTRACTOR shall provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction work shall be performed by the CONTRACTOR at no additional cost to the OWNER until the specified compaction is obtained. This Work shall include complete removal of unacceptable fill areas and replacement and recompaction until acceptable fill is provided.

E. Crushed Stone and Gravel Placement:
1. Crushed stone shall be placed in hand-tamped lifts not to exceed 8 inches.

F. Backfill in Pipe Trenches-CPVC Pipe:
1. All buried CPVC piping shall be encased from 12 inches below the pipe to 12 inches above the pipe in a granular fill. The granular fill material shall be a clean well graded sand. The material shall be loosely placed and then compacted with a sled type vibrator. Backfill above 12 inches above the top of the pipe shall be the same material as used in the general fill or select fill.

G. Placement of Backfill in Pipe Trenches-Fiberglass Pipe:
1. Additional bedding material (pea gravel or No. 67 size crushed stone or gravel) shall be placed from the 0.70 pipe diameter level to 12 inches above the top of the pipe and compacted to 85 percent Proctor density, or 40 percent relative density.
2. Backfill 12 inches above the top of the pipe shall be the same material as used in the general fill or select fill.

H. Placement of Aggregate Base Material:
1. Aggregate base material shall be placed in horizontal loose lifts not exceeding 6 inches in thickness. The aggregate base material shall be compacted by equipment and methods described hereinbefore.

I. Placement of Clay Liner Material:
1. Clay liner material (sandy clay) shall be placed in horizontal loose lifts not exceeding 6 inches in thickness. The second and third lift shall be placed so as not to have any joint in the upper lift above a joint in the lower lift.
2. The clay liner material shall be placed at a moisture content that falls in the range of laboratory optimum moisture content plus or minus 1 percent.
3. The liner material shall be compacted by equipment and methods described hereinbefore.

3.6 SHEETING, SHORING AND BRACING

A. General:
1. Except for tunnels and where otherwise shown, excavations for structures and pipelines shall be open excavation, sheeted, shored and braced where necessary to prevent injury to workmen, structures or pipelines.
2. All municipal, county, state and federal ordinances, codes, regulations and laws shall be observed.

3. The clearances and types of the temporary structures, insofar as they affect the character of the finished Work, will be subject to the approval of the ENGINEER, but the CONTRACTOR shall be responsible for the adequacy of all sheeting, bracing, cofferdamming, etc.
4. No separate payment will be made for providing, removing or leaving in place steel or wood sheet piling; payment shall be considered as having been included in the unit or lump sum price bid for the Contract.
5. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary work. Used material shall be in good condition, not damaged or excessively pitted.
6. All timber used for breast boards (lagging) shall be new or used, meeting the requirements for Douglas Fir Dense Construction Grade or Southern Pine No. 2 Dense, S3.
7. All steel work for sheeting, shoring, bracing, cofferdams etc., shall be designed in accordance with the provisions of the "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", of the AISC except that field welding will be permitted.
8. Steel sheet piling shall be manufactured from steel conforming to ASTM A 328. Steel for soldier piles, wales and braces shall be new or used and shall conform to ASTM A 36.
9. Maintain shoring and bracing in excavations regardless of the time period excavations will be open. Carry down shoring and bracing as excavation progresses.
10. Unless otherwise shown, specified, or ordered, all materials used for temporary construction shall be removed when the Work is completed. Such removal shall be made in a manner not injurious to the structure or its appearance or to adjacent work.

B. Sheeting Left in Place:
1. Steel sheet piling shown to be left in place or ordered in writing to be left in place by the ENGINEER, shall consist of rolled sections of the continuous interlocking type unless otherwise approved. The type and design of the sheeting and bracing shall conform to the above specifications for all steel work for sheeting and bracing. Steel sheeting installed but not removed shall be new.
2. Steel sheet piling to be left in place shall be driven straight to the lines and grades as shown or directed. The piles shall penetrate into firm materials with secure interlocking throughout the entire length of the pile. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
3. The type of guide structure used and method of driving for steel sheet piling to be left in place shall be subject to the approval of the ENGINEER. Jetting will not be permitted.
4. Where shown, CONTRACTOR shall cut off piling left in place to the grades shown or ordered by the ENGINEER and shall remove the cut-offs from the site.
5. Where not shown, sheeting left in place shall be cut off three feet below the finished surface. Payment for sheeting left in place shall be considered as having been included in the price bid for the Contract.
6. CONTRACTOR shall thoroughly clean wales, braces and all other items to be embedded in the permanent structure, and shall make provisions so that the concrete surrounding the embedded element is sound and free from air pockets or harmful inclusions. The provisions shall

include the cutting of holes in the webs and flanges of wale and bracing members, and the welding of steel diaphragm waterstops perpendicular to the centerline of brace ends which are to be embedded.

7. Subsequent to removal of the inside face forms, and when removal of bracing is permitted, steel shall be cut back at least 2 inches inside the wall face and the opening patched with cement mortar. The concrete shall be thoroughly worked beneath wales and braces, around stiffeners and in any other place where voids may be formed.
8. Portions of sheeting or soldier piles and breast boards which may be in contact with the foundation concrete shall be left in place, together with wales and bracing members which are cast into foundation or superstructure concrete.

C. Maintenance and Removal:
1. All sheeting and bracing must be maintained until replaced by other sheeting and bracing or until the permanent construction is able to withstand lateral pressures from soil and water.
2. Remove sheeting and bracing from excavations as they are being backfilled unless otherwise shown, acceptable to ENGINEER or ordered in writing by the ENGINEER. Removal shall be done so as to not cause damage to the Work or caving-in. Removal shall be equal on both sides of excavations to ensure no unequal loads will be imposed on the pipe or structure.
3. Defer removal of sheeting and bracing where removal may cause soil to come into contact with concrete until the following conditions have been satisfied:
   a. Concrete has cured a minimum of seven days.
   b. Wall and floor framing up to and including grade level floors are in place.

3.7 TEST PITS

A. Test pits shall be excavated in advance of construction wherever mutually agreed to by CONTRACTOR and ENGINEER. Perform all Work required including excavation, stockpiling, maintaining, sheeting, shoring, backfilling and replacing pavement. Test pits shall also be made for utility services and for other facilities not necessarily shown but known to exist by its owner.

B. Payment for test pits shall be made at the unit price bid for Extra Earth Excavation.

C. No additional payment will be made for test pits made by the CONTRACTOR for his own use at his option.

3.8 FINAL GRADING AND EMBANKMENTS

A. To the extent available, backfill material from excavations shall be placed to final grade in accordance with Paragraph 3.5.B.

B. After other outside work has been finished and backfilling and embankments completed and settled, all areas on the site of the Work which are to be graded shall be brought to a subgrade consistent with the indicated elevations, slopes, and contours with suitable excess excavation material. Subgrade shall be left 6 inches below the finished grades shown to allow for topsoil placement.

C. The use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. All surfaces shall be graded to secure effective drainage. Unless otherwise shown, a slope of at least one percent shall be provided. Grading and surfacing shall be completed to the satisfaction of the ENGINEER.

+ + END OF SECTION + +

SECTION 2D4

RIPRAP

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall furnish and place riprap at locations shown and specified.

B. Related Work Specified Elsewhere:
   1. Section 2D1, Excavation and Backfill.
   2. Section 2D5, Crushed Stone and Gravel.

1.2 QUALITY ASSURANCE

A. CONTRACTOR shall conform to all applicable requirements of Section 703 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and these Specifications, the provisions of these Specifications shall govern.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Riprap:
   1. Riprap shall be composed of smooth surface river rock having a minimum dimension of 8 inches. All materials shall be from a single production source and shall present a uniform appearance.

B. Riprap Bedding:

   1. CONTRACTOR shall furnish and place all material required for riprap bedding as shown , specified or ordered by the ENGINEER. Graded gravel or layers of sand and gravel or crushed rock are required for riprap bedding. All bedding materials are included.
   2. All sand shall consist of clean, hard, durable particles free from organic or other deleterious matter. Crushed stone, crushed or uncrushed gravel shall be clean, hard, durable material of acceptable quality.
   3. Material used on slopes shall be crushed gravel or crushed stone. Screened river gravel is not acceptable.
   4. Samples of all material shall be submitted to the ENGINEER for approval.

PART 3 - EXECUTION

3.1 PLACING

A. Riprap shall be placed on a prepared layer of crushed stone and gravel as specified in Section 2D5 and as shown on the Drawings. All

fill required in the subgrade beneath the crushed stone and gravel layer shall be compacted to a density approximating that of the surrounding undisturbed material.

B. Prior to placing of riprap, the area shall be made free of weeds using chemical control and a preemergence control such as Dacthal, or equal. The material shall be applied in accordance with the manufacturer's printed instructions.

C. Minimum total thickness of the installed riprap layer shall be 14 inches.

D. The stones shall be placed so that the weight of the stone is carried by the underlying material and not by the adjacent stones. On slopes, the largest of the stones shall be placed at the bottom. Riprap shall be of proper size to form a compact solid blanket to protect the slopes.

E. Riprap may be placed in location by equipment, however, care shall be taken in placing to obtain a good gradation of materials so that the riprap will be firm and solid. Surfaces shall be leveled to the required alignment and slopes by hand placing the stone so as to fill large voids and to make the surface even.

+ + END OF SECTION + +

SECTION 2D5

CRUSHED STONE AND GRAVEL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish and place crushed stone and gravel of the types specified at the locations shown, specified and ordered by the ENGINEER.

B. Related Work Specified Elsewhere:
1. Section 2D1, Excavation and Backfill.
2. Section 2D4, Riprap.
3. Section 15A1, Buried Piping Installation.

1.2 QUALITY ASSURANCE

A. CONTRACTOR shall conform to all applicable requirements of Section 701 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and these Specifications, the provisions of these Specifications shall govern.

1.3 SUBMITTALS

A. CONTRACTOR shall furnish representative samples of the crushed stone or gravel to the ENGINEER and shall advise of the source location.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Crushed Stone or Screened Gravel for Foundations:
1. CONTRACTOR shall furnish and place crushed stone or screened gravel fill under structures in addition to that required under other Sections.
2. The material shall be well-graded, clean, screened gravel or crushed stone obtained from an approved source. Maximum size shall be 1-1/2 inches and 95 percent shall be retained on a No. 4 screen.

B. Riprap Bedding Gravel:
1. Riprap bedding gravel shall be furnished as a graded gravel conforming to the size distribution specified below.

Sieve Size	Percent Passing
3-inch	100
No. 4	40 to 80
No. 8	30 to 70
No. 30	15 to 50
No. 200	0 to 10

PART 3 - EXECUTION

3.1 PLACING

A. Gravel shall be spread in layers of uniform thickness not exceeding 8 inches and shall be thoroughly compacted with suitable power driven tampers or other power driven equipment. The placing of crushed stone or gravel shall conform to applicable requirements of Section 2D1 except as noted above.

B. Riprap bedding gravel shall be placed to the lines and grades shown and thoroughly compacted in place by means approved by ENGINEER. Maximum thickness of each layer shall not exceed 8 inches.

+ + END OF SECTION + +

SECTION 2H6

MANHOLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all precast and cast-in-place manholes.

B. General:
1. Structures shall conform in shape, size, dimensions, material, and other respects to the details shown, referenced or as ordered by the ENGINEER.
2. Cast-iron frames, grates and covers shall be the standard frame and grate or cover unless otherwise shown and shall be as specified in Section 5E11.
3. Concrete shall conform to the requirements specified under Division 3.
4. Inverts shall conform accurately to the size and elevation of the adjoining pipes. Side inverts shall be curved and main inverts, where direction changes, shall be laid out in smooth curves of the longest possible radius which is tangent to the centerlines of adjoining pipelines.

C. Related Work Specified Elsewhere:
1. 2D Sections on Sitework.
2. Section 3D, Cast-In-Place Concrete.
3. Section 5E3, Miscellaneous Metal Fabrications.
4. Section 5E11, Castings.
5. 15A Sections on Piping.

1.2 QUALITY ASSURANCE

A. CONTRACTOR shall conform to all applicable requirements of Section No. 625 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Associations of Governments (MAG). Where there is a conflict between MAG Standard Specifications and these Specifications, provisions of these Specifications shall apply.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM C 32, Sewer and Manhole Brick (made from Clay or Shale).
2. ASTM C 139, Concrete Masonry Units for Construction of Catch Basins and Manholes.
3. ASTM C 140, Sampling and Testing Concrete Masonry Units.
4. ASTM C 207, Hydrated Lime for Masonry Purposes.
5. ASTM C 478, Precast Reinforced Concrete Manhole Sections.
6. ASTM C 923, Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
7. AWWA C302, Reinforced Concrete Pressure Pipe, Noncylinder Type, for Water and Other Liquids.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Design and construction details of all precast concrete manholes including but not limited to details on joints, reinforcement, pipe connections, mortar, construction details, weights and design calculations for top slabs if required, signed by a Licensed Professional Engineer.
   2. Schedule of manhole assemblies including piping locations in bases.

B. Samples: Submit for approval the following:
   1. Samples of brick, block, gaskets and all accessories required for the manholes.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

A. Precast manholes shall be constructed in conformance with Section 625 of the MAG Standard Specifications.

B. Precast concrete manholes, bases, risers, cones, slab tops and grade rings shall conform to the requirements of ASTM C 478. Maximum absorption rate shall not exceed 9 percent using Method A of ASTM C 497.

C. Manholes, frames, covers and steps shall be constructed in conformance with MAG Series 400 Details.

D. Precast manhole bases shall be of approved design and of sufficient strength to withstand the loads to be imposed upon them. An approved joint shall be provided to receive the pipe sections forming the barrel.

E. Manhole bases, risers, cones and slabs shall be manufactured to the dimensions as shown on the Drawings, and shall be marked immediately after manufacture with diameter, class and wall thickness, date of manufacture, and name or trade mark of manufacturer.

F. Joints shall be rubber and concrete using O-ring gaskets conforming with AWWA C302. For rubber ring joints, the base of the bell shall be buttered with 1 to 2 cement-sand mortar to provide a uniform bearing for the spigot of the entering pipe. All joints shall be sealed with cement mortar inside and out, troweled to the contour of the wall surface.

G. A precast or cast-in-place slab or precast eccentric cone, as shown or approved, shall be provided at the top of the manhole barrel to receive the cast iron frame and cover. The slab or cone shall be of acceptable design and of sufficient strength to safely support an H-20 loading. Concrete slabs shall be not less than 6 inches thick.

H. Manhole sections shall contain manhole steps, 12 inches on centers, accurately positioned and embedded in the concrete. Steps shall be as specified under Section 5E3.

I. Joint seal between manhole and pipes entering and exiting manholes shall be as follows:

1. Flexible watertight pipe connections shall be cast into all pipe openings in the precast manholes where shown or required and shall be capable of deflecting a minimum of 10 degrees. Installation shall be in accordance with the manufacturer's written instructions.
2. Flexible watertight pipe connections shall conform to ASTM C 923.
3. Flexible pipe connection shall be A-LOK as manufactured by A-LOK Seals.

2.2 MASONRY

A. Masonry where shown or otherwise approved by the ENGINEER shall conform to the following:
   1. Brick: Brick shall conform to the requirements of ASTM C32, Grade SS for sewer brick and Grade MS for manhole brick.
   2. Mortar: The mortar shall be composed of Portland cement, hydrated lime, and sand, in which the volume of sand shall not exceed three times the sum of the volumes of cement and lime.
   3. Cement shall be Type II Portland cement as specified for concrete masonry.
   4. Hydrated lime shall be Type S conforming to ASTM C 207.
   5. The sand shall comply with the Specifications for "Fine Aggregate" for concrete except that all of the sand shall pass a No. 8 sieve.

2.3 MISCELLANEOUS METALS

A. Metal frames, covers, steps, toe pockets and similar required items shall be provided in accordance with 5E Sections on Metal Fabrications.

PART 3 - EXECUTION

3.1 MANHOLE BASES

A. Cast-in-place bases shall be placed on suitable foundations after the pipes are laid. They shall be cast monolithically to at least 12 inches above the top of the highest pipe entering the manhole, except where a drop connection is to be installed. Base walls and bottom shall be at least of the thickness shown and reinforced to withstand the loads to be expected. Concrete for cast-in-place bases shall conform to requirements of Division 3D. Special care shall be taken in placing the concrete around the bottom of the pipes to obtain a waterproof structure. An approved bell shall be cast in the base to receive the pipe sections forming the barrel.

B. Precast bases shall be set on a concrete or crushed stone foundation, not less than 8 inches thick. Precast bases shall be set at the proper grade and carefully leveled and aligned.

3.2 PRECAST MANHOLE SECTIONS

A. Set sections vertical with steps and sections in true alignment.

B. Install sections, joints and gaskets in accordance with manufacturers recommendations.

C. Lifting holes shall be sealed tight with a solid rubber plug driven into hole and the remaining void filled with 1 to 2 cement-sand mortar.

3.3 LAYING MASONRY

A. Brick shall be satisfactorily wet when being laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The joints shall not be wider than 3/8 inch, except when the bricks are laid radially, in which case the narrowest part of the joint shall not exceed 1/4 inch.

B. Each grading ring shall be laid in a full bed of mortar and shall be thoroughly bonded.

3.4 MANHOLE CHANNELS

A. For straight through flow, channels shall be formed from vitrified tile pipe laid through the manholes. A bench of concrete shall be built up to the 2/3 point of the vertical sewer diameter before the top of the sewer pipe is broken out.

B. Where side channels and curved sections occur, the channels within the manholes shall be formed of Class B concrete and shall be given a hard trowel finish, or channels may be constructed using ASTM C 32, Grade SS sewer brick. Channels shall be formed to provide the maximum radius possible.

3.5 GRADING RINGS AND MANHOLE FRAMES AND COVERS

A. Grading rings or brick stacks shall be used for all manholes where required. Stacks shall be a maximum of 12 inches in height, constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the stack shall be such as is necessary to bring the manhole frame to the proper grade.

B. Brick work shall be as specified in Paragraphs 2.2 and 3.3 herein.

C. Frames shall be set with the tops conforming accurately to the grade of the finished pavement or finished ground surface or as shown on the Drawings.

D. Frames shall be set concentric with the top of the grading ring or brick stack and in a full bed of mortar so that the space between the top of the manhole grading ring or brick stack and the bottom flange of the frame shall be completely filled and watertight.

E. Manhole frames shall be mechanically fastened to the manhole by means of 3/4 inch stainless steel expansion bolts through the cored slotted holes in the frame flange.

F. A thick ring of mortar extending to the other edge of the manhole shall be placed all around and on the top of the bottom flange. The mortar shall be smoothly finished and have a slight slope to shed water away from the frame.

3.6 GRADING AT MANHOLES

A. All manholes in unpaved areas shall be built as shown or directed to an elevation higher than the original ground.

B. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around them to the level of the upper rim of the manhole frame, and the surface evenly graded on a 1 to 5 slope to the existing surrounding ground unless otherwise shown.

3.7 MANHOLE WATERTIGHTNESS

A. All manholes shall be free of visible leakage. Each manhole shall be tested for leaks and inspected, and all leaks shall be repaired in a manner subject to ENGINEER'S approval.

3.8 FLEXIBLE PIPE JOINT AT MANHOLE BASE

A. An approved flexible completely tight compression gasket type joint shall be provided between each pipe entering and exiting manhole as shown and as specified.

3.9 PLASTERING

A. The outside of grading rings shall be neatly plastered with 1/2 inch of cement mortar as the Work progresses.

3.10 MANHOLE COATINGS

A. All interior surfaces of manholes shall be coated with ZBRON coating or equal, as specified under Section 9L.

B. Surface preparation, priming, and application shall be in strict conformance with the coating manufacturer's printed instructions.

C. Refer to Section 9L.

+ + END OF SECTION + +

SECTION 2J1

FENCING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all fencing Work.
   2. The extent of fencing Work is shown.
   3. The types of fencing Work includes, but is not necessarily limited to, the following:
      a. Tubular steel main entry gates.
      b. Miscellaneous supplies and equipment as may be required to furnish completely operating systems functioning as specified herein.

B. Related Sections:
   1. Section 2I2, Pavement and Parking Stripes.
   2. Section 3D, Cast-In-Place Concrete.
   3. Section 9L, Painting.

C. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the fencing Work.

1.2 QUALITY ASSURANCE

A. Erector Qualifications: Erector must be a firm experienced in the erection of fencing and accessories of the types specified. Erector must be approved by the manufacturer of the fencing Work.

B. Design Criteria: The requirements of this Section shall generally conform to MAG Standard Specifications 420, 771 and 772, except as modified, added to, or changed herein. Where there is a conflict between MAG Standard Specification and this Specification the provisions of this Specification shall apply.

C. Source Quality Control: Provide tubular steel main entry gates as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ASTM A 120, Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe of Ordinary Uses.
   2. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. Maricopa Association of Governments, Uniform Standard Specifications for Public Works Construction.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. 6-inch long samples of each framework member, accessory and attachment devices required by the Work.
   2. ENGINEER'S review will be for general appearance, and color only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval Shop Drawings for tubular steel main entry gates including plan layout and details illustrating gate heights, types, footings, hardware list and erection procedures.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Deliver material in manufacturer's original packaging with all tags and labels intact and legible.

B. Handling of Materials: Handle and store material in such manner as to avoid damage.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where specified manufacturer's minimum suggested sizes are greater than those specified in MAG Sections, manufacturer's minimum suggested sizes shall be provided at no additional cost to OWNER.

B. Provide tubular steel main entry gates 6 foot-0 inches high.

2.2 TUBULAR STEEL MAIN ENTRY GATES

A. Provide two cantiliver gates each 12 foot-0 inches wide, and one swing gate 3 foot-0 inches wide.

B. Provide gate frames consisting of 2-inch by 2-inch 14 gage galvanized steel tubes with vertical 2-inch by 2-inch intermediate tube spaced 6 foot-0 inches from ends.

C. Provide 1-1/8-inch by 1-1/8-inch intermediate 16 gage galvanized steel pickets with spear-shaped tops.

D. Provide manufacturer's extra heavy-duty tracks, ball-bearing hanger sheaves, overhead framing and supports, guides, stays, bracing and accessories as required for masonry mounting of both sliding and swing gate.

E. Provide all stainless steel fasteners for attachment of gate to masonry. Size fasteners to accept all superimposed loads with a safety factor of 4.

F. Product and Manufacturer: Provide one of the following:
   1. Heavy Aristocrat Special by Builders Fence Company, Incorporated.
   2. Barrier Traditional by Westmoreland Tubular Products Manufacturing Company.

2.3 FABRICATION OF TUBULAR STEEL MAIN ENTRY GATES

A. Provide all 2-inch by 2-inch galvanized steel frame members welded throughout. After welding, weld zone shall be ground smooth and zinc metalized.

B. Space intermediate picket rails 6 inches on center, fasten to frame with stainless steel rivets.

C. All gates shall be preassembled in the shop and shipped with all necessary hardware.

D. Provide substrate acceptable to paint system specified in Section 9L, Painting for exterior galvanized steel.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and conditions under which the fencing Work are to be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Do not begin fence installation and erection before the final grading is completed, with finish elevations established.

3.3 INSTALLATION

A. Gates: Install gates and adjust for proper operation. Install gates plumb, level, and secure for full opening without interference.

B. Install ground-set items in concrete for anchorage, as recommended by the gate manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

3.4 ADJUSTMENT AND CLEANING

A. Adjust gates and leave in good working condition.

B. Repair or replace all broken or bent components.

C. Protect gates from construction traffic until Final Acceptance of the Work.

+ + END OF SECTION + +

SECTION 2J6

SPRINKLER IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install a complete and workable system of underground sprinkler irrigation system including piping, sprinkler heads, pneumatic control tubing, pneumatic control valves, valves, and accessories as shown on the Drawings or as specified below.

B. Related Work Specified Elsewhere:
   1. Section 2D1, Earthwork.
   2. Section 2K, Landscaping.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. City Code of Chandler, Arizona.
      b. Maricopa Association of Governments, Uniform Standard Specifications for Public Works Construction (MAG Spec.)
   2. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. The requirements of this Section shall generally conform to MAG Standard Specification Sections 440 and 757 except as modified, added to, or changed herein. Where there is a conflict between MAG Standard Specification and this Specification the provisions of this Specification shall apply.
   2. ANSI B2.1, Pipe Threads.
   3. ANSI B16.15, Cast Bronze Screwed Fittings, 125 lb and 250 lb.
   4. ANSI B16.22, Wrought Copper and Bronze Solder-Joint Pressure Fittings.
   5. ANSI A21.11, Specification for Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings.
   6. ASTM B 32, Solder Metal.
   7. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
   8. ASTM D 1577, Moisture Density Relations of Soils, Using 10.01B (4.5 kg) Rammer and 18-inch (457 mm) Drop.
   9. ASTM D 1785, Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   10. ASTM D 2466, Standard Specification for Socket-Type Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
   11. ASTM D 2467, Standard Specification for Socket Type Poly Vinyl Chloride Plastic Pipe Fittings, Schedule 80.
   12. ASTM D 2470, Standard Specification for Poly Vinyl Chloride (PVC) Plastic Tubing.

13. ASTM D 2564, Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
14. ASTM D 2855, Recommended Practice for Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
15. Federal Specification WW-P-421D Grade C Pipe, Cast Gray and Ductile Iron, Pressure.

C. Installer Qualifications: Installer shall have satisfactorily installed acceptable underground sprinkler systems on at least 3 other projects of comparable complexity.

D. All similar units of irrigation equipment shall be in accordance with MAG Spec. Section 757.1.

E. Manufacturing Qualifications: Provide the landscape irrigation system as a complete unit produced by a single acceptable manufacturer for all portions of the Work, including heads, emitters, valves, piping circuits, and accessories.

F. Due to the scale of Drawings, it is not possible to indicate all offsets, fittings, sleeves, etc., which may be required. The CONTRACTOR shall carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such fittings, etc. as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the Work to be installed. The Work shall be installed in such a manner as to avoid conflicts between irrigation systems, planting, and architectural features.

G. The CONTRACTOR shall not willfully install the irrigation system as shown on the Drawings when it is obvious in the field that unknown obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in engineering. Such obstructions or differences shall be brought to the attention of the ENGINEER. In the event this notification is not performed, the CONTRACTOR shall assume full responsibility for any revision necessary.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, specifications, and engineering data including dimensions, size and materials for the following:
   a. Pipe and fittings.
   b. Valves.
   c. Strainers.
   d. Solenoid valves.
   e. Sprinkler heads.
   f. Bubblers.
   g. Valve boxes.
   h. Other materials and equipment specified by the ENGINEER.
2. Detailed drawings clearly showing plan of designed layout and details illustrating location and type of heads, valves, piping circuits, piping sizes, controls and accessories.
   a. Sheet scales shall be not less than 1 inch equals 20 feet-0 inch.

b. Provide details of bubbler layouts and installation details.
c. Provide details of sprinkler head layout and installation details.

3. Submit installation instructions, including mounting details.

B. Extra Stock:
1. In addition to installed system, provide OWNER with:
a. Two sprinkler heads of each size and type used.
b. Two valve keys for operating manual valves.
c. Two keys for valve markers.
d. Two wrenches for each type of head cover.
e. Two wrenches for removing and installing each type of head.

C. Certificate of Qualification: Submit certification of installer's experience identifying previous projects with names of Owners and Architect/Engineer.

D. Record Drawings: During progress of the Work, keep an up to date set of drawings showing field and Shop Drawing modifications. Immediately upon completion of piping Work, submit cloth or mylar tracings showing the actual in-place installation of all piping and equipment installed under this Section, at a scale satisfactory to the OWNER. The Drawings shall show all piping on plans and in sections, with all reference dimensions and elevations required for complete "record" drawings of the piping systems. Two paper prints shall also be furnished. The tracings shall be furnished not later than 30 days after completion of the Contract and prior to final payment.

E. Guarantees: Submit for approval a written guarantee in the terms specified under "Guarantee" provisions of these Specifications signed by the CONTRACTOR and the Subtier contractor, if applicable.

F. Operation and Maintenance Data:
1. Submit detailed operation and maintenance data for all equipment and accessories provided under this Section including assembly and parts lists for each type of valve, sprinkler head, etc., furnished.
2. The CONTRACTOR shall furnish 6 copies of a hard cover bound operation and maintenance manual prepared by the manufacturers of all items of equipment furnished under this Section. The manual shall include maintenance instructions, copies of approved shop and installation drawings for all equipment and manufacturers' recommended lubricant and spare parts lists.

1.4 JOB CONDITIONS

A. Protection: Properly plug or cap the open ends of all pipe at the end of each days work or other stopping point throughout construction. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury.

B. It is intended that the system be a completely automatic underground sprinkler irrigation system giving 100 percent coverage to all plant and tree material when integrated with the underground sprinkler control system specified in Section 13A2, Irrigation Control System.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Water: Non-potable water.

B. Pressure: 80 psi.

C. Maximum Zone Flow Rate: 40 gpm.

D. Maximum Water Velocity in Pipes: 5 fps.

2.2 MATERIALS

A. Water Supply Lines:
   1. Poly Vinyl Chloride (PVC):
      a. Pipe: PVC Schedule 40, ASTM D 1785.
      b. Type: Type I, Grade I, 2000 psi.
      c. Fittings: Socket type, ASTM D 2467.
      d. Joints: PVC Solvent Cement, ASTM D 2564.

B. Individual Zone Supply Lines (Downstream from Zone Valves):
   1. Poly Vinyl Chloride (PVC):
      a. Pipe: Class 200, ASTM D 1785.
      b. Type: Type I Grade I.
      c. Fittings: Socket type, ASTM D 2466.
      d. Joints: PVC Solvent Cement, ASTM D 2564.

C. Control Valve Boxes:
   1. Control valve boxes shall be structurally molded of non-corrosive polyethylene, green in color, and marked with "Irrigation Control Valve." Valve boxes shall be of adequate size for valve and feature locking lid.
   2. Marking: Mark valve box covers with "Lawn Valve", "Drain Valve" or "Control Valve" as applicable.

D. Sprinkler Heads:
   1. Impact Sprinklers: 1-1/2-inch inlet size and smaller.
      a. Product and Manufacturer: Provide sprinklers manufactured by the following:
         1) Rain Bird Sprinkler Manufacturing Company.
         2) Or equal.
      b. Type: Full or part circle impact drive sprinklers as specified on the Drawings.
      c. Materials and Construction:
         1) Body, Arm, Nozzle and Bearing Nipple: Brass.
         2) Arm Spring, Bearing Spring: Stainless steel.
      d. Rotation: Horizontal oscillating arm actuated by the outlet water stream.
   2. Pop-up Spray Sprinklers:
      a. Product and Manufacturer: Provide sprinklers as manufactured by one of the following:
         1) Rain Bird Sprinkler Manufacturing Company.
         2) Or equal.
      b. Type: Pop-up spray sprinklers for lawn areas for full or part circle coverage.

c. Materials and Construction:
   1) Body, Stem, and Screen: Heavy duty plastic.
   2) Wiper Seal: Soft elastomer.
   3) Retract Spring: Stainless steel.
   4) Nozzle: Brass with adjusting screw.
d. Sprinkler shall have a ratcheting system to align pattern.
e. Sprinkler shall have screen under nozzle.
f. Rectangular spray sprinkler coverage shall be 6 foot wide by 13 foot long at 30 psi water inlet pressure.

E. Zone Control Valves:
1. Product and Manufacturer: Provide valves as manufactured by one of the following:
   a. Rainbird.
   b. Or equal.
2. Type: Normally closed, 24 volt, solenoid actuated.
3. Materials and Construction:
   a. Body: Glass filled nylon.
   b. Diaphragm: Nylon reinforced rubber.
4. Actuator: 24 volt solenoid.

F. Flexible PVC Nipples:
1. Product and Manufacturer: Provide flexible nipples manufactured by one of the following:
   a. Excalibor, Placentia, Calif. patent #3,759,445.
   b. Or equal.
2. Type: Flexible PVC nipples for use on branches to sprinkler and drip irrigation heads.
3. Construction:
   a. Hose: ASTM D 2287.
   b. Schedule 40 Fitting: ASTM D 2466.

PART 3 - EXECUTION

3.1 INSPECTION

A. Site Conditions:
1. All scaled dimensions are approximate. The CONTRACTOR shall check and verify all size dimensions and all grades to satisfy himself that he may safely proceed with Work. Any major deviations from plans shall be brought to the attention of the ENGINEER prior to starting Work.
2. Coordinate installation of sprinkler irrigation materials, including pipe, so there shall be no interference with utilities or other construction difficulty in planting trees, shrubs, and ground covers.

3.2 PREPARATION

A. Water Supply:
1. Sprinkler irrigation system shall be connected to water supply points of connection as indicated on the Drawings.
2. Connections shall be made at approximate locations as shown on Drawings. CONTRACTOR is responsible for minor changes caused by actual site conditions.

B. Electrical Supply:
   1. Electrical connections for automatic controllers shall be made to electrical points of connection as indicated on the Drawings.
   2. Connections shall be made at approximate locations as shown on the Drawings. CONTRACTOR is responsible for minor changes caused by actual site conditions.

3.3 PREPARATION OF PIPE

A. Clean pipe prior to installation and maintain in that condition during installation. When pipe laying is not in progress, close open end of pipe by approved means.

B. Plastic pipe and fittings shall be free from dirt, dust and moisture. Apply an even coat of solvent with a natural bristle brush to the outside of the pipe. A light, but complete coat of solvent shall then be applied to the fitting socket. Another light coat of solvent shall be applied to the outside of the pipe making sure that the coated area on the pipe is equal to the depth of the fitting socket. Care shall be taken to prevent the solvent from running through the fitting into the pipe. The pipe shall be quickly inserted into the fitting and turned approximately 1/4 turn and held for approximately 15 seconds. After joining, the excess solvent shall be immediately removed from the pipe. Care shall be taken so as not to use an excess amount of solvent, thereby causing a burr or obstruction to form on the inside of the pipe.

C. Allow a minimum of 15 minutes curing time for each welded joint before subjecting the pipe to stresses. Another fitting or pipe section may be installed after approximately two minutes if care is exercised so that strain is not placed on the previous assembly before the 15 minutes time has elapsed.

D. Plastic to Metal Connections: Male adaptors shall be hand tightened with final tightening not to exceed one turn with a strap wrench.

E. Threaded polyvinyl chloride adaptors into which pipe may be solvent welded shall be used where threaded plastic connectors are required. Only Schedule 80 pipe may be threaded.

F. As each line is completed, prior to the installation of irrigation heads and the last welded joint has had 12 hours to set and cure, the line shall be charged and flushed of all foreign materials. Any failures evident at this time shall be corrected. Adjustable caps may be used to facilitate the flushing operations. No portion of the line having welded or threaded fittings shall be covered with backfill prior to completing of the flushing operation.

3.4 INSTALLATION

A. Trenching:
   1. Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow layout indicated on Drawings and as noted. Trench width shall be minimum necessary for proper installation of pipe.
   2. Provide for a minimum of 18-inches cover for all pressure supply lines.

3. Provide for a minimum of 12-inches cover for all non-pressure supply lines.
4. Provide for a minimum of 18-inches cover for 24 volt wiring.
5. Clearances:
   a. Maintain following minimum horizontal clearances between lines:
      1) Pipe 2 inches and Smaller: 4 inches.
      2) Pipe 2-1/2 inches and Larger: 12 inches.
      3) Other Services: 12 inches.
   b. Maintain a minimum 1 inch vertical clearance clearance between lines crossing at an angle greater than 45 degrees.
6. Sprinklers and Quick Coupling Assemblies:
   a. Sprinklers and Quick Coupling Assemblies: Install plumb to within 1/16 inch.
   b. Heads Along Walks and Curbs: Set flush to within 1/8 inch with walks and ciurbs.
   c. Other Heads:
      1) Impact Sprinklers: Install as per details on Drawings.

B. Backfilling:
1. The trenches shall not be backfilled until all required tests are performed. Trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand or other approved materials, free from large clods of earth of stone. Backfill shall be mechanically compacted in landscape planted areas to a dry density equal to 95 percent compaction, per ASTM 1557.
2. Sand shall be initially placed to 3 inches above the pipe. No foreign matter larger than 1/2 inch in size will be permitted in the initial backfill.

C. Trenching and Backfill Under Traffic Areas:
1. Trenches located under areas where driveway, asphaltic concrete or concrete, will be installed shall be backfilled with sand (a layer 6-inches below the pipe and 3-inches above the pipe) and compacted in layers to 95 percent compaction per ASTM 1557, using manual or mechanical tamping devices. All trenches shall be left flush with the adjoining grade. The CONTRACTOR shall set in place, cap and pressure test all piping under traffic areas prior to work.

D. Remote Control Valves:
1. Install where shown on Drawings and details. When grouped together, allow at least 12-inches between valves. Install each remote control valve in a separate valve box.

E. Sprinkler Heads:
1. Install the sprinkler heads as designated on the Drawings and as indicated in the installation details.
2. Spacing of heads shall not exceed the maximum indicated on the Drawings. In no case shall the spacing exceed the maximum recommended by the manufacturer.
3. Set sprinkler heads, as per details shown.

3.5 FIELD QUALITY CONTROL

A. Flushing: After all piping and risers are in place and connected, and all related Work has been completed, and prior to installation of

heads, open control valves and using a full head of water flush out system. Flush 3 minutes through the further-most head from the valve. After flushing, cap the risers and pressure test the system.

B. Testing:
   1. Test sprinkler lines, in place, before backfilling, for a period of not less than 4 hours. During the test period, maintain minimum pressure at the highest point of the section being tested of 100 psi. Test is acceptable if no leakage or loss of pressure is evident without any make-up air.
   2. At the conclusion of the pressure test, install heads and test for operation in accordance with design requirements under normal operating pressure.
   3. Do not cover or enclose any Work until it has been inspected, tested and approved. Should any Work be enclosed or covered before such test and approval, uncover Work and after it has been inspected, tested and approved, make all repairs with like materials necessary to restore all Work to the Specification.

C. Adjustment of the System:
   1. The CONTRACTOR shall flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings.
   2. All sprinkler heads shall be set perpendicular to finished grades unless otherwise designated on the Drawings.

3.6 CLEAN UP

A. Clean up shall be made as each portion of the Work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be broomed or washed down, and any damage sustained on the work of others shall be repaired to original conditions at CONTRACTOR'S expense.

+ + END OF SECTION + +

SECTION 2K5

DECORATIVE STONE SURFACING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide decorative stone surfacing as shown and specified.
   2. The types of decorative stone surfacing Work required include the following:
      a. Decomposed granite.
   3. The extent of the decorative stone surfacing is as shown on the Drawings.

B. Coordination:
   1. Review installation procedures under other sections and coordinate the installation of items that must be installed with the decorative stone surfacing.

C. Related Work Specified Elsewhere:
   1. Section 2D1, Earthwork
   2. Section 2K, Landscaping.

1.2 QUALITY ASSURANCE

A. Source Quality Control: Supply thoroughly washed decomposed granite, from a single source, consisting of tough, hard stone free from coatings, clay, caliche or organic matter.

B. Design Criteria: The requirements of this Section shall generally conform to MAG Standard Specification Section 430, 702 and 795, except as modified, added to, or changed herein. Where there is a conflict between MAG Standard Specification and this Specification the provisions of this Specification shall apply.

1.3 SUBMITTALS

A. Samples: Make available for inspection and approval prior to placement of the material a representative 50 pound sample of stone from the intended supply source.

B. Shop Drawings: Submit for approval name of intended decomposed granite source.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Decomposed Granite:
   1. Provide decomposed granite complying with MAG Standard Specification Sections 430.4, 702.4 and 795.8.4. Decomposed granite

shall be free from lumps or balls of clay and shall not contain calcareous coatings, caliche, organic matter, or foreign substances. The grading requirements shall be as follows:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	85 - 100
No. 40	5/20

2. Color: Desert Gold. Provide material from a single production source of uniform appearance.

B. Pre-emergent:
   1. Product and Manufacturer:
      a. Surflan
      b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the subgrade, verify the elevations, observe the conditions under which the Work is to be performed, and notify the ENGINEER of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Outline areas to receive decorative stone surfacing and secure ENGINEER'S acceptance before start of Work. Make minor adjustments as may be necessary by field conditions.

3.3 INSTALLATION

A. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned.

B. Rake, level and smooth subgrade so that it is free from all construction debris and other foreign material.

C. Apply pre-emergent as per manufacturer's directions.

D. Place decorative stone 2-inches deep to the proper lines and grades as shown.

3.4 MAINTENANCE

A. Repair all erosion channels that may form as directed by the ENGINEER until Final Acceptance.

B. Keep decorative stone surfacing free of any foreign material including but not limited to soil, debris and weeds until Final Acceptance.

C. Pre-emergent should be applied prior to installation and immediately prior to Final Acceptance.

3.5 INSPECTION

A. When the decorative stone surfacing Work is completed, including maintenance, the ENGINEER will make an inspection to determine acceptability.

B. Where inspected decorative stone surfacing Work does not comply with the requirements, replace rejected Work and continue specified maintenance until reinspected by the ENGINEER and found to be acceptable.

+ + END OF SECTION + +

SECTION 3A

CONCRETE FORMWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install concrete formwork. The Work also includes:
   a. Providing openings in formwork to accommodate the Work under this and other Sections and building into the formwork all items such as sleeves, anchor bolts, inserts and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the formwork.
2. Notify Subcontractors in advance of the construction of the formwork to provide the Subcontractors with sufficient time for the installation of items included in their work that must be installed with the formwork.
3. Coordinate formwork specifications herein with the requirements for finished surfaces specified in Section 3D.

C. Related Work Specified Elsewhere:
1. Section 3G, Precast Concrete.

1.2 QUALITY ASSURANCE

A. Standard Specification and Details:
1. CONTRACTOR shall conform to all applicable requirements of Section No. 505 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Associations of Governments (MAG). Where there is a conflict between MAG Standard Specifications and these Specifications, provisions of these Specifications shall govern.

2. CONTRACTOR shall examine the substratum and the conditions under which concrete formwork is to be performed, and notify the ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
1. ACI 301, Specifications for Structural Concrete for Buildings.
2. ACI 347, Recommended Practice for Concrete Formwork.

C. Allowable Tolerances:

1. Construct formwork to provide completed concrete surfaces complying with tolerances specified in ACI 347, Chapter 3.3, except as otherwise specified.

D. All items for permanent or temporary facilities shall be used in accordance with manufacturers instructions.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Submit for information purposes copies of manufacturer's data and installation instructions for proprietary materials, including form coatings, manufactured form systems, ties and accessories.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. On delivery to job site, place materials in area protected from weather.

B. Store materials above ground on framework or blocking. Cover wood for forms with protective waterproof covering. Provide for adequate air circulation or ventilation.

C. Handle materials to prevent damage.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete:
   1. Unless otherwise shown or specified, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood-faced or other panel type materials acceptable to ENGINEER, to provide continuous, straight, smooth as-cast surfaces. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown or specified. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

B. Forms for Unexposed Finish Concrete:
   1. Form concrete surfaces that will be unexposed in the finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least 2 edges and 1 side.

C. Cylindrical Columns and Supports:
   1. Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
      a. Provide manufacturer's seamless units to minimize spiral gaps or seams.
   2. Fiberglass or steel forms may be used for cylindrical columns if approved by the ENGINEER.

D. Form Ties:
   1. Provide factory-fabricated, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal. Materials used for tying forms will be subject to approval of the ENGINEER.
   2. Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1 inch from the outer concrete surface. Unless otherwise shown, provide form ties that will leave a hole no larger than 1-inch diameter in the concrete surface.
   3. Ties for exterior walls and walls subject to hydrostatic pressure shall have waterstops.
   4. Provide wood or plastic cones for ties, where concrete is exposed in the finish structure and in the interior of tanks.

E. Form Coatings:
   1. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds. For concrete surfaces which will be in contact with potable water, the form coating shall be a mineral oil base coating.

2.2 DESIGN OF FORMWORK

A. Design, erect, support, brace and maintain formwork so that it shall safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system or in-place construction that has attained adequate strength for this purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.

B. Design forms and falsework to include values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.

C. Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

D. Support form facing materials by structural members spaced sufficiently close to prevent significant deflection. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances. For long span members without intermediate supports, provide camber in formwork as required for anticipated deflections resulting from weight and pressure of fresh concrete and construction loads.

E. Design formwork to be readily removable without impact, shock or damage to concrete surfaces and adjacent materials.

F. Provide formwork sufficently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

PART 3 - EXECUTION

3.1 FORM CONSTRUCTION

A. General: Construct forms complying with ACI 347; to the exact sizes, shapes, lines and dimensions shown; as required to obtain accurate alignment, location and grades; to tolerances specified; and to obtain level and plumb work in finish structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required. Use selected materials to obtain required finishes. Finish shall be as determined by approved mock-up or sample panel, if specified.

B. Fabricate forms for easy removal without damaging concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

C. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms in locations as inconspicuous as possible, consistent with requirements of the Work. Form intersecting planes of openings to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

D. Falsework:
   1. Erect falsework and support, brace and maintain it to safely support vertical, lateral and asymmetrical loads applied until such loads can be supported by in-place concrete structures. Construct falsework so that adjustments can be made for take-up and settlement.
   2. Provide wedges, jacks or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce finished Work of required dimensions.

E. Forms for Exposed Concrete:
   1. Do not use metal cover plates for patching holes or defects in forms.
   2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
   3. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.

4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
5. Form molding shapes, recesses and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

F. Corner Treatment:
1. Form exposed corners of beams, walls, foundations, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown. Except as specified below for reentrant or internal corners, exposed corners shall be chamfered.
2. Form chamfers with 3/4-inch by 3/4-inch strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
3. Reentrant or internal corners and unexposed corners may be formed square.

G. Joints:
1. See Section 3B of these Specifications for treatment of joints. Locate as shown and specified.

H. Openings and Built-In Work:
1. Provide openings in concrete formwork shown or required by other Sections or other contracts. Refer to paragraph 1.1.B herein for the requirements of coordination.
2. Accurately place and securely support items to be built into forms.

I. Cleaning and Tightening:
1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Retighten forms immediately after concrete placement as required to eliminate mortar leaks.

3.2 FORM COATINGS

A. Coat form contact surfaces with a non-staining form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Form release agents, concrete curing compounds or hardeners shall not be used where concrete surfaces are to be lined with plastic channel liner material.

C. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into the formwork, anchorage devices and other embedded items, shown, specified or required by other Sections and other contracts. Refer to paragraph 1.1.B herein for the

requirements of coordination. Use necessary setting drawings, diagrams, instructions and directions.

B. Edge Forms and Screeds Strips for Slabs:
   1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support screeds.

3.4 FIELD QUALITY CONTROL

A. Before concrete placement, CONTRACTOR shall check the formwork, including lines, ties, tie cones, and form coatings. He shall make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

B. During concrete placement CONTRACTOR shall check formwork and related supports to ensure that forms are not displaced and that completed Work shall be within specified tolerances.

C. If CONTRACTOR finds that forms are unsatisfactory in any way, either before or during placing of concrete, placement of concrete shall be postponed or stopped until the defects have been corrected, and reviewed by the ENGINEER.

3.5 REMOVAL OF FORMS

A. Conform to the requirements of ACI 301, Chapter 4 and ACI 347, Chapter 3.6.2.3, except as specified below.

B. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the load upon them. Results of suitable control tests may be used as evidence that the concrete has attained sufficient strength.

C. The time for removal of all forms will be subject to the ENGINEER'S approval.

3.6 PERMANENT SHORES

A. Provide permanent shores as defined in ACI 347 Chapter 3.7.

B. Reshores will not be permitted.

3.7 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces. Form surfaces shall be subject to the ENGINEER'S approval.

+ + END OF SECTION + +

SECTION 3B

CONCRETE JOINTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install concrete joints.
   2. The types of concrete joints required include the following:
      a. Construction joints.
      b. Expansion joints and fillers.
      c. Waterstops.
      d. Control joints.

B. General: All joints subject to hydrostatic pressure shall be provided with continuous waterstop.

C. Related Work Specified Elsewhere:
   1. Section 3A, Concrete Formwork.
   2. Section 3D, Cast-In-Place Concrete.
   3. Section 7J1, Calking and Sealants.

1.2 QUALITY ASSURANCE

A. Standard Sepcifications and Details:
   1. CONTRACTOR shall conform to all applicable requirements of Section No. 505 and 729 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Sepcifications and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ACI 301, Specifications for Structural Concrete for Buildings, Chapter 6, Joints and Embedded Items.
   2. ASTM A 36, Structural Steel.
   3. ASTM D 1752, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

C. All manufactured items shall be installed in accordance with manufacturer's instructions.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for all materials required.
   2. Layout of all construction joint locations prior to the submittal of steel reinforcing drawings.
   3. Detail for joining polyvinyl chloride to steel waterstops.

B. Samples: Submit for approval the following:
   1. Polyvinyl chloride and metal waterstops for joints.
   2. Cork expansion joint fillers.

PART 2 - PRODUCTS

2.1 WATERSTOPS

A. Polyvinyl Chloride:
   1. Construction Joints: Minimum of 3/8-inch thick.
      a. Width shall be as shown, or if not shown, as recommended by the manufacturer.
   2. Expansion Joints: Uniform minimum thickness of 5/32 inch by 9 inches minimum width. Center bulb shall be "O" or "U" shaped and of material with maximum flexibility. The top of the "U" shall be jointed by a membrane which will tear when the expansion occurs.
   3. Product and Manufacturer: Provide waterstops as manufactured by one of the following:
      a. W.R. Meadows, Inc.
      b. W.R. Grace and Company.

B. Carbon Steel:
   1. Provide steel waterstops complying with ASTM A 36; thickness not less than 1/4 inch; width 6 inches or as shown.

2.2 PREFORMED EXPANSION JOINT FILLER

A. Provide preformed expansion joint filler complying with ASTM D 1752, Type II, cork.

2.3 CONCRETE CONSTRUCTION JOINT ROUGHENER

A. Provide a water soluble non-flammable, surface-retardant roughener.

B. Product and Manufacturer: Provide one of the following:
   1. Rugasol-S by Sika Chemical Corporation, for horizontal joints only.
   2. EAC-S by Preco Industries, Ltd., for horizontal joints only.
   3. Super Tuf-Cote II (Deep Etch) by Preco Industries Ltd., for vertical joints.

2.4 EPOXY BONDING AGENT

A. Provide a two component epoxy-resin bonding agent.

B. Product and Manufacturer: Provide one of the following:
   1. Sikadur Hi-Mod by Sika Chemical Corporation
   2. Epoxtite Binder (Code #2390) by A.C. Horn, Inc.

PART 3 - EXECUTION

3.1 CONSTRUCTION JOINTS

A. Comply with ACI 301, Chapter 6, and as specified below.

B. Locate and install construction joints as shown. Additional construction joints shall be located as follows:
   1. In walls locate joints at a spacing of approximately 25 feet and approximately 12 feet from corners.
   2. In foundation slabs and slabs on grade locate joints at a spacing of approximately 25 feet. Place concrete in a checkerboard pattern.
   3. In mats and structural slabs and beams, locate joints in compliance with ACI 301, Chapter 6.

C. Horizontal Joints:
   1. Roughen concrete at the interface of construction joints in accordance with instructions of the manufacturer of joint roughener. Immediately before placing fresh concrete, thoroughly clean the existing contact surface using a stiff brush or other tools and a stream of water under pressure. The surface shall be clean and wet, but free from pools of water at the moment the fresh concrete is placed.
   2. Remove laitance, waste mortar or other substance which may prevent complete adhesion.
   3. Place a 2-inch thick coat of mortar, of similar proportions to the mortar in the concrete, over the contact surface of the old concrete. Place fresh concrete before the mortar has attained its initial set.

D. Vertical Joints:
   1. Apply roughener to the form in a thin, even film by brush, spray or roller in accordance with the manufacturer's instructions. After roughener is dry, concrete may be placed.
   2. When concrete has been placed and the form removed, wash loosened material off with high pressure water spray to obtain roughened surface subject to approval by ENGINEER.

3.2 EXPANSION JOINTS

A. Comply with ACI 301, Chapter 6, and as specified below.

B. Locate and install expansion joints as shown. Install cork filler in accordance with manufacturer's instructions. Calking and sealants shall be installed as specified in Section 7J1.

3.3 WATERSTOPS

A. General:
   1. Comply with ACI 301, Chapter 6, and as specified below. All joints shall be made in accordance with manufacturer's instructions.
   2. Obtain ENGINEER'S approval for waterstop locations not shown.
   3. Provide waterstops in all foundations, tanks and other substructures up to an elevation at least 12 inches above grade or to an elevation at least 12 inches above liquid level in tanks, whichever is higher, except where otherwise shown or noted.

B. Steel Waterstop:
   1. Before installation, remove any paint, rust, scale or other coatings that will destroy or reduce bonding of steel waterstops.

2. Splice steel waterstops by butt welding.

C. Polyvinyl Chloride Waterstop:
1. Tie waterstop to reinforcement so that it is securely and rigidly supported in the proper position during concrete placement. Continuously inspect waterstops during concrete placement to insure their proper positioning.
2. Waterstops shall be fused using equipment as supplied by or recommended by the manufacturer.
3. Where required, weld polyvinyl chloride waterstop to steel waterstop by gently heating while applying pressure to the two materials. Use a steel plate and two "C" clamps to apply the pressure and a propane torch to apply the heat. The polyvinyl chloride waterstop shall be clamped between the steel waterstop and the steel plate which is held in place by the two "C" clamps. As heat is applied to the steel waterstop tighten the "C" clamps. Heat for approximately 15 minutes at a temperature just enough to make the polyvinyl chloride "runny" and the weld complete. After cooling remove the "C" clamps and plate. ENGINEER must approve polyvinyl chloride before embedding in concrete.

3.4 BONDING WITH EPOXY ADHESIVE

A. Use adhesive for the following:
1. Bonding of fresh concrete to concrete cured at least 28 days or to existing concrete.
2. Bonding of horizontal construction joints where these are required by the Drawings or approved by ENGINEER for foundation mats that are 5 feet thick or greater.

B. Handle and store epoxy adhesive in compliance with the manufacturer's printed instructions, including safety precautions.

C. Mix the epoxy adhesive in complete accordance with the instructions of the manufacturer.

D. Before placing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with epoxy grout not less than 1/16-inch thick. Place fresh concrete while the epoxy material is still tacky, without removing the in-place grout coat, and as directed by the epoxy manufacturer.

+ + END OF SECTION + +

SECTION 3C

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install concrete reinforcement.
2. The extent of concrete reinforcement is shown on the Drawings.
3. The Work includes fabrication and placement of reinforcement including bars, ties and supports, and welded wire fabric for concrete, encasements and fireproofing.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 4B, Masonry Accessories.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details
1. CONTRACTOR shall conform to all applicable requirements of Section No. 727 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and this Specification, provisions of this Specification shall govern.

B. CONTRACTOR shall examine the substrate and the conditions under which concrete reinforcement is to be placed, and notify the ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
1. Concrete Reinforcing Steel Institute, "Manual of Standard Practice", includes ASTM standards referred to herein.
2. ACI 318, "Building Code Requirements for Reinforced Concrete".
3. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
4. Concrete Reinforcing Steel Institute, Placing Reinforcing Bars.

D. Allowable Placing Clearances: Comply with ACI 318, Chapter 7 - Details of Reinforcement except as shown on Contract Drawings.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Shop Drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315, Chapters 1 thru 8. For walls, show elevations to a minimum scale of 1/4 inch to 1 foot. For slabs, show top and bottom reinforcing on separate plan views. Show bar schedules, stirrup spacing, diagrams of bent bars, arrangements

and assemblies, as required for the fabrication and placement of concrete reinforcement unless otherwise noted. Splices shall be kept to a minimum. Splices in regions of maximum tension stresses shall be avoided whenever possible.

a. Drawings detailing the location of all construction and expansion joints as required under Section 3B, shall be submitted and approved before Shop Drawings for reinforcing steel are submitted.

2. Submit copies of manufacturer's specifications and installation instructions for all materials and reinforcement accessories.

B. Certificates:

1. Submit 1 copy of steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

1.4 DELIVERY, HANDLING AND STORAGE

A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

B. Store concrete reinforcement material at the site to prevent damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars: ASTM A 615, and as follows:

1. Provide Grade 60 for all bars except for stirrups and ties which shall be Grade 40.

B. Steel Wire: ASTM A 82.

C. Welded Smooth Wire Fabric: ASTM A 185.

1. Furnish in flat sheets, or rolls.

D. Column Spirals: Hot-rolled rods for spirals, ASTM A 615.

E. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.

1. Use wire bar type supports complying with CRSI recommendations, except as specified below. Do not use wood, brick, or other unacceptable materials.
2. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
3. For all concrete surfaces, where legs of supports are in contact with forms, provide supports complying with CRSI "Manual of Standard Practice" as follows:
   a. Either hot-dip galvanized, plastic protected or stainless steel legs.
4. Over waterproof membranes, use precast concrete chairs.

2.2 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice". In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken the material.

B. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the Work:
   1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
   2. Bends or kinks not shown on approved Shop Drawings.
   3. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the applicable recommendations of specified codes and standards, and CRSI "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement against displacement during formwork construction or concrete placement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
   1. Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Reinforcing steel shall not be secured to forms with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least one full mesh and lace splices with 16 gage wire. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.

E. Provide sufficient numbers of supports of strength required to carry reinforcement. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

F. Splices:
   1. Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars.

3.2 INSPECTION OF REINFORCEMENT

A. Concrete shall not be placed until the reinforcing steel is inspected and permission for placing concrete is granted by the ENGINEER. All concrete placed in violation of this provision will be rejected.

+ + END OF SECTION + +

SECTION 3D

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install cast-in-place concrete.
2. The Work includes providing concrete consisting of portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished and cured. The Work also includes:
   a. Providing openings in concrete to accommodate the Work under this and other Sections and building into the concrete all items such as sleeves, frames, anchor bolts, inserts and all other items to be embedded.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.
2. Notify Subcontractors in advance of the placing of concrete to provide the Subcontractors with sufficient time for furnishing of items included in their work that must be installed in the concrete.

C. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 3A, Concrete Formwork
3. Section 3B, Concrete Joints
4. Section 3C, Concrete Reinforcement

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
1. CONTRACTOR shall conform to all applicable requirements of Section Nos. 505, 725 and 726 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ACI 301, Specification for Structural Concrete for Buildings, (includes ASTM Standards referred to herein).
2. ACI 318, Building Code Requirements for Reinforced Concrete.
3. ACI 304, Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 311, Recommended Practice for Concrete Inspection.
5. ACI 211.1, Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete.
6. ACI 214, Recommended Practice for Evaluation of Compression Test

Results of Field Concrete.
7. ACI 305, Recommended Practice for Hot Weather Concreting.
8. ACI 306, Recommended Practice for Cold Weather Concreting.
9. ACI 309, Recommended Practice for Consolidation of Concrete.
10. AASHTO M 182, Burlap Cloth Made From Jute or Kenaf.

C. Concrete Testing Service:
1. CONTRACTOR shall employ, at his own expense, a testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
   a. Testing agency shall meet the requirements of ASTM E 329.
   b. Selection of a testing laboratory is subject to the ENGINEER'S approval.
   c. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information which may be requested by the ENGINEER.
2. Materials and installed Work may require testing and retesting, as directed by the ENGINEER, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be done at the OWNER'S expense, including the retesting of rejected materials and installed Work, shall be done at the CONTRACTOR'S expense.

D. Qualifications of Water-Reducing Admixture Manufacturer:
1. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. CONTRACTOR shall furnish copy of manufacturer's quality assurance handbook to document the existence of the program. Manufacturer shall maintain a concrete testing laboratory which has been approved by the Cement and Concrete Reference Laboratory at the Bureau of Standards, Washington, D.C.
2. When requested by ENGINEER, provide a qualified concrete technician employed by the admixture manufacturer to assist in proportioning the concrete for optimum use of the admixture. The concrete technician, when requested, shall advise on proper addition of the admixture to the concrete and on adjustment of the concrete mix proportions to meet changing jobsite conditions.

E. Tests for Concrete Materials:
1. Submit written reports to the ENGINEER, for each material sampled and tested, prior to the start of Work. Provide the Project identification name and number, date of report, name of CONTRACTOR, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs.
2. The following information, if ready-mixed concrete is used.
   a. Physical capacity of mixing plant.
   b. Trucking facilities available.

c. Estimated average amount which can be produced and delivered to the site during a normal 8 hour day, excluding the output to other customers.

3. Copies of manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.

B. Samples: Submit for approval the following:
1. Samples of materials as specified and as otherwise may be requested by the ENGINEER, including names, sources and descriptions.

C. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. ENGINEER'S review will be for general information only. Production of concrete to comply with specified requirements is the responsibility of the CONTRACTOR.

D. Submit notarized certification of conformance to referenced standards when requested by the ENGINEER.

E. Delivery Tickets: Furnish to ENGINEER copies of all delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C 94, Section 14.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to insure that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement:
1. Portland cement, ASTM C 150, Type II; or blended hydraulic cement, ASTM C 595, Type 1P.
2. Use portland cement made by a well-known acceptable manufacturer and produced by not more than one plant.
3. Do not use cement which has deteriorated because of improper storage or handling.

B. Aggregates: ASTM C 33 and as herein specified.
1. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.
2. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
   a. Dune sand, bank run sand and manufactured sand are not acceptable.
3. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:

a. Crushed stone, processed from natural rock or stone.
b. Coarse Aggregate Size: Size to be ASTM C 33, Nos. 57 or 67, except that No. 467 may be used for footings, foundation mats and walls 16 inches or greater in thickness.

C. Water: Clean, free from injurious amounts of oils, acids, alkalis, organic materials or other substances that may be deleterious to concrete or steel.

2.2 CONCRETE ADMIXTURES

A. Provide admixtures produced by established reputable manufacturers, and use in compliance with the manufacturer's printed instruction. Do not use admixtures which have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by the ENGINEER.

B. Air-Entraining Admixtures: ASTM C 260.
1. Product and Manufacturer: Provide one of the following:
a. SIKA AER by Sika Chemical Corporation.
b. MB-VR by Master Builders Company.

C. Water-Reducing Admixture: ASTM C 494, Type A.
1. Proportion all concrete with non-air entraining, normal setting, water-reducing, aqueous solution of a modification of the salt of polyhydroxylated organic acids. The admixture shall not contain more chloride ions than are contained in municipal drinking water. Provide one of the following:
a. Eucon WR-75 by The Euclid Chemical Company.
b. Pozzolith by Master Builders Company.

D. Calcium Chloride: Do not use calcium chloride in concrete, unless otherwise authorized in writing by the ENGINEER. Do not use admixtures containing calcium chloride where concrete is placed against galvanized steel.

2.3 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes of concrete. Use the same design mix for both classes of concrete. Mixes subject to the following limitations:
1. Specified 28-day Compressive Strength: 4,000 psi.
2. Maximum Water-Cement Ratio by Weight: 0.45.
3.

Coarse Aggregate Number	Minimum Cement Content-Pounds Per Cubic Yard	Percent Air Content
57, 67	564	6 ± 1%
467	517	5 ± 1%

B. Use an independent testing facility acceptable to the ENGINEER for preparing and reporting proposed mix designs.
1. The testing facility shall not be the same as used for field quality control testing.

C. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the Project for concrete

required. Comply with ACI 211.1 and report to the ENGINEER the following data:

1. Complete identification of aggregate source of supply.
2. Tests of aggregates for compliance with specified requirements.
3. Scale weight of each aggregate.
4. Absorbed water in each aggregate.
5. Brand, type and composition of cement.
6. Brand, type and amount of each admixture.
7. Amounts of water used in trial mixes.
8. Proportions of each material per cubic yard.
9. Gross weight and yield per cubic yard of trial mixtures.
10. Measured slump.
11. Measured air content.
12. Compressive strength developed at 7 days and 28 days, from not less than 3 test cylinders cast for each 7-day and 28-day test, and for each design mix.

D. Submit written reports to the ENGINEER of proposed mix of concrete at least 15 days prior to start of Work. Do not begin concrete production until mixes have been approved by the ENGINEER.

E. Laboratory Trial Batches: When laboratory trial batches are used to select concrete proportions, prepare test specimens and conduct strength tests as specified in ACI 301, Chapter 3 - Proportioning, Method 1. 4,000 psi concrete mixes need not be designed for greater than 4,600 psi regardless of the production facilities standard deviation.

F. Field Experience Method: When field experience methods are used to select concrete proportions, establish proportions as specified in ACI 301, Chapter 3, Method 2.

G. Water-Cement Ratio Methods: If suitable data from field experience or laboratory trial batches cannot be obtained, concrete proportions may be established as specified in ACI 301, Chapter 3, Method 3.

H. Adjustment to Concrete Mixes: Mix design adjustments may be requested by CONTRACTOR when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the OWNER and as accepted by ENGINEER. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by ENGINEER before using the revised mixes.

I. Admixtures:

1. Use air-entraining admixture in all concrete, except interior slabs subject to abrasion, unless otherwise shown or specified. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the prescribed limits.
2. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

J. Slump Limits:
   1. Proportion and design mixes to result in concrete slump at the point of placement of not less than 1 inch and not more than 4 inches.

2.4 EPOXY BONDING AGENT

A. Provide a two component epoxy-resin bonding agent.

B. Product and Manufacturer: Provide one of the following:
   1. Sikadur Hi-Mod by Sika Chemical Corporation.
   2. Epoxtite binder (Code #2390) by A.C. Horn, Inc.

2.5 UNDERSLAB VAPOR BARRIER

A. Provide 7 mil white polyethylene sheet as manufactured by:
   1. Sto-Cote Products Inc.

2.6 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
   1. Waterproof paper.
   2. Polyethylene film.
   3. White burlap-polyethylene sheet.

C. Curing and Sealing Compound: Federal Spec TT C-800A, 30 percent solids content minimum. A chlorinated rubber or acrylic compound.
   1. Product and Manufacturer: Provide one of the following:
      a. Super Floor Coat or Super Pliocure by The Euclid Chemical Company.
      b. Masterseal by Master Builders Company.

D. Curing and Hardening Compound: ASTM C 309 (Water retention requirements). A silicate based compound.
   1. Product and Manufacturer: Provide one of the following:
      a. Eucosil by The Euclid Chemical Company.
      b. Curetox by Toch Brothers.

E. Evaporation Retarder:
   1. Product and Manufacturer: Provide one of the following:
      a. "Confilm" by Master Builders Company.
      b. "Euco Bar" by Euclid Chemical Company.

PART 3 - EXECUTION

3.1 CONCRETE MIXING

A. General:
   1. Concrete may be produced at batch plants or it may be produced by the ready-mixed process. Batch plants shall comply with the

recommendations of ACI 304, and shall have sufficient capacity to produce concrete of the qualities specified, in quantities required to meet the construction schedule. All plant facilities are subject to testing laboratory inspection and acceptance of the ENGINEER.

2. Mixing:
   a. Mix concrete with an approved rotating type batch machine, except where hand mixing of very small quantities may be permitted.
   b. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.
   c. Replace mixer blades when they have lost 10 percent of their original height.
   d. Use quantities such that a whole number of bags of cement is required, unless otherwise permitted.

B. Ready-Mix Concrete:
   1. Comply with the requirements of ASTM C 94, and as herein specified. Proposed changes in mixing procedures, other than herein specified, must be accepted by the ENGINEER before implementation.
      a. Plant equipment and facilities: Conform to National Ready-Mix Concrete Association "Plant and Delivery Equipment Specification".
      b. Mix concrete in revolving type truck mixers which are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
      c. Do not exceed the proper capacity of the mixer.
      d. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
      e. Do not allow the drum to mix while in transit.
      f. Mix at proper speed until concrete is discharged.
      g. Maintain adequate facilities at the job site for continuous delivery of concrete at the required rates.
      h. Provide access to the mixing plant for the ENGINEER at all times.

C. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.

3.2 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 45 minutes after water has been added to the dry ingredients.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not retemper partially set concrete.

E. Use suitable and approved equipment for transporting concrete from mixer to forms.

3.3 CONCRETE PLACEMENT

A. General: Place concrete continuously so that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified in Section 3B of these Specifications. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure which will cause segregation.
   1. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.
   2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.
   3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and secure position.
   4. Do not place footings in freezing weather unless adequate precautions are taken against frost action.
   5. Do not place footings, piers or pile caps on frozen soil.
   6. Unless otherwise approved, place concrete only when ENGINEER is present.
   7. Allow a minimum of 7 days before placing concrete against a slab or wall already in place.

B. Concrete Conveying:
   1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods which will prevent segregation and loss of concrete mix materials.
   2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, in cluding chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.
   3. Do not use chutes for distributing concrete unless approved in writing by the ENGINEER.
      a. Provide sketches showing methods by which chutes will be employed when requesting such approval.
      b. Design chutes, if permitted, with proper slopes and supports to permit efficient handling of the concrete.
   4. Do not pump concrete unless permitted by the ENGINEER, and, if permitted, do not use aluminum piping.

C. Placing Concrete into Forms:
   1. Deposit concrete in forms in horizontal layers not deeper than 18 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place concrete at such a rate that concrete which is being integrated with fresh concrete is still plastic.
   2. Do not permit concrete to free fall within the form from a distance exceeding 4 feet. Use "elephant trunks" to prevent free fall and excessive splashing on forms and reinforcement.

3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the applicable recommended practices of ACI 309. Vibration of forms and reinforcing will not be permitted, unless otherwise accepted by the ENGINEER.
5. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6 inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
6. Do not place concrete in beam and slab forms until the concrete previously placed in columns and walls is no longer plastic.
7. Force concrete under pipes, sleeves, openings and inserts from one side until visible from the other side to prevent voids.

D. Placing Concrete Slabs:
1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified for formed concrete structures.
4. Bring slab surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

E. Underslab Vapor Barrier:
1. Place vapor barrier under all concrete slabs and footings.
2. Where instructed to do so, delete vapor barrier below footing.

F. Bonding for Next Concrete Pour: Roughen surfaces of set concrete at all joints, except where bonding is obtained by use of a concrete bonding agent. Construction joints shown on the Drawings are specified in Section 3B of these Specifications. Clean surfaces of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and to not leave laitance, loose particles of aggregate, or damaged concrete at the surface.
1. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:
   a. Thoroughly wet the surface but allow no free standing water.
   b. For horizontal surfaces place a 2-inch layer of mortar, 1 part sand and 1 part cement with water, over the hardened concrete surface.

c. Place fresh concrete before the mortar has attained its initial set.

2. Bonding of fresh concrete to fully-cured hardened concrete or existing concrete shall be accomplished by using an epoxy-resin bonding agent as specified in Section 3B of these Specifications.

G. Quality of Concrete Work:

1. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.
2. All concrete for liquid retaining structures, and all concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
3. Cut out and properly replace to the extent ordered by the ENGINEER, or repair to the satisfaction of the ENGINEER, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Thin patches or plastering will not be acceptable.
4. All leaks through concrete, and cracks, holes or other defective concrete in areas of potential leakage, shall be repaired and made watertight by the CONTRACTOR.
5. Repair, removal, and replacement of defective concrete as ordered by the ENGINEER shall be at no additional cost to the OWNER.

H. Cold Weather Placing:

1. Protect all concrete Work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.
2. When the air temperature has fallen to or may be expected to fall below 40 F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50 F and 70 F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to insure that the ambient temperature does not fall more than 30 F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
3. When air temperature has fallen to or is expected to fall below 40 F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55 F and not more than 85 F at point of placement.
4. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.
5. Do not use salt and other materials containing antifreeze agents or chemical accelerators, or set-control admixtures, unless approved by the ENGINEER, in mix designs.

I. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 80 F when the temperature is rising and below 85 F when the temperature is falling. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated in the total amount of mixing water.
3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
4. Wet forms thoroughly before placing concrete.
5. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.
6. Do not use set-control admixtures unless approved by the ENGINEER in mix designs.
7. Obtain ENGINEER'S approval of other methods and materials proposed for use.

3.4 FINISH OF FORMED SURFACES

A. Rough Form Finish:
1. Standard rough form finish shall be the concrete surface having the texture imparted by the form material used, with tie holes and defective areas repaired and patched with mortar of 1 part cement to 1 1/2 parts sand and all fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
2. Use rough form finish for the following:
   a. Exterior vertical surfaces up to 1 foot below grade.
   b. Interior exposed vertical surfaces of liquid containers up to 1 foot below liquid level.
   c. Interior and exterior exposed beams and undersides of slabs.
   d. Other areas shown.

B. Smooth Form Finish:
1. Produce smooth form finish by selecting form materials which will impart a smooth, hard, uniform texture. Arrange panels in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas as above with all fins or other projections completely removed and smoothed.
2. Use smooth form finish for surfaces that are to be covered with a coating material. The material may be applied directly to the concrete or may be a covering bonded to the concrete such as waterproofing, dampproofing, painting or other similar system.

C. Smooth Rubbed Finish:
1. Provide smooth rubbed finish to concrete surfaces which have received smooth form finish and receive as follows:
   a. Rubbing of concrete surfaces not later than the day after form removal.
   b. Moistening of concrete surfaces and rubbing with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
2. Except where surfaces have been previously covered as specified above, use smooth rubbed finish for the following:
   a. Interior exposed walls and other vertical surfaces.

b. Exterior exposed walls and other vertical surfaces down to 1 foot below grade.
c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
d. Interior exposed vertical surfaces of liquid containers down to 1 foot below liquid level.
e. Other areas shown.

D. Related Unformed Surfaces:
1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.5 MONOLITHIC SLAB FINISHES

A. Float Finish:
1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently. Use a wood float only. Check and level the surface plane to a tolerance not exceeding 1/4 inch in 10 feet when tested with a 10 foot straightedge placed on the surface at not less than 2 different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.
2. Use float finish for the following:
a. Interior exposed horizontal surfaces of liquid containers.
b. Exterior below grade horizontal surfaces.
c. Surfaces to receive additional finishes, except as shown or specified.

B. Trowel Finish:
1. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
2. Consolidate the concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8 inch in 10 feet when tested with a 10 foot straight edge. Grind smooth surface defects which would telegraph through applied floor covering system.
3. Use trowel finish for the following:
a. Interior exposed slabs unless otherwise shown or specified.
b. Slabs to receive resilient floor finishes.

C. Non-Slip Broom Finish:
1. Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as shown on the Drawings or in schedules.
2. Immediately after trowel finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fiber-bristle broom unless otherwise directed. Coordinate the required final finish with the ENGINEER before application.

3.6 CONCRETE CURING AND PROTECTION

A. General:
1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
2. Prior to curing, apply evaporation retarder to horizontal surfaces in accordance with the rates and directions recommended by the manufacturer.
3. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared for the concrete surface. Keep continuously moist for not less than 72 hours.
4. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures. For concrete sections over 30 inches thick, continue final curing for an additional 7 days, minimum. Avoid rapid drying at the end of the final curing period.

B. Curing Methods:
1. Perform curing of concrete by moist curing, or by moisture-retaining cover curing, by curing compound, or by combinations thereof, as herein specified.
   a. For curing, use water that is free of impurities which could etch or discolor exposed, natural concrete surfaces.
2. Provide moisture curing by any of the following methods:
   a. Keeping the surface of the concrete continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering the concrete surface with the specified absorptive cover, thoroughly saturating the cover with water, and keeping the absorptive cover continuously wet with sprinklers or porous hoses. Place absorptive cover so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
3. Provide moisture-retaining cover curing as follows:
   a. Cover the concrete surfaces with the specified moisture-retaining cover for curing concrete, placed in the widest practical width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
4. Provide liquid curing compound as follows:
   a. Apply the specified curing and sealing compound to all slabs with carpet, with resilient tile or left exposed. Apply the specified curing and hardening compound to all other interior slabs and tank bases that are to receive grout topping. The compounds shall be applied immediately after final finishing in a continuous operation by power spray equipment in accordance with the manufacturer's directions. Recoat areas which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period. For concrete surfaces which will be in contact with potable water, the manufacturer shall certify that the curing compound used is non-toxic.

C. Curing Formed Surfaces:
   1. Cure formed concrete surfaces, including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
   2. Form release agents, concrete curing compounds or hardeners shall not be used where concrete surfaces are to be lined with plastic channel liner material.

D. Curing Unformed Surfaces:
   1. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by applying the specified curing compound.
   2. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.

E. Temperature of Concrete During Curing:
   1. When the atmospheric temperature is 40 F and below, maintain the concrete temperature between 50 F and 70 F continuously throughout the curing period. When necessary, make arrangement before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protection complying with the requirements of ACI 306.
   2. When the atmospheric temperature is 80 F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protection complying with the requirements of ACI 305, unless otherwise specified.
   3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5 F in any one hour and 50 F in any 24 hour period.

F. Protection from Mechanical Injury:
   1. During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.7 FIELD QUALITY CONTROL

A. The OWNER will employ a testing laboratory to perform field quality control testing. ENGINEER will make slump tests and will direct the number of tests and cylinders required. The testing laboratory will make standard compression test cylinders and entrained air tests as specified below, under the direct inspection by the ENGINEER. CONTRACTOR shall furnish all necessary assistance required by the testing laboratory. CONTRACTOR shall furnish the facilities described in Section 1G18, "On Site Facilities for Testing Laboratory".

B. Quality Control Testing During Construction:
   1. The testing laboratory will perform sampling and testing for field quality control during the placement of concrete, as follows:
      a. Sampling Fresh Concrete: ASTM C 172.
      b. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
      c. Air Content: ASTM C 231; one for every other concrete load at point of discharge, or when required by an indication of change.
      d. Compressive Strength Tests: ASTM C 39; one set of compression cylinders for each 50 cubic yards or fraction thereof, of each mix design placed in any one day or for each 2,500 square feet of surface area placed; 1 specimen tested at 7 days, and 2 specimens tested at 28 days.
         1) Adjust mix if test results are unsatisfactory and resubmit for ENGINEER'S approval.
         2) Concrete which does not meet the strength requirements is subject to rejection and removal from the Work, or to other such corrective measures as directed by the ENGINEER, at the expense of the CONTRACTOR.
      e. Compression Test Specimens: ASTM C 31; make one set of 3 standard cylinders for each compressive strength test, unless otherwise directed.
         1) Cast, store and cure specimens as specified in ASTM C 31.
      f. Concrete Temperature: Test hourly when air temperature is 40 F and below, and when 80 F and above; and each time a set of compression test specimens is made.
   2. The testing laboratory will promptly submit certified copies of test results directly to the ENGINEER and the CONTRACTOR after tests are made.

C. Evaluation of Quality Control Tests:
   1. Do not use concrete delivered to the final point of placement which has slump or total air content outside the specified values.
   2. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength tests results equal or exceed the 28 day design compressive strength of the type or class of concrete; and, no individual strength test falls below the required compressive strength by more than 500 psi.
      a. Where questionable field conditions may exist during placing concrete or immediately thereafter, strength tests of specimens cured under field conditions will be required by the ENGINEER to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded at the same time and from the same samples as the laboratory cured specimens.
         1) Provide improved means and procedures for protecting concrete when the 28 day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders.
         2) When laboratory-cured cylinder strengths are appreciably higher than the minimum required compressive strength, field-cured cylinder strengths need not exceed the

minimum required compressive strength by more than 500 psi even though the 85 percent criterion is not met.

3) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to assure that the load-bearing capacity of the structure is not jeopardized. If the likelihood of low-strength concrete is confirmed and computations indicate the load-bearing capacity may have been significantly reduced, tests of cores drilled from the area in question will be required at the CONTRACTOR'S expense.

b. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to replacement, reconstruction or to other action approved by ENGINEER.

D. Testing Concrete Structure for Strength:

1. When there is evidence that the strength of the in-place concrete does not meet specification requirements, CONTRACTOR shall employ at his expense the services of a concrete testing service to take cores drilled from hardened concrete for compressive strength determination. Tests shall comply with ASTM C 42 and the following:
   a. Take at least 3 representative cores from each member or suspect area at locations directed by ENGINEER.
   b. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85 percent and no single core is less than 75 percent of the 28 day required compressive strength.
   c. Report test results in writing to ENGINEER on the same day that tests are made. Include in test reports the Project identification name and number, date, name of CONTRACTOR, name of concrete testing service, location of test core in the structure, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of the concrete as placed, and the moisture condition of the core at time of testing.
2. Fill core holes solid with patching mortar, and finish to match adjacent concrete surfaces.
3. Conduct static load test and evaluations complying with ACI 318 if the results of the core tests are unsatisfactory, or if core tests are impractical to obtain, as directed by ENGINEER.

3.8 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In:

1. Fill-in holes and openings left in concrete structures for the passage of work by other contractors, unless otherwise shown or directed, after the work of other contractors is in place. Mix,

place and cure concrete as herein specified, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the Work.

B. Curbs:
1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
2. Exterior curbs shall have rubbed finish for vertical surfaces and a broomed finish for top surfaces.

C. Equipment Bases:
1. Unless specifically shown otherwise, provide concrete bases for all pumps and other equipment. Construct bases to the dimensions shown, or as required to meet manufacturers; requirements and Drawing elevations. Where no specific elevations are shown, bases shall be 6 inches thick and extend 3 inches outside the metal equipment base or supports. Bases to have smooth trowel finish.
2. Include all concrete equipment base work not specifically included under other Sections or other contracts.
3. In general, place bases up to 1 inch below the metal base. Properly shim equipment to grade and fill 1 inch void with non-shrink grout as specified in Section 3I.

3.9 CONCRETE REPAIRS

A. Repair of Formed surfaces:
1. Repair exposed-to-view formed concrete surfaces, that contain defects which adversely affect the appearance of the finish. Surface defects that require repair include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolts; fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning.
2. Repair concealed formed concrete surfaces that may contain defects that adversely affect the durability of the concrete. Surface defects that require repair include cracks in excess of 0.01 inch wide, cracks of any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls except minor breakage at corner.
3. Pressure grout structural cracks, and cracks in water-holding structures, using one of the following:
   a. Sikadur Hi-Mod L.V. and Gel by Sika Chemical Company.
   b. Euco Epoxy #460 and #461 by The Euclid Chemical Company.
4. Repair and patch defective areas with cement mortar immediately after removal of forms and as directed by ENGINEER.
5. Cut out honeycomb, rock pockets, voids over 1/2-inch diameter, and holes left by tie rods and bolts, down to solid concrete but, in no case, to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water, and brush-coat the area to be patched with the specified bonding agent.

a. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, the patching mortar color will match the color of the surrounding concrete. CONTRACTOR shall impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

6. Fill holes extending through concrete by means of a plunger-type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure completely filling.
7. Sandblast exposed-to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.

B. Repair of Unformed Surfaces:
1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.
2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.
3. Repair finish of unformed surfaces that contain defects which adversely affect the durability of the concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to the reinforcement or completely through non- reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
4. Grout structural cracks, and cracks in water holding structures, using one of the following:
   a. Sikadur Hi-Mod L.V. and Gel by Sika Chemical Company.
   b. Euco Epoxy #460 and #461 by The Euclid Chemical Company.
5. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
6. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Use one of the following:
   a. Poly-Patch by The Euclid Chemical Company.
   b. Sikatop by Sika Chemical Company.
7. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush with the specified bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same materials and proportions to provide concrete of the same type or class as the

original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

8. Repair isolated random cracks, and single holes not over 1-inch diameter, by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.
9. Assure that surface is acceptable for flooring material to be installed in accordance with manufacturer's recommendations.
10. Repair methods not specified above may be used if approved by the ENGINEER.

+ + END OF SECTION + +

SECTION 3G1

ARCHITECTURAL PRECAST CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all architectural precast concrete Work.
   2. The extent of architectural precast concrete is shown.
   3. The types of architectural precast concrete Work required includes, but is not necessarily limited to, the following:
      a. Precast concrete copings.
      b. Miscellaneous accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate them with the Work specified herein.

C. Related Sections:
   1. Section 4C3, Concrete Unit Masonry.
   2. Section 5E3, Miscellaneous Metal Fabrications.
   3. Section 7C10, Exterior Wall Insulation and Finish System.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Firms which have successful experience in the fabrication of architectural precast concrete Work, similar to units required for this project, will be acceptable. Fabricator must have sufficient production capacity to produce, transport, and deliver required units without causing delay in the Work.
   2. If units are produced at locations other than precast concrete fabricating plants, maintain procedures and conditions for quality control equivalent to plant production.

B. Erector Qualifications: Firms which have successful experience in the erection of architectural precast concrete units, similar to units required for this project, will be acceptable.

C. Design Criteria: Comply with recommended practices and procedures of the Prestressed Concrete Institute (PCI) MNL-117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products," for production and quality control of precast units and as herein specified.

D. Design Responsibility:
   1. The fabricator is responsible for structural design of the architectural precast concrete units and all support system components.
   2. Maintain general design concept shown without increasing or decreasing sizes or altering profiles and alignment shown.

3. General design concept indicated on the Drawings is provided to establish a minimum level of quality for the Work.
4. Reinforcing steel is not shown but shall be required as specified herein.
5. Provide complete design calculations and Shop Drawings signed and stamped with the seal of a Registered Professional Engineer licensed to practice in the State of Arizona and recognized as an expert in the specialty involved.
6. All fasteners, anchors and other supports shall be designed for a minimum safety factor of four. Exposed anchors shall not be approved for the Work.

E. Design Deviations: Design modifications may be made only as necessary to meet field conditions and to ensure proper fitting of the Work, and only as acceptable to ENGINEER.

F. Fabrication Tolerances:
1. Units shall be true to dimensions. Unit bow, as fabricated and installed, shall not exceed 1/8 inch per unit in the short dimension and 1/4 inch per unit in the long dimension. Step in alignment face and jog in alignment shall not exceed 1/4 inch. All molding shall be true to profile, and shall match and be continuous at the joints.
2. Imperfections such as air bubbles, ripples, joint lines, warpage, stains, projections, honeycombs, uneven matrix plate and other imperfections not in the approved sample panel will not be acceptable.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. 12-inches long by 12-inches wide by 2-inches thick samples of architectural precast concrete units showing finish, texture and color specified for the Work.
2. Samples of cast-in-place inserts, anchorages and other attachments and accessories as required by ENGINEER.
3. ENGINEER'S review of samples will be for finish, texture and color only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
1. Complete information for fabrication and installation of architectural precast concrete units. Indicate member dimensions and cross-section; location, size and type of reinforcement, sequence of erection and layout and identification of each architectural precast concrete unit.
2. Show location and details of anchorage devices that are to be embedded in other construction. Detail inserts, connection and joints, including all accessories.
3. Manufacturer's specifications, data and instructions for manufactured materials and products. Include manufacturer's certifications and laboratory test reports as required.

1.4 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver architectural precast concrete units to project site in such quantities and at such times to assure continuity of installation.

B. Storage of Materials:
   1. Store units off ground and on firm surfaces in a manner that will prevent cracking, distortion, warping, staining, or other physical damage and so that architectural precast units are without damage at time of installation.
   2. Separate stacked units by battens placed full width of each bearing.

C. Handling of Materials:
   1. Lift and support units only at designated lifting or supporting points as shown on final Shop Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Formwork:
   1. Provide forms of metal, plastic, wood, or other acceptable material that is non-reactive with concrete and will produce required finish surfaces.
   2. Accurately construct forms, mortar-tight, and of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and prestressing, pretensioning and detensioning operations. Maintain framework to provide completed architectural precast concrete units of shapes, lines and dimensions indicated, within specified fabrication tolerances.

B. Reinforcing Materials:
   1. Reinforcing Bars: ASTM A 615, Grade 60, unless otherwise indicated.
   2. Low-Alloy Steel Reinforcing Bars: ASTM A 706.
   3. Steel Wire: ASTM A 82, plain, cold-drawn, steel, galvanized complying with ASTM A 153.
   4. Welded Wire Fabric: ASTM A 185, galvanized after fabrication complying with ASTM A 153.
   5. Welded Deformed Steel Wire Fabric: ASTM A 497, galvanized after fabrication complying with ASTM A 153.
   6. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing.
   7. Where legs of supports are in contact with forms, provide supports with legs of stainless steel.

C. Concrete Materials:
   1. Portland Cement: ASTM C 150, Type I or Type III.
      a. Use only one brand and type of cement throughout the project unless otherwise acceptable to ENGINEER.
   2. Fine Aggregate: ASTM C 144.
   3. Coarse Aggregate: ASTM C 33; hard, durable aggregate, carefully selected and graded; free of material causing staining or reacting with cement.
   4. Water: Potable.
   5. Air-Entraining Admixture: ASTM C 260.
   6. Water-Reducing Admixture: ASTM C 494, Type A.
   7. Calcium Chloride: Do not use calcium chloride in architectural precast concrete.

D. Connection Materials:
   1. Stainless Steel Shapes: ASTM A 276, Type 316.
   2. Anchor Bolts: ASTM A 320, stainless steel bolts AISI Type 316, regular stainless steel Type 316 hexagon nuts and stainless steel washers.
   3. Inserts and Ferrules: Stainless steel AISI Type 316, sized as shown, unless heavier or larger units are required.

E. Miscellaneous Materials:
   1. Setting Pads: Lead or plastic wedges.
   2. Shims: Structural quality, stainless steel, ASTM A 176.

2.2 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type of concrete required.

B. Design mixes may be prepared by an independent testing facility or by qualified architectural precast manufacturing plant personnel, at precast manufacturer's option.

C. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each type of concrete required, complying with ACI 211.1 or ACI 211.2

D. Concrete Mix: Standard-weight concrete consisting of specified portland cement, pigments, aggregates, admixtures, and water to produce the following properties:
   1. Compressive Strength: 5,000 pounds per square inch minimum at 28 days.
   2. Total Air Content: Not less than 4 percent nor more than 6 percent.

E. Submit written reports to ENGINEER of proposed mix for each type of concrete at least 15 days prior to start of precast unit production. Do not begin concrete production until mixes and evaluations have been reviewed by ENGINEER.

F. Adjustment to Concrete Mixes: Mix design adjustments may be requested when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by ENGINEER before using in the Work.

G. Admixtures: Use air-entraining admixture in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion, or provide increased workability for low-slump concrete, may be used subject to ENGINEER'S acceptance.
   1. Use amounts as recommended by admixture manufacturer for climatic conditions prevailing at time of placing. Adjust quantities of admixtures as required to maintain quality control.

2.3 FABRICATION

A. General: Fabricate architectural precast concrete units complying with manufacturing and testing procedures, quality control recommendations, and dimensional tolerances of PCI MNL-117, unless otherwise indicated. Keep bar sizes small, even where this will reduce the spacing of the bars.

B. Fabricate units straight, smooth, and true to size and shape, with exposed edges and corners precisely radiused and square as shown.
   1. Precast units which are warped, cracked, broken, spalled, stained, or otherwise defective will not be acceptable.

C. Built-In Items: Provide slots, holes, and other accessories in units to receive dowels, reglets, and other similar Work as indicated.

D. Surface Finish: Fabricate precast units and provide exposed surface finishes as follows:
   1. Prepare surfaces of other units of architectural precast concrete acceptable to the manufacturer of acrylic stucco system specified in Section 7C10, Exterior Wall Insulation and Finish System.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and the conditions under which Work is to be performed and notify ENGINEER of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Before proceeding with the architectural precast concrete coping installation, CONTRACTOR shall verify that flashing and all anchors have been properly placed, and that anchor rod penetrations in flashing have been waterproofed with mastic.

B. Commencement of the Work of this Section shall be interpreted by ENGINEER that all conditions are suitable to produce an acceptable installation.

3.3 INSTALLATION

A. General: Deliver anchorage items which are to be embedded in other construction before start of such Work. Provide setting diagrams, templates, instructions and directions as required for installation.

B. Do not install architectural precast units until concrete has attained its design compressive strength.

C. Install architectural precast concrete copings plumb, level, and in alignment within PCI MNL-117 specified limits of erection tolerances unless indicated otherwise on Drawings.

D. Accessories: Install rods, clips, bolts, eye bolts and other accessories required for erection of precast copings and wainscot moldings.

E. Set all architectural precast concrete copings and wainscot moldings in full horizontal bed of mortar. All bed joints shall be 3/8-inch.

F. Use plastic pads, as required, to avoid squeezing mortar from joints.

3.4 ADJUSTMENT AND CLEANING

A. Cleaning: Clean exposed facings to remove dirt, mortar and stains which may be on units after erection and completion of joint treatments. Wash and rinse in accordance with precast concrete manufacturer's recommendations. Protect other work from damage due to cleaning operations.

B. In addition to above, in-place units may be rejected for any one of the following:
   1. Exceeding the specified installation tolerances.
   2. Damaged during construction operations.
   3. Exposed-to-view surfaces which develop surface finish deficiencies, discolorations or staining.
   4. Other defects as listed in PCI MNL-117.

C. Replace architectural precast concrete Work damaged for any reason or which fail to perform as specified until Final Acceptance by ENGINEER.

+ + END OF SECTION + +

SECTION 3G2

PRECAST CONCRETE PLANKS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install precast nailable concrete planks. The Work also includes:
      a. Providing openings in units to accommodate the Work under this and other Sections and building into the planks items such as sleeves, anchors and inserts.

B. Coordination:
   1. Review applicable installation procedures under other Sections and coordinate the installation of items that must be installed in the precast concrete planks.

C. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. Section 3D, Cast-In-Place Concrete.
   3. Section 7J1, Calking and Sealants.
   4. Section 9L, Painting.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. CONTRACTOR shall conform to all applicable requirements of Section Nos. 506 and 725 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ACI 318, Building Code Requirements for Reinforced Concrete, which includes referenced ASTM Standards.
      a. Comply with local building code requirements where more stringent than ACI 318.
   2. ACI 211.2, Recommended Practice for Selecting Proportions for Lightweight Concrete.
   3. ACI 517, Recommended Practice for Atmospheric Pressure Steam Curing of Concrete.

C. Fabricator Qualifications: Fabricated by a firm regularly engaged in the manufacture of precast concrete planks for at least two years. Manufacturer to participate in and furnish evidence to ENGINEER of plant quality control program.
   1. Manufacturer: Provide precast concrete planks as manufactured by one of the following:
      a. Concrete Products Company, Inc.
      b. Federal Cement Products.

D. Source Quality Control: Make cylinder tests of concrete quality in accordance with ASTM C 192, for each mix design, for each day of production, or for each 100 cubic yards of concrete.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Shop Drawings showing all dimensions, openings, jointing, inserts, reinforcing and design calculations, and method of handling. Include manufacturer's standard and special loading chart data for span and load conditions required, and manufacturer's setting plans and anchorage details. Show all conditions at openings, including size, location, and grout details, fasteners, etc., and dimensions.
   2. Copies of all concrete cylinder test reports.
   3. Manufacturer's literature and installation instructions.
   4. Certificates of material conformance with Specifications.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling: Transport and handle precast concrete planks with proper equipment to protect units from dirt and damage. Handle by means of lifting inserts.

B. Storage: Store units off ground and on firm surfaces to avoid warping and cracking. Protect units from damage and discoloration. Stack so that lifting devices are accessible and undamaged. Separate stacked members by battens across full width of each bearing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete:
   1. Portland cement shall conform to ASTM C 150, Types II or III. Type I may be used when acceptable to ENGINEER.
   2. Aggregate shall conform to ASTM C 330, for fine to coarse gradation.
   3. Admixtures: Chemical admixtures shall conform to ASTM C 494. Calcium chloride shall not be used.
   4. Water shall be free from foreign materials in amounts harmful to concrete.

B. Reinforcement: Welded wire fabric conforming to ASTM A 185.

C. Weld inserts, clips, anchors, and anchor plates shall be as shown and as required for anchoring planks to supports.

2.2 MIXES

A. Mix design shall be in accordance with ACI 211.2.

B. Measurements of concrete mix materials shall be within the following limits:
   1. Cement: plus or minus 1 percent.
   2. Water: plus or minus 1 percent.
   3. Fine Aggregate: plus or minus 2 percent.

4. Coarse Aggregate: plus or minus 2 percent.
5. Admixtures: plus or minus 3 percent.

2.3 DESIGN AND FABRICATION

A. Design units to support a superimposed load of 60 psf, with a factor of safety of 4.

B. Type: Machine made, solid precast concrete units 16 inches wide and depth shown on the drawings, produced under a rigid factory-inspected process acceptable to ENGINEER.

C. Furnish units which are free of voids and honeycomb, with straight true edges and surfaces. Longitudinal joints shall be tongue and groove.
   1. Provide units of a uniform color and free from stains or discoloration. Top surface to have a float finish free from holes.
   2. Any unit cracked or damaged shall be replaced if, in the opinion of the ENGINEER, such cracks or damage affect the strength or appearance of the units. Imperfections such as air bubbles, ripples, joint lines, warpage, projections or honeycombs will not be acceptable. Units may be patched or repaired if approved by the ENGINEER.
   3. Fabrication of units shall be to ACI tolerance standards.
   4. On-site casting of precast concrete elements will not be permitted.

D. Fabrication: Manufacture units of concrete materials which will provide a 28 day minimum compressive strength of 1,000 psi.

E. Adequately reinforce slab units to resist all transporting and handling stresses.

F. Include cast-in weld plates where required for anchorage or lateral bracing to structural steel members.

G. Identifications: Provide permanent markings as shown on the Shop Drawings. Markings shall not show in the finished Work.

H. Provide clip fasteners recommended by manufacturer, or as shown on the drawings, to connect planks to support framing, to resist a minimum uplift of 30 psf.

I. Planks may be naturally cured under cover, wet or steam cured at atmospheric pressure. If steam cured, conform to the requirements of ACI 517.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which precast concrete planks are to be installed. Notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

3.2 INSTALLATION

A. Lift, place, and secure plank units in accordance with manufacturer's printed instructions and approved Shop Drawings. Keep planks tight and perpendicular to bearing supports. Do not install planks until supporting members are in place and secured. If any units rest on masonry block lintels, assure that voids in lintels are filled with concrete.
   1. Follow erection procedures and sequence of erection as recommended by precast concrete plank manufacturer and as acceptable to the ENGINEER.

B. Units having any dimension smaller or greater than required or that are outside the specified tolerance limits, will be rejected if the appearance or function of the structure is adversely affected.

C. Level planks accurately or set to uniform slope as shown.
   1. Align and level to approved tolerance by methods, procedures, and equipment as recommended by the precast concrete plank manufacturer.
   2. Where adjacent planks are not in vertical alignment due to camber or other reason, provide mortar fill on lower unit to create a smooth transitional surface for the application of insulation. Slope of fill, measured perpendicular to side joints, shall not be steeper than 1/8-inch per foot.

D. Do not cut holes or install sleeves larger than size permitted by precast concrete plank manufacturer for pipe, conduits, duct or other penetrations after fabrication, except as otherwise shown or specified.

E. Do not cut reinforcing without approval of manufacturer and as acceptable to the ENGINEER.

F. Field cut holes for openings that are in accordance with precast concrete plank manufacturer's instructions, unless otherwise shown or specified.

G. Weld inserts in planks to bearing surfaces, as shown and specified.

H. Repair damaged exposed surfaces. Leave planks in a condition acceptable to the ENGINEER and ready to receive subsequent work.

+ + END OF SECTION + +

SECTION 3I

GROUT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install grout.
2. Grout shall be placed at the following locations:
   a. Column and equipment bases.
   b. Handrails and railings.
   c. Filter cell sheets.
   d. Topping in concrete tanks.
   e. Foundation grouting.
3. The types of grout include the following:
   a. Non-shrink, epoxy type.
   b. Non-shrink, non-metallic type.
   c. Ordinary cement-sand.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 3C, Concrete Reinforcement.
3. Section 3D, Cast-In-Place Concrete.
4. Section 4A, Mortar (grout for masonry work).
5. Section 5A1, Structural Steel.
6. Section 5E9, Steel Handrails and Railings.
7. Section 5E10, Aluminum Handrails and Railings.
8. Section 11 Series (for topping in tanks).

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
1. CONTRACTOR shall conform to all applicable requirements of Section No. 725 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM C 144, Aggregate for Masonry Mortar
2. ASTM C 150, Portland Cement
3. ASTM C 109, Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50 mm. Cube Specimens).
4. ASTM C 191, Time of Setting of Hydraulic Cement by Vicat Needle.
5. CRD-C-588, Specifications for Non-Shrink Grout.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. Submit copies of manufacturer's specifications and installation instructions for all proprietary materials.

B. Reports and Certificates:
1. For proprietary materials, submit copies of reports on quality control tests.
2. For nonproprietary materials, submit certification that materials meet specification requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Grout materials from manufacturers shall be delivered in unopened containers and shall bear intact manufacturer's labels.

B. Storage of Materials: Grout materials shall be stored in a dry shelter and shall be protected from moisture.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Non-metallic, 100 percent solids, high strength epoxy grout.
1. Use clean well graded sand with epoxy resins suitable for use on dry or damp surfaces.
2. Product and Manufacturer: Provide one of the following:
   a. Euco High Strength Grout by The Euclid Chemical Company.
   b. Sikadur Hi-Mod Grout by Sika Chemical Company.
   c. Five Star Epoxy Grout by U.S. Grout Corporation.

B. Non-Shrink, Non-Metallic Grout:
1. Pre-mixed non-staining cementious grout requiring only the addition of water at the jobsite.
2. Product and Manufacturer: Provide one of the following:
   a. Euco N-S by The Euclid Chemical Company.
   b. Masterflow 713 by Master Builders Company.
   c. Five Star by U.S. Grout Corporation.

C. Ordinary Cement-Sand Grout:
1. Except where otherwise specified use 1 part cement to 3 parts sand complying with the following:
   a. Cement: ASTM C 150, Type II.
   b. Sand: ASTM C 33.
2. Where water repelling and shrinkage reducing requirements are shown or specified, use admixtures.
   a. Product and Manufacturer: Provide one of the following:
      1) Integral Waterpeller by The Euclid Chemical Company.
      2) Omicron, Type OM by Master Builders Company.
      3) Hydrocide Powder by Sonneborn-Contech.

D. Water:
1. Use clean, fresh, potable water free from injurious amounts of oils, acids, alkalies or organic matter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Specifications do not proceed until ENGINEER provides clarification.
2. Drypacking will not be permitted.
3. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions.
4. Placing grout shall conform to temperature and weather limitations in Section 3D.

B. Column and Equipment Bases:
1. After shimming columns and equipment to proper grade, securely tighten anchor bolts. Properly form around the base plates allowing sufficient room around the edges for placing the grout. Adequate depth between the bottom of the base plate and the top of concrete base must be provided to assure that the void is completely filled with the non-metallic grout.

C. Handrails and Railings:
1. After posts have been propertly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the non-shrink, non-metallic grout. Bevel grout at juncture with post so that moisture flows away from post.

D. Grout for Topping in Concrete Tanks:
1. Install topping where shown. Insure that equipment has been checked for accurate adjustment before starting the grouting.
2. Use a 1 to 3 mixture by volume of ordinary cement-sand grout. A retarding admixture may be used, subject to approval of the ENGINEER.
3. Maximum slump allowed is 5 inches.
4. Prior to placement of the topping, remove all laitance, debris and loose and foreign material from the base slab. Use a metal screed or the tank mechanism to check the surface elevation of the base, and to ensure that at least the thickness of grout shown can be placed. If there is insufficient room for this grout, remove the high spots in the concrete or adjust the mechanism, or both, to provide proper clearance. Thoroughly wet the base at least 24 hours before the topping is placed. Keep surface damp. Brush in neat cement grout immediately before application of grout topping.

+ + END OF SECTION + +

SECTION 4A

MORTAR

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish all mortar Work.
2. This Section specifies the mortar for masonry materials specified in the following:
   a. Section 4C3, Concrete Unit Masonry.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
1. Do not change source or brands of mortar materials during the course of the Work.
2. Where question of compliance to the requirements of this Section arise the mortar properties specification shall take precedence over the mortar proportion specifications.
3. No change shall be made in the proportions established for mortar accepted under the property specifications nor shall materials with different physical characteristics be utilized in mortar used in the Work unless compliance with the requirements of the property specifications is re-established by Shop Drawing data submission to ENGINEER.
4. Two air-entraining materials shall not be combined in mortar.

B. Design Criteria
1. CONTRACTOR shall conform to all applicable requirements of Section No. 776 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) except as modified, added to, or changed herein. Where there is a conflict between MAG Standard Specifications and this Specification, provisions of this Specification shall govern.
2. Provide mortar work complying with the requirements for special inspection as determined by the Uniform Building Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM C 5, Quicklime for Structural Purposes.
2. ASTM C 91, Masonry Cement.
3. ASTM C 136, Sieve or Screen Analysis of Fine and Coarse Aggregates.
4. ASTM C 144, Aggregate for Masonry Mortar.
5. ASTM C 150, Portland Cement.
6. ASTM C 207, Hydrated Lime for Masonry Purposes.
7. ASTM C 270, Mortar for Unit Masonry.
8. UL, Design Numbers U901 through U908.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval, copies of manufacturer's specifications and instructions for each manufactured product.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Manufactured materials, such as cement and lime, shall be delivered and stored in their original containers, plainly marked with identification of materials and manufacturer.

B. Storage of Materials:
   1. Store mortar materials off the ground in a dry location and under a properly constructed shelter using tarpaulins, felt paper, or polyethylene sheets.
   2. Protect liquid admixtures from freezing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement: Provide the following for portland cement-lime mortars:
   1. ASTM C 150, Type I.
   2. Use ASTM C 150, Type III, high early strength, for laying masonry when outside temperature is less than 50 F.
   3. Provide nonstaining portland cement of natural color.
   4. Product and Manufacturer: Provide one of the following:
      a. Speed Portland Cement and Hi-Speed Portland Cement by Louisville Cement Company.
      b. Atlas Type I and Atlas Type III Portland Cement by Lehigh Portland Cement Company.
      c. Or equal.

B. Masonry Cement: Provide the following for masonry cement mortars:
   1. ASTM C 91, Type S; proportioned as specified to comply with ASTM C 270.
   2. Maximum Air Content, ASTM C 91: 18 percent.
   3. Product and Manufacturer: Provide one of the following:
      a. Brixment Type S by Louisville Cement Company.
      b. Atlas Masonry Cement Type S by Lehigh Portland Cement Company.
      c. Or equal.

C. Hydrated Lime: ASTM C 207, Type S, or lime putty ASTM C 5.

D. Sand Aggregates: ASTM C 144.

E. Water: Free from injurious amounts of oils, acids, alkalis, or organic matter, and clean, fresh and potable.

2.2 MORTAR MIXES

A. General:
   1. Anti-Freeze Admixture or Agents: Not permitted.
   2. Calcium Chloride: Not permitted.

B. Mortar for Unit Masonry: Comply with ASTM C 270, Table 2, except limit materials to those specified herein, and limit cement to lime ratio by volume as follows:
   1. Type S: Provide the following upon Shop Drawing material approval. Property specifications apply to both alternatives:
      a. Provide the following proportions by volume for portland cement-lime mortar:
         1) Portland Cement: 1 part.
         2) Hydrated Lime or Lime Putty: Over 1/4 to 1/2 maximum.
         3) Aggregate Ratio (Measured in Damp Loose Condition): Not less than 2-1/4 and not more than 3 times the sum of the volumes of cement and lime.
      b. Provide the following proportions by volume for masonry cement mortar:
         1) Portland Cement: 1/2 part.
         2) Masonry Cement: 1 part.
         3) Aggregate Ratio (Measured in a Damp Loose Condition): Not less than 2-1/4 and not more than 3 times the sum of the volumes of cement and lime.
      c. Property Specification:
         1) Average Compressive Strength, ASTM C 270: 1800 pounds per square inch.
         2) Minimum Water Retention, ASTM C 270: 75 percent.
         3) Maximum Air Content, ASTM C 270: 12 percent for portland cement-lime mortars and 18 percent for masonry cement mortars.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measurement of Materials:
   1. Cement and Hydrated Lime: Batched by the bag.
   2. Sand: Batched by volume in suitably calibrated containers, provided proper allowance is made for bulking and consolidation and for weight per cubic foot, of contained moisture.
   3. Proportion of Volumetric Mixtures: One 94-pound sack of portland cement and one 50-pound sack of hydrated lime constitute nominal one cubic foot.
   4. Shovel measurement: Not permitted.

B. Mortar Mixing:
   1. Type of Mixer: Machine mix in approved mixer in which the quantity of water is accurately and uniformly controlled.
   2. While mixer is in operation add approximately 3/4 the required water, 1/2 the sand, all the cement, then add remainder of sand.
   3. Allow batch to mix briefly then add water in small quantities until satisfactory workability is obtained.
   4. Mix for not less than five minutes after all materials have been added.
   5. Hydrated Lime for Mortar Requiring Lime Content: Use dry-mix method. Turn over together the materials for each batch until the even color of the mixed, dry materials indicates that cementitious material has been thoroughly distributed throughout the mass, then add water to obtain required plasticity.

6. Lime putty if approved for use shall be prepared in accordance with ASTM C 5.
7. The mixer drum shall be completely emptied before recharging the next batch.
8. Limit batch size to avoid retempering. Retempering of mortar shall not be permitted.

3.2 INSTALLATION

A. Refer to the following:
   1. Section 4C1, Unit Masonry Construction.

+ + END OF SECTION + +

SECTION 4B

MASONRY ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish all masonry accessories Work.
   2. The types of masonry accessories required includes, but is not necessarily limited to, the following:
      a. Continuous horizontal wire reinforcing and ties.
      b. Anchoring devices.
   3. This Section specifies the masonry accessories for Work under the following Sections:
      a. Section 4C1, Unit Masonry Construction.
      b. Section 4C3, Concrete Unit Masonry.

B. Related Sections:
   1. Section 4A, Mortar.
   2. Section 4C1, Unit Masonry Construction.
   3. Section 4C3, Concrete Unit Masonry.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Provide accessories complying with the requirements established by governing authorities.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. ASTM A 82, Cold-Drawn Steel Wire for Concrete Reinforcement.
   2. ASTM A 116, Zinc-coated (Galvanized) Iron or Steel Farm-Field and Railroad Right-of-Way Wire Fencing.
   3. ASTM A 153, Zinc-Coating (Hot Dip) on Iron and Steel Hardware.
   4. ASTM A 615, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval to ENGINEER copies of manufacturer's specifications and installation instructions for each masonry accessory required. Include data substantiating that materials comply with specified requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Deliver accessories in original packages, plainly marked with identification of materials and manufacturer.

B. Storage of Materials: Store and cover materials to prevent corrosion and deterioration.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Continuous Wire Reinforcing and Ties for Masonry: Welded wire units prefabricated in straight lengths of not less than 10 feet, with matching corner "L" units. Fabricate from cold-drawn steel wire complying with ASTM A 82, with deformed continuous 9 gage side rods and plain 9 gage cross rods, with unit width of 1-1/2 to 2 inches less than thickness of wall or partition. All reinforcing shall be hot dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A 153, Class B-2 unless otherwise specified.
   1. For all single-wythe masonry walls, use units fabricated as follows:
      a. Truss-type fabricated with two side rods and continuous diagonal cross-rods spaced not more than 16 inches on centers.
      b. Product and Manufacturer: Provide one of the following:
         1) Single-wythe Wall Truss by Dur-O-Wal Incorporated.
         2) Blok-Truss AA600 by AA Wire Products Company.
         3) Or equal.

B. Anchoring Devices for Masonry: Use bolts and rods of the type and size shown. Fabricate from steel with 1.5 ounces per square foot of zinc coating complying with ASTM A 153, Class B-2.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the following:
   1. Section 4C1, Unit Masonry Construction.

+ + END OF SECTION + +

SECTION 4C1

UNIT MASONRY CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to install all unit masonry construction Work. The Work also includes:
      a. Providing openings in masonry to accommodate the Work under this and other Sections and building into the masonry all items such as sleeves, anchor bolts, inserts and all other items to be embedded in masonry for which placement is not specifically provided under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the masonry.
   2. This Section specifies the installation of unit masonry specified in the following:
      a. Section 4C3, Concrete Unit Masonry.

C. Related Sections:
   1. Section 4A, Masonry Mortar.
   2. Section 4B, Masonry Accessories.
   3. Section 4C3, Concrete Unit Masonry.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable requirements for materials and installation established by the Uniform Building Code.

B. Design Criteria:
   1. CONTRACTOR shall conform to all applicable requirements of Section No. 510 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) except as modified, added to or changed herein. Where there is a conflict between MAG Standard Specifications and this Specification, provisions of this Specification shall govern.
   2. Structural unit masonry construction Work shall be subject to the requirements of the Uniform Building Codes criteria for special inspection. Provide all Work complying with the requirements for special inspection as required to produce Work acceptable to the special inspector and the Uniform Building Code.

C. Construction Tolerances:
   1. Variation from Plumb: For lines and surfaces of vertical grooves, walls and arrises, do not exceed 1/4 inch in 10 feet.
   2. Variation from Level: For lines of exposed lintels, sills, horizontal grooves and other conspicuous lines, do not exceed 1/4 inch in 10 feet maximum.

3. Variation of Linear Building Line: For position shown in Drawings and related portion of walls do not exceed 1/4 inch in 10 feet maximum.
4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4 inch nor plus 1/2 inch.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM C 67, Standard Methods of Sampling and Testing Brick.
2. Brick Institute of America, "Technical Notes on Brick and Tile Construction".
3. Brick Institute of America, Technical Bulletin 1A, "Construction and Protection Recommendations for Cold Weather Masonry Construction".
4. Brick Institute of America, Technical Notes on "Cleaning Clay Products, Masonry".
5. National Concrete Masonry Association, "Guide Specifications" and "Technical Bulletins".

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Materials: Protect masonry materials during storage and construction with a properly erected shelter from wetting by rain, snow or ground water and from soilage or intermixture with earth or other materials.

B. Handling Materials: Handle materials in a manner that minimizes chips, cracks, voids, discolorations or other defects which might be visible or cause staining in finished Work.

1.4 JOB CONDITIONS

A. Environmental Requirements: Do not place any masonry when air temperature is 40 F and falling. Masonry may be placed when air temperature is 32 F and rising. In either case, it may not be placed if temperature is expected to drop below 32 F during next 72 hours unless adequate protection is provided as specified in paragraph 1.4.B.4.b. of this Section.

B. Protection:
1. Protect partially completed masonry against weather, when Work is not in progress, by covering top of walls with strong, waterproof, nonstaining membrane. Extend membrane at least 2 feet down both sides of walls and hold securely in place.
2. Cold Weather Protection.
   a. When surrounding air temperature is 48 F to 40 F protect masonry construction from rain or snow for a minimum of 48 hours by covering with nonstaining weathertight membrane.
   b. When surrounding air temperature is 40 F and below maintain masonry construction temperature above 40 F for a minimum of 48 hours by enclosure and supplementary heat, electric heating blankets, infrared lamps, or other methods acceptable to the ENGINEER.
   c. Comply with governing codes and review the "Construction and Protection Recommendations for Cold Weather Masonry Construction" of the Technical Notes on Brick and Tile Construction by

the Brick Institute of America. Comply with recommendations except where superseded by this Section.

d. Frozen Materials: Do not use frozen materials or materials mixed or coated with ice or frost.

e. Frozen Work: Do not build on frozen Work. Remove and replace masonry Work damaged by frost or freezing as directed by ENGINEER.

3. Hot Weather Protection: Protect masonry construction, by methods acceptable to ENGINEER, from direct exposure to wind and sun when the surrounding air temperature is 99 F in the shade with relative humidity less than 50 percent.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to the following Sections for required masonry materials.
   1. Section 4A, Mortar.
   2. Section 4B, Masonry Accessories.
   3. Section 4C3, Concrete Unit Masonry.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine areas and conditions under which the Work is to be performed and advise ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION, GENERAL

A. Thickness: Build single-wythe walls to the full thickness shown.

B. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to starting of masonry Work. After installation of said items, complete masonry Work to match Work immediately adjacent to openings.

C. Cut masonry units using motor driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining Work neatly. Use full size units without cutting wherever possible.

3.3 LAYING MASONRY WALLS

A. General:
   1. Mortar Types: Unless otherwise indicated, use mortar as specified in Section 4A, Mortar, and as follows:
      a. For all Work, use Type S mortar.
      b. Do not use mortar or grout which has begun to set or if more than 1/2 hour has elapsed since initial mixing. Retemper mortar during the 1/2 hour period only as required to restore workability.

2. Layout walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, expansion joints, returns and offsets. Avoid the use of less than half size units at corners, jambs and wherever possible at other locations.
3. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced and coordinated with other work.
4. Pattern Bond: Lay concrete masonry units in a running bond pattern.

B. Mortar Bedding and Jointing:
1. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
   a. Maintain joint widths shown, except for minor variations required to maintain pattern bond alignment and continuity. If not shown, lay walls with 3/8-inch joints.
2. Strike joints flush.
3. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

C. Built-in Work: As the Work progresses, build in items shown, specified or required by others. Refer to Paragraph 1.1.B. of this Section for the requirements of coordination with others. Fill cores in all concrete block solidly with mortar.

D. Horizontal Joint Reinforcing:
1. Provide continuous horizontal joint reinforcing as shown and specified. Refer to Section 4B, Masonry Accessories, for type of reinforcing units required. Fully embed longitudinal side rods in mortar for their entire length with a minimum cover of 1/2 inch. Lap reinforcement a minimum of 6 inches at ends of units.
2. Reinforce all walls with continuous horizontal joint reinforcing unless specifically noted or specified to be omitted.
3. Space continuous horizontal reinforcing as follows:
   a. For single-wythe walls, space reinforcing 8 inches on centers vertically.

3.4 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Protection: Protect the Work from deterioration, discoloration or damage during subsequent construction operations. See Section 6A, Rough Carpentry.

+ + END OF SECTION + +

SECTION 4C3

CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish concrete unit masonry Work.
2. The extent of each type of concrete unit masonry is shown.
3. The types of concrete masonry units required include the following:
   a. Lightweight, hollow load-bearing units.

B. Related Sections:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 4A, Mortar.
3. Section 4B, Masonry Accessories.
4. Section 4C1, Unit Masonry Construction.

1.2 QUALITY ASSURANCE

A. Codes: Comply with applicable requirements of governing authorities and the Uniform Building Code for types of concrete unit masonry shown.

B. Source Quality Control: Obtain units from one manufacturer, cured by one process and of uniform texture and color, for each type required.

C. Design Criteria:
1. The requirements of this Section shall generally conform to MAG Standard Specification Section 775 except as modified, added to, or changed herein. Where there is conflict between MAG Standard Specifications and this Specification, the provisions of this Specification shall govern.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM C 90, Hollow Load Bearing Concrete Masonry Units.
2. ASTM C 331, Standard Specification for Lightweight Aggregates for Concrete Masonry Units.
3. UL Design Numbers U901 through U908.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval copies of manufacturer's specifications and test data for each type of concrete masonry unit required, including notarized certification that each type complies with the specified requirements. Include instructions for handling, storage, installation and protection of each type of concrete masonry unit.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Deliver concrete masonry units in original packages and pallets, plainly marked with identification of materials and manufacturer.

B. Storage of Materials: Store and cover concrete masonry units to prevent damage such as chipping, staining or water absorption.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Size: Manufacturer's standard units with nominal face dimensions of 16-inches long by 8-inches high (15-5/8-inches by 7-5/8-inches actual), unless otherwise specified.

2.2 CONCRETE MASONRY UNITS

A. General: Where concrete masonry units are shown, comply with the following classifications, weights, grades, curing, and other requirements as specified.

B. Hollow Load-Bearing Concrete Masonry Units: ASTM C 90, Grade N-1.

C. Weight: Provide lightweight units using aggregate complying with ASTM C 331 producing dry net weight of not more than 105 pounds per cubic foot, unless otherwise specified.

D. Curing:
   1. Cure units in a moisture controlled atmosphere or in an autoclave at normal pressure and temperature to comply with ASTM C 90, Type I.
   2. Limit moisture absorption during delivery and until time of installation to the maximum percentage specified for Type I units for the average annual relative humidity as reported by the United States Weather Bureau Station nearest the project site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 4C1, Unit Masonry Construction.

+ + END OF SECTION + +

SECTION 5E3

MISCELLANEOUS METAL FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals as shown, specified and required to provide and install miscellaneous metal fabrications, including surface preparation and shop priming.
2. The extent of miscellaneous metal fabrications Work is shown on the Drawings or in schedules and includes items fabricated from iron, steel and aluminum shapes, plates, bars, castings and extrusions, which are not a part of other metal systems covered by other Sections of these Specifications.
3. The types of miscellaneous metal items include, but are not limited to the following:
   a. Ladders.
   b. Extruded aluminum stair nosings.
   c. Cast-in-place shelf angle supports.
   d. Shelf angles.
   e. Miscellaneous framing and supports.
   f. Manhole steps.
   g. Truck bollards.
   h. Adjustable weir in oxidation ditch.
   i. Miscellaneous pipe supports.
   j. Insect screens.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 2H6, Manholes.
3. Section 3D, Cast-In-Place Concrete.
4. Section 4C1, Unit Masonry Construction.
5. Section 5G, Anchor bolts, Expansion Anchors, Fasteners and Concrete Inserts.
6. Section 5E10, Aluminum Handrails and Railings.
7. Section 9L, Painting, (Surface preparation and shop priming are under Section 5E3).

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
1. CONTRACTOR shall conform to all applicable requirements of Part 700 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and this Specifications, provisions of this Specification shall govern.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified:
1. ASTM A 36, Structural Steel.

2. ASTM A 123, Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
3. ASTM A 153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A 240, Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels.
5. ASTM A 320, Alloy Steel Bolting Material for Low Temperature Service.
6. ASTM A 386, Zinc Coating (Hot-Dip) on Assembled Steel Products.
7. ASTM B 209, Aluminum-Alloy Sheet and Plate.
8. ASTM B 211, Aluminum-Alloy Bars, Rods and Wire.
9. ASTM B 221, Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
10. ANSI A14.3, Safety Requirements for Fixed Ladders.
11. AWS D1.1, Structural Welding Code.
12. AISI Standards for Stainless Steel.
13. Maricopa Association of Governments, Uniform Standard Specifications for Public Works Construction.

C. Design Criteria: The size and spacing of expansion bolts, anchor bolts, cast-in-place inserts and similar items shown on the Drawings or specified shall be considered the minimum acceptable size. Final selection of these items shall be based upon the actual design load times a minimum safety factor of four. Where the size and spacing of expansion bolts, anchor bolts, cast-in-place inserts and similar items are not shown on the Drawings or are not specified CONTRACTOR shall provide such items of sufficient size, length, load carrying capacity and spacing required to carry the design load times a minimum safety factor of four.

D. Field Measurements: Take field measurements where required prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

E. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.3 SUBMITTALS

A. Samples: Submit for approval sets of representative samples of materials including nosings, rungs and other finished products as may be requested by ENGINEER. Review will be for color, texture, style, and finish only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
1. Shop Drawings for the fabrication and erection of all assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for location and installation of miscellaneous metal items and anchorage devices.

2. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel Sheet and Plate: ASTM A 240.

B. Steel Plates, Shapes and Bars: ASTM A 36.

C. Aluminum:
1. Alloy and Temper: Provide alloy and temper as shown or specified, or as otherwise recommended by the aluminum producer or finisher.
2. Extruded Shapes and Tubes: ASTM B 221.
3. Plate and Sheet: ASTM B 209.
4. Bars, Rods and Wire: ASTM B 211.
5. Finish: Provide Architectural Class I anodized finish AA-M32C22A41 Clear as specified in the NAAMM Manual.

D. Stainless Steel Fasteners and Fittings: ASTM A 320.

E. Zinc Coated Hardware: ASTM A 153.

2.2 MISCELLANEOUS METAL ITEMS

A. Aluminum Ladders:
1. Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as shown and specified. Comply with the requirements of ANSI A14.3, except as otherwise shown or specified.
   a. Unless otherwise shown, provide aluminum pipe, ASTM B 429, 554, 1.90-inch outside diameter, Schedule 80 side rails spaced 18 inches apart, minimum.
   b. Provide solid aluminum square rungs, spaced 12 inches on centers, maximum, with non-slip surface on the top of each rung.
2. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
3. Support each ladder at top and bottom and at intermediate points spaced not more than 5 feet on centers. Use welded or bolted brackets, designed for adequate support and anchorage, and to hold the ladder clear of the wall surface with a minimum of 7 inches clearance from wall to centerline of rungs. Unless otherwise shown or approved, extend rails 42 inches above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.

B. Extruded Aluminum Stair Nosings for Concrete Stairs:
1. Fabricate of sizes and configurations as shown.
2. Unless otherwise shown, provide ribbed abrasive filled type, using black abrasive filler.
3. Provide anchors for embedding in concrete, either integral or applied to treads, as standard with the manufacturer.

4. Product and Manufacturer: Provide one of the following:
   a. Type 231-A by American Abrasive Metals Company.
   b. Type 231 by Wooster Products Incorporated.

C. Shelf Angles: Provide galvanized steel shelf angles of sizes shown for attachment to concrete and masonry construction. Provide horizontal slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and not more than 2 foot-6 inches on centers. Weld adjoining members together to form a single unit and grind welds smooth where exposed in the finished Work.

D. Cast-In-Place Shelf Angle Supports:
   1. Provide wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.
   2. Provide hot dipped galvanized steel shims, washers and other accessories.
   3. Provide stainless steel askew head bolts.
   4. Product and Manufacturer: Provide one of the following:
      a. 3/4-inch Standard Concrete Wedge Insert by Richmond Screw Anchor Company, Incorporated.
      b. 3/4-inch Standard Concrete Wedge Insert by Hohmann and Barnard, Incorporated.

E. Miscellaneous Framing and Supports:
   1. Provide miscellaneous metal framing, supports and other metal items required to complete the Work.
   2. Fabricate miscellaneous units to the sizes, shapes and profiles shown or, if not shown, of the required dimensions to receive adjacent grating, plates, tanks, doors, or other work to be retained by the framing. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Cut, drill and tap units to receive hardware and similar items to be anchored to the Work.

F. Manhole Steps: Provide steel reinforced plastic manhole steps which will resist pullout force of 1500 pounds and impact of 300 pounds. Step shall be 14-inches minimum wide, 5-inches minimum from concrete face, with anti slip construction and end lugs.

G. Truck Bollards: Provide 8-inch diameter, double extra strong galvanized steel pipe, 3 foot-4 inches above grade, 3 feet below grade. Fill with concrete and mound top.

2.3 SURFACE PREPARATION AND SHOP PAINTING

A. Surface preparation and shop painting is required for all ferrous metals, equipment and accessories. Stainless steel shall not be painted.

B. All ferrous metal surfaces shall be cleaned and provided with two coats of priming paint in accordance with the applicable requirements of Section 9L, Painting. All prime coat materials shall be compatible with the finish coat materials to be furnished under Section 9L.

All ferrous metal surfaces may be given two coats of the manufacturer's standard paint system in lieu of the priming paint, provided that the total mil thickness of paint is equal to that specified for the priming paint. Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6).

C. All galvanizing of fabricated steel items shall comply with the requirements of MAG Standard Specification Section 771.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set miscellaneous metal fabrications accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry or similar construction.

B. Anchor securely as shown or as required for the intended use, using concealed anchors wherever possible.

C. Fit exposed connections accurately together to form tight hairline joints. Weld steel connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind steel joints smooth and touch up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Follow manufacturer's recommendations for installation inserts and cast-in-place shelf angle supports.

E. Install cast-in-place shelf angle supports as specified in Section 3D, Cast-In-Place Concrete and as shown. Space cast-in-place shelf angle supports maximum of 2 foot-6 inches on centers. Develop strength of cast-in-place shelf angle supports by provided extra reinforcing bars as recommended by the manufacturer.

F. Protection of Aluminum from Dissimilar Materials: Using approved washers, strips or sheets of felt, and asphaltic or zinc chromate paint, protect all surfaces of aluminum from contact with dissimilar materials such as concrete, masonry, steel, nonferrous metals, etc.

+ + END OF SECTION + +

SECTION 5E5

ALUMINUM GRATING AND CHECKERED PLATE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide aluminum grating, checkered plate, and frames as shown and specified.
2. The Work also includes:
   a. Providing openings in grating to accommodate the Work under this and other Sections and attaching to the grating all items such as sleeves, bands, studs, fasteners and all items required for which provision is not specifically included under other Sections.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to the grating.

C. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.
1. ASTM B 210, Aluminum-Alloy Drawn Seamless Tubes.
2. ASTM B 221, Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
3. NAAMM, Metal Finishes Manual, and Metal Bar Grating Manual.
4. Aluminum Association Standards.

B. Field Measurements:
1. Take field measurements prior to preparation of Shop Drawings and fabrication where required, to ensure proper fitting of the Work.

1.3 SUBMITTALS

A. Samples: Submit representative samples of grating, checkered plate, appurtenances and other finished products requested by the ENGINEER. His review will be for type and finish only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
1. Shop Drawings for the fabrication and erection of all Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.
2. Setting drawings and templates for location and installation of anchorage devices.
3. Manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

A. The manufacturer shall furnish grating to conform the following criteria:
   1. Design Loads: Uniform live load or a concentrated load on any area 24 inches square, whichever gives the greatest stresses.

	Live Load	Concentrated Load
a.	200 psf	2000 lbs

   2. Maximum Clear Span Deflection: 1/120 of span or 1/4 inch, whichever is smallest.
   3. Maximum Fiber Stress: 12,000 psi.
   4. Bearing bars shall be a maximum of 1-3/16 inches on center and 3/16 inches minimum thickness.
   5. Cross bars or bent connecting bars shall not exceed 7 inches on center.

2.2 GRATING MATERIALS

A. Bearing Bars: Alloy 6061-T6 or Alloy 6063-T6, conforming to ASTM B 221.

B. Cross Bars or Bent Connecting Bars: Alloy conforming to either ASTM B 221 or ASTM B 210.

2.3 GRATING FABRICATION

A. Use materials of the minimum size and thickness as specified above unless shown otherwise. Work to the dimensions shown on approved Shop Drawings.

B. Grating shall be as shown and shall comply with the NAAMM "Metal Bar Grating Manual", except as specified herein.

C. Grating may be I-bar type, welded or pressure locked.

D. Provide non-slip exposed surface.

E. Type of Finish: Clear anodized with a minimum coating of 0.0008 inch in accordance with Aluminum Association Standard A41.

F. Provide grating sections with end-banding bars welded about 4 inches on centers for each panel, 4 saddle clip or flange block anchors designed to fit 2 bearing bars, and 4 stud or machine bolts with washers and nuts, unless otherwise indicated.

G. Cut gratings for penetrations as indicated. Layout units to allow grating removal without disturbing items penetrating grating.
   1. For openings in grating separated by more than 4 bearing bars, provide banding of same material and size as bearing bars, unless otherwise indicated. Weld band to each bearing bar.
   2. Notching of bearing bars at supports to maintain elevations will not be permitted.

H. Weld stainless steel stud bolts to receive saddle clip or flange block anchors to supporting steel members. Drill for machine bolts when supports are aluminum.

I. Gratings in concrete floors shall be removable or hinged and shall be arranged in sizes to be readily lifted. Provide gratings in concrete with aluminum angle frames having metered corners and welded joints. Grind exposed joints smooth. Frames shall have welded anchors set into concrete. Angle size shall match grating depth selected to assure flush fit.

2.4 CHECKERED PLATES

A. Provide removable checkered plates in the locations and sizes indicated on the Drawings. Also provide perforated plates where shown.

B. Plates shall be made of aluminum, at least 1/4 inch thick, and designed to withstand loadings of 300 pounds per square foot.

C. Each plate shall be provided with two lifting handles as recommended by the manufacturer. The lifting handles shall be of the recessed, drop handle type.

D. Plates shall have a checkered, nonslip surface.

E. The aluminum plates shall be mill finished. Protect finish with a factory-applied coating of lacquer standard with the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fastening to In-Place Construction:
   1. Use anchorage devices and fasteners to secure grating to supporting members or prepared openings, as recommended by the manufacturer.

B. Cutting, Fitting and Placement:
   1. Perform all cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true and free of rack. Do not use wedges or shimming devices.
   2. Wherever gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and attach a strap collar not less than 1/8-inch thick to the cut ends of the bars.
   3. Divide the panels into sections only to the extent required for installation wherever grating is to be placed around previously installed pipe, ducts, and structural members.

C. Protection of Aluminum from Dissimilar Materials: Using approved asphaltic or zinc chromate paint, provide two heavy coats on aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals.

+ + END OF SECTION + +

SECTION 5E7

FLOOR ACCESS HATCH COVERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, tools, equipment and incidentals required to provide hinged floor access hatch covers as shown and specified.
2. The types of floor access hatch covers include the following:
   a. Aluminum covers with frames.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 3D, Cast-in-Place Concrete.
3. Section 5E3, Miscellaneous Metal Fabrication.

1.2 QUALITY ASSURANCE

A. Manufacturer: All floor covers for the project shall be the product of a single manufacturer. Covers from more than one manufacturer will not be permitted.

B. Reference Standards: Comply with applicable provisions of Section 5E3, Miscellaneous Metal Fabrication, except as otherwise shown or specified.

C. Shop Assembly:
1. Preassemble items in the shop to greatest extent possible. Disassemble units only to the extent necessary for shipment and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Shop Drawings showing dimensional plans of all floor covers, quantity schedule, materials of construction, details of fabrication and erection, and anchorage and required interfacing with related equipment.

1.4 GUARANTEE

A. CONTRACTOR shall furnish a written guarantee obtained from the manufacturer. Guarantee shall state the following:
1. Floor covers are to operate properly and be free of defects in material and workmanship for a period of five years from date of purchase.
2. Should any part fail to function, or break in normal use during this period, manufacturer shall furnish a new part at no charge to OWNER.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION

A. General:
   1. Provide manufacturer's standard fabricated units, modified, if necessary, to comply with the requirements. Where standard units are not available for the sizes and types required, custom fabricate units to match manufacturer's similar units.
   2. Fabricate each unit in the shop, complete with anchors, gaskets, hardware and accessory items as required.

B. Covers with Frames for Drainage:
   1. Provide covers, with frames for drainage, designed to withstand loadings of 300 pounds per square foot unless otherwise shown or specified.
   2. Both frames and door leaves shall be 1/4 inch thick, minimum.
   3. Furnish stainless steel hardware for aluminum doors.
   4. Product and Manufacturer: Provide one of the following:
      a. Double leaf door covers fabricated of aluminum. Sizes as shown on the Drawings.
         1) Type JD by the Bilco Company.
         2) Or equal.
      b. Single leaf door covers fabricated of aluminum. Sizes as shown on the Drawings.
         1) Type J by The Bilco Company.
         2) Or equal.

C. Door leaves shall be 1/4-inch checkered or diamond plate, or other approved non-slip surface.

D. Frames shall have anchor flanges or strap anchors.

E. Door shall have hold-open devices.

F. Door leaves 10 square feet and larger shall have torsion bars, springs or other approved means for counterbalanced operation.

G. Covers shall have flush exterior locking device with removable handle and interior turn handle.

H. All aluminum covers shall be mill finished. Protect finish with a factory applied coating of lacquer standard with the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install doors in accordance with approved Shop Drawings on concrete curbs, where shown or required.

B. Set doors plumb, level and true to line or grade, without warp or rack, for anchoring under other Sections of these Specifications.

C. Protection of Aluminum from Dissimilar Materials: Using approved asphaltic or zinc chromate paint, provide two heavy coats on aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals.

3.2 TOUCH-UP

A. Galvanized Covers: Touch-up abraded areas, where zinc coating has been damaged, with a 2-mil coating of an approved high-zinc-dust- content paint.

+ + END OF SECTION + +

SECTION 5E10

ALUMINUM HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install aluminum handrail and railing Work. The Work also includes:
   a. Providing openings in and attachments to railing to accommodate the Work under this and other Sections and providing for the handrail and railing all items such as anchor bolts, fasteners, studs and all items required for which provision is not specifically included under other Sections.
2. The extent of each type of aluminum handrail and railing is shown and specified.
3. The types of aluminum handrail and railing Work required includes, but is not necessarily limited to, the following:
   a. Top and two intermediate horizontal railings.
   c. Handrails.
   d. Toeboards.
   e. Anchors and fasteners.
   f. Sleeves, castings, reinforcing inserts, wall brackets, and other miscellaneous accessories.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to the aluminum handrail and railing Work.

C. Related Sections:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 3I, Grout.
3. Section 5E3, Miscellaneous Metal Fabrications.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Engage a single firm, with undivided responsibility for performance of the aluminum handrail and railing Work.
2. Engage a firm which can show five years previous successful experience in the fabrication and erection of aluminum handrail and railing systems of scope and type similar to the required Work.
3. Provide manufacturer capable of fabricating custom details shown.

B. Design Criteria:
1. The requirements of this Section shall generally conform to MAG Standard Specification Section 520, except as modified, added to, or changed herein. When there is conflict between MAG Standard Specifications and this Specification, the provisions of this Specification shall govern.

2. Provide adequate expansion within the fabricated system which allows a thermal change of 100 F above installation temperature without warp or bow. Provide 0.1 inch space for each 20 feet of length of rail for each 25 F difference of thermal change specified or use manufacturer's published formulas for determining expansion joint movement and spacing. Limit the exposed width of each expansion joint to 1/4 inch.
3. Provide expansion joint in aluminum handrail and railing system Work where systems cross expansion joints in structure.
4. Aluminum handrail and railing is shown to indicate general locations where handrail and railing is required by ENGINEER. Where handrail or railing is required by either the Uniform Building Code or the Occupational Safety and Health Act of 1970, aluminum handrail and railing of the type specified herein shall be provided at no additional cost to OWNER, whether or not shown.
5. Provide aluminum handrail and railing system Work that conforms to OSHA, Part 1910.23, including the 200 pound loading requirement. In addition, the system shall conform to the following requirements of ANSI A12.1:
   a. Completed aluminum handrail and railing system Work to withstand a load of 25 pounds per linear foot applied in any direction at the top of the handrail and railing.
   b. Intermediate rails to withstand a horizontal load of 20 pounds per linear foot.
   c. All above loads are not additive.
6. Select systems components and post spacing so that specified applied loads produce no permanent set in the completed aluminum handrail and railing system Work.
7. All railing system posts shall be provided with a reinforcing bar or tube at each post. Select schedule of pipe using alloys, minimum diameter, loadings and maximum post spacing specified in order to limit deflection in each single-span of handrail and railing to 1.5-inches maximum and on railing posts to 1.4-inches maximum and with a safety factor of 1.65:1 for all Work.

C. Codes: Comply with the applicable requirements of the Uniform Building Code and the Occupational Safety and Health Act of 1970 for types of aluminum handrail and railing system Work shown and specified.

D. Allowable Tolerances:
1. Limit variation of cast-in-place inserts, sleeves and field- drilled holes to the following:
   a. Spacing: ±3/8 inch.
   b. Alignment: ±1/4 inch.
   c. Plumbness: ±1/8 inch.
2. Limit variation of completed railing system alignment to 1/4 inch in 12 feet.
3. Set rails horizontal or parallel to rake of steps or ramp to within 1/4 inch in 12 feet.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM B 26, Aluminum-Alloy Sand Castings.
2. ASTM B 210, Aluminum-Alloy Drawn Seamless Tubes.
3. ASTM B 221, Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

4. ASTM B 241, Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
5. ASTM B 247, Aluminum-Alloy Die and Hand Forgings.
6. ASTM B 429, Aluminum-Alloy Extruded Structural Pipe and Tube.
7. AWS D10.7, Gas Shielded-Arc Welding of Aluminum and Aluminum- Alloy Pipe.
8. The Aluminum Association, Aluminum Standards and Data; and Standards for Anodized Architectural Aluminum.
9. NAAMM, Metal Finishes Manual".
10. NAAMM, Pipe Railing Manual.
11. ANSI A12.1, Safety Requirements for Floor and Wall Openings, Railings, and Toeboards.
12. OSHA Part 1910.23 - Guarding Floor and Wall Openings and Holes.

F. Field Measurements: Take field measurements, where required, prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

G. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinate installation.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. Full size sample of assembled post and rails intersections with all associated components including mounted toeboard and socket, all with specified metal finish, including typical welded or bolted connections, with rails not less than 6-inches long. Samples will be reviewed for finish, color, joinery tolerances, workmanship and general component assembly only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.
2. Color Samples: Maximum range of clear anodized aluminum that shall appear in finished Work. Prepare range samples, to show the highest level of color control feasible for actual aluminum handrail and railing system Work, as determined by the licensor of the finishing process selected, on actual extrusions and castings of the Work.

B. Shop Drawings: Submit for approval the following:
1. Shop Drawings for the fabrication and erection of aluminum handrail and railing system Work. Include all plans and elevations identifying the location of all handrail and railing, and details of sections and connections. Show all anchorage items.
2. Calculations for the complete structural design of the aluminum handrail and railing system Work including calculations showing compliance with design criteria specified.
3. Manufacturer's complete catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by ENGINEER.
4. Maintenance Manuals: Upon completion of the Work, furnish 6 copies of detailed maintenance manual including the following information:
   a. Product name and number.
   b. Name, address and telephone number of manufacturer and local distributor.

c. Detailed procedures for routine maintenance and cleaning, including cleaning materials, application methods and precautions as to use of materials that may be detrimental to finish when improperly applied.

C. Certification: Furnish certification by manufacturer that load tests have been performed on the aluminum handrail and railing systems Work and that they conform to all applicable OSHA, ANSI and building code requirements for loading and deflections and meet minimum criteria specified herein.

D. Finish: Furnish a written certificate confirming specified coating film thickness, coating weight, sealing treatment and stain test.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver materials to the site in good condition and properly protected against damage to finished surfaces.

B. Storage of Materials:
1. Store all materials in clean, dry location, away from uncured concrete and masonry.
2. Cover all materials with waterproof paper, tarpulin or polyethylene sheeting.

C. Handling of Materials:
1. Keep on-site handling to a minimum.
2. Maintain protective covering on handrails and railings until installation is complete.

1.5 JOB CONDITIONS

A. Protection: Protect cast-in-place sleeves and field-drilled holes from debris and water intrusion by use of temporary covers or removable foam inserts.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Extruded Aluminum Architectural and Ornamental Shapes: ASTM B 221, Alloy 6063-T52.

B. Aluminum Forgings: ASTM B 247.

C. Extruded or Drawn Aluminum Pipe and Tube:
1. ASTM B 429 or ASTM B 241, Alloy 6063-T5, 6063-T52 or 6063-T832 as required by loadings, deflections and post spacings specified.
2. Provide all rails and posts with minimum outside diameter of 1.900-inches.

D. Reinforcing Bars: Solid 24-inch long 6061-T6 aluminum reinforcing bars with same outside diameter as inside diameter of post.

F. Anchors and Fastenings: Aluminum and stainless steel of the type recommended by the manufacturer of the aluminum handrail and railing system.

G. Castings:
   1. Provide high strength aluminum alloy brackets, flanges and fittings suitable for anodizing as specified.
   2. Aluminum-Alloy Sand Castings: ASTM B 26.

H. Connector Sleeves: Schedule 40, 5-inches long by 1.610-inches diameter.

I. Brackets and Flanges: Provide manufacturer's complete selection of standard and custom brackets and flanges for railing posts and for handrail supports.

J. Sockets: Provide 6-inch deep by 2-1/2-inch outside diameter aluminum sockets with 3-1/2-inch wide socket cover on bottom of all sockets and on top and bottom of removable post sockets.

K. Hinges: Provide two self-closing aluminum hinges for each railing system gate shown.

L. Latches and Stops: Provide one latch and stop with rubber bumper and 1-inch diameter plastic knob for each railing system gate shown.

M. Chain, Snaps and Eye Bolts: Provide oblong 0.250-inch welded link, Type 316 stainless steel chain weighing 57 pounds per cubic foot, each link 1-1/8-inch by 7/16-inch. Provide stainless steel eyebolts, 1/4-inch stainless steel threaded quick links and heavy duty swivel snaps with spring loaded latch.

N. Cover Flanges: Provide 1-inch high by 4-inch diameter aluminum cover flanges for all non-removal posts and 3-1/2-inch wide by 1-1/8-inch high aluminum pipe collars with 1/4-inch set screws for all removeable posts.

O. Components and Miscellaneous Accessories: Provide a complete selection of manufacturer's standard and custom aluminum handrail and railing components and miscellaneous accessories.

P. Adhesive: Epoxy type as recommended by handrail and railing manufacturer.

2.2 FABRICATION

A. Form exposed Work true to line and level with accurate angles, surfaces and straight edges.

B. Form bent-metal corners to the radius shown without causing grain separation or otherwise impairing the Work. Form all change in handrail and railing direction with radius bends.

C. Remove burrs from all exposed edges.

D. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces, or use prefabricated bends.

E. Locate intermediate rails equally spaced between top rail and finished floor.

F. Close aluminum pipe ends by using prefabricated fittings.

G. Weep Holes:
   1. Fabricate joints which will be exposed to the weather so as to exclude water.
   2. Provide 15/64 inch diameter weep holes at the lowest possible point on all railing system posts.
   3. Provide pressure relief holes at closed ends of handrails and railings.

H. Toeboards:
   1. Provide extruded 6063 alloy aluminum toeboards for railings, unless railing is mounted on curbs or other construction of sufficient height and type to meet the requirements of OSHA 1910.23. Bars or plates are not acceptable and shall not be approved by ENGINEER.
   2. Unless otherwise specified, toeboards shall meet requirements of OSHA Part 1910.23, Section (e).
   3. Provide manufacturer's toeboard detail which accommodates movement caused by thermal change specified without warping or bowing toeboards.

I. Reinforcing Bars: Provide reinforcing bar friction-fitted at all railing system posts. Extend reinforcing bars 6-inches into cast-in-place sleeves or other types of supporting brackets.

J. Mechanically Fitted Component Pipe Handrail and Railing:
   1. Use a nonwelded pipe handrail and railing system with posts, top and intermediate rail(s) and flush joints.
   2. Provide a top and two intermediate horizontal rails, equally spaced.
   3. Blind rivets, pop rivets or other exposed fastening devices shall not be used in the Work. Fasteners used for side mounting fascia flanges where shown or specified may be exposed in the Work. Provide internal threaded tubular aluminum rivets, stainless steel through bolts with lock nuts, stainless steel sheet metal screws with lockwashers and epoxy adhesive for fastening all components of the Work.
   4. Product and Manufacturer: Provide one of the following:
      a. Custom Fabricated Connectorail System by Julius Blum & Company, Incorporated.
      b. Custom Fabricated Series 500 Non-Welded Aluminum Pipe Railing by Superior Aluminum Products, Incorporated.
      c. Or equal.

2.3 ALUMINUM COATINGS

A. General:
   1. Prepare surfaces for finishing in accordance with recommendations of the aluminum producer and the finisher or processor.
   2. Adjust and control the direction of mechanical finishes specified to achieve the best overall visual effect in the Work.
   3. Color and Texture Tolerance: ENGINEER reserves the right to reject aluminum materials because of color or texture variations, which are visually objectionable, but only where the variation exceeds the

range of variations extablished by the manufacturer prior to the Work, by means of range samples which have been accepted by ENGINEER.

4. Anodize all aluminum components of the Work.

B. Exposed Aluminum Anodic Coating: Provide anodic coatings as specified which do not depend on dyes or impregnation processes to obtain color. Apply architectural Class 1 coatings using only the alloy and electrolyte to obtain specified colors. Comply with the following:
   1. Chemically finish aluminum by etching to a medium matte finish, Aluminum Association Designation - C22.
   2. Desmut by bathing the aluminum in either nitric acid solution or as recommended by the coating applicator.
   3. Clean and rinse between steps as recommended by the aluminum manufacturer.
   4. Provide architectural Class I high density anodic coating, Aluminum Association Designation A41, for clear coatings.
   5. Coating Thickness, ASTM B 244: Minimum of 0.7 mils thick.
   6. Coating Weight, ASTM B 137: Minimum of 32 mg/sq. in.
   7. Resistance to Staining, ASTM B 136: No stain after 5 minutes dye solution exposure.
   8. Salt Spray, ASTM B 117: 30,000 hours exposure with no corrosion or shade change.

PART 3 - EXECUTION

3.1 . INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and conditions under which the aluminum handrail and railing system Work is to be performed and notify ENGINEER in writing of unsatisfactory tolerances which exceed specified limits and other conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Fastening to In-Place Construction:
   1. Adjust aluminum handrail and railing system Work prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
      a. Anchor posts in concrete by means of sockets and side mounted fascia flange brackets, set and anchored into the concrete floor slabs and sides of concrete slabs, masonry parapets and raised walkways. Provide closure secured to the bottom of sleeve. Before installing posts remove all debris and water from sleeves. Verify that reinforcing bars or tubes have been inserted into posts before installation. Do not install posts without reinforcing bar. For all nonremovable railing sections, after the posts have been inserted into the sockets, fill the annular space between posts and sockets solid with grout as specified in Section 3I, Grout.

b. Anchor posts to stair stringers with stringer or support flanges, angle type or floor type as required by conditions, shop connected to posts and bolted to the supporting members. Flanges shall be as recommended by manufacturer. Verify that reinforcing bars have been inserted into posts before installation. Do not install posts without reinforcing bar.
c. Provide removable railing sections where shown. Removable railing posts shall be provided with friction fitted reinforcing bar in each post. Provide sockets with socket covers stored in extruded toeboard. Provide aluminum pipe collars for all removeable posts. Accurately locate sleeves to match post spacings.
d. All posts set in concrete shall be provided with an aluminum floor cover flange.

2. Use devices and fasteners recommended by the aluminum handrail and railing manufacturer.

B. Cutting, Fitting and Placement:
1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels.
2. Fit exposed connections accurately together to form tight hairline joints. Do not cut or abrade the surfaces of units which have been finished after fabrication, and are intended for field connections.
3. Permanent field splice connections shall be made using manufacturer's recommended epoxy adhesive and 5-inch minimum length connector sleeves. Tight press-fit all field splice connectors and install in accordance with manufacturer's written instructions. Follow epoxy manufacturer's recommendations for requirements of installation and conditions of use.
4. Make all splices as near as possible to posts but not exceeding 12 inches from nearest post.
5. Space posts 6 foot-0 inch minimum on centers and 8 foot-0 inch maximum on centers, based on loading and deflection criteria specified and manufacturer's suggested maximum spacing except where details shown dimension required locations for posts. Where details show post location requirements at or near end of runs, uniformly space intermediate posts as required to meet loading and deflection criteria specified but not greater than maximum spacing specified.
6. Provide hinged railing sections as shown. Provide hinges and latch for connection to adjacent railing.
7. Provide chain sections as shown. Provide one chain length with fastening accessories for top and each intermediate railing.
8. Secure handrails to walls with wall brackets and end fittings as shown. Locate brackets as shown or, if not shown, at not more than 5 feet on centers.
9. Secure wall brackets to building construction as follows:
   a. For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.
   b. For hollow masonry anchorage, use toggle bolts having square heads.
10. Securely fasten toeboards in place with not more than 1/4 inch clearance above floor level.
11. Drill one 15/64 inch diameter weep hole not more than 1/4 inch above the top of location of solid reinforcing bar or tube in each post.

C. Expansion Joints:
   1. Provide slip joint with internal sleeve extending 2 inches minimum beyond joint on each side.
   2. Construct expansion joints as for field splices except fasten internal sleeve securely to one side of rail only.
   3. Locate joints within 6 inches of posts.
   4. Submit locations and details of all expansion joints to ENGINEER.

D. Protection from Dissimilar Materials:
   1. Coat all surfaces of aluminum in contact with dissimilar materials such as concrete, masonry and steel as specified in Section 9L, Painting.
   2. Remove coating where exposed in the finished Work.

3.3 CLEANING AND REPAIRING

A. Remove protective plastic as recommended by manufacturer immediately after installation.

B. Remove all stains, dirt, grease or other substances by washing railings thoroughly using clean water and soap; rinse with clean water.

C. Do not use acid solution, steel wool or other harsh abrasives. If stain remains after washing remove defective sections and replace with new material meeting the requirements of the Specification.

D. Remove all damaged or otherwise defective Work and replace with material that meets specification requirements.

+ + END OF SECTION + +

SECTION 5E11

CASTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all castings.
   2. Castings include metal items which are not a part of the miscellaneous metal fabrications or metal systems in other Sections of these Specifications.

B. Castings shall be for the following types of construction:
   1. Manholes.

C. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. Section 2H6, Manholes.
   3. Section 5E3, Miscellaneous Metal Fabrications.
   4. Section 5G, Anchor Bolts, Expansion Anchors, Fasteners and Concrete Inserts.

1.2 QUALITY ASSURANCE

A. Standard Sepcifications and Details:
   1. CONTRACTOR shall conform to all applicable reqruiements of Section Nos. 600 and 700 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and this Specifications, provisions of this Specification shall govern.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 48, Gray Iron Castings.

B. Shop Assembly:
   1. Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Plans, elevations, and details of sections and connections. Show anchorage and accessory items.
   2. Setting drawings for location and installation of castings and anchorage devices.

B. Specifications: Submit copies of manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast Iron: ASTM A 48, Class 30A.

B. Manhole Frames With Covers:
   1. Roadway standard with 24-inch opening and cast covers conforming to the MAG Uniform Standard Details for Public Works Construction, Detail No. 424, except where otherwise shown.
   2. Provide lettering as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's printed instructions and approved Shop Drawings.

B. Set castings accurately to required location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork.

+ + END OF SECTION + +

SECTION 5G

ANCHOR BOLTS, EXPANSION ANCHORS, FASTENERS AND CONCRETE INSERTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals required to provide anchor bolts, expansion anchors, concrete inserts, connection bolts and fasteners as shown, specified and required.

B. This Section includes all bolts, anchors and inserts required for the Work but not specified under other Sections.

C. The types of work using the bolts, anchors and inserts include, but are not limited to the following:
   1. Baffles, Weirs and Troughs.
   2. Rails.
   3. Sluice and Slide Gates.
   4. Hangers and Brackets.
   5. Equipment.
   6. Piping.
   7. Screen.
   8. Grating and Floor Plate.
   9. Electrical, Plumbing and HVAC Work.
   10. Wood and Plastic Fabrications.
   11. Partitions and Ceilings.
   12. Structural Steel.

D. General:
   1. In general, connections to new concrete structures shall be made using hooked embedded anchor bolts installed during the placement of concrete. Expansion anchors and/or concrete inserts may be used in special circumstances, but only with the approval of the ENGINEER.

E. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. Section 5E3, Miscellaneous Metal Fabrications.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. CONTRACTOR shall conform to all applicable reqruiements of Part 770 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG). Where there is a conflict between MAG Standard Specifications and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 320, Alloy-Steel Bolting Materials for Low-Temperature Service.

C. Expansion anchors and inserts shall be UL or FM approved conforming to Federal Specification FF-S-325, Group I, II or III.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Representative samples of bolts, anchors and inserts as may be requested by the ENGINEER. His review will be for type and finish only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Setting drawings and templates for location and installation of anchorage devices.
   2. Copies of manufacturer's specifications, load tables, dimension diagrams and installation instructions for the devices.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. When the size, length or load carrying capacity of an anchor bolt, expansion anchor, or concrete insert is not shown on the Drawings, provide the size, length and capacity required to carry the design load times a minimum safety factor of four.

B. Determine design loads as follows:
   1. For equipment anchors, use the design load recommended by the manufacturer and approved by the ENGINEER.
   2. For pipe hangers and supports, use one half the total weight of pipe, fittings, valves, accessories and water contained in pipe, between the hanger or support in question and adjacent hangers and supports on both sides.
   3. Allowances for vibration are included in the safety factor specified above.
   4. Anchors shall develop ultimate shear and pull-out loads of not less than the following values in concrete:

Bolt Diameter (Inches)	Min. Shear (Pounds)	Min. Pull-Out Load (Pounds)
1/2	4,500	6,300
5/8	6,900	7,700
3/4	10,500	9,900

2.2 MATERIALS

A. Anchor Bolts:
   1. Provide stainless steel bolts complying with ASTM A 320, AISI Type 304. Other AISI types may be used subject to ENGINEER'S approval.

B. Expansion Anchors:
   1. Provide stainless steel anchors complying with ASTM A 320, AISI Type 303. Other AISI types may be used, subject to ENGINEER'S approval.

2. Anchors shall be of the size required for the concrete strength specified. Provide stud type (male thread) or flush type (female thread), as required.
3. Product and Manufacturer: Provide anchors by one of the following:
   a. Molly Division of USM Corporation.
   b. Hilti, Incorporated.
   c. Or equal.

C. Concrete Inserts:
1. For piping, grating and floor plate, provide malleable iron inserts. Providing those recommended by the manufacturer for the required loading.
2. Finish shall be black.
3. Product and Manufacturer: Provide one of the following inserts:
   a. Figure 282 by ITT Grinnell.
   b. No. 380 by Hohmann and Barnard, Inc.
   c. Or equal.

D. Connection Bolts:
1. Materials shall be as specified in other Sections of the Specifications, or as shown on the Drawings. Where materials are not specified or shown on the Drawings, they shall be of Type 304 stainless steel, with Type 304 stainless steel or Monel nuts.

E. Power actuated fasteners and other types of bolts and fasteners not specified herein shall not be used unless approved by ENGINEER.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Drilling equipment used and installation of expansion anchors shall be in accordance with manufacturer's instructions.

B. Assure that embedded items are protected from damage and are not filled in with concrete.

C. Expansion anchors may be used for hanging or supporting pipe 2 inches diameter and smaller. Expansion anchors shall not be used for larger pipe unless otherwise shown or approved by the ENGINEER.

D. Use concrete inserts for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

E. Unless otherwise shown or approved by ENGINEER conform to following for expansion anchors:
1. Minimum embedment depth in concrete: 5 diameters.
2. Minimum anchor spacing on centers: 10 diameters.
3. Minimum distance to to edge of concrete: 5 diameters.
4. Increase dimensions above if required to develop the required anchor load capacity.

3.2 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

+ + END OF SECTION + +

SECTION 6A

ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, material, equipment and incidentals as shown, specified and required to furnish and install all rough carpentry Work. The Work also includes:
   a. Providing openings in rough carpentry to accommodate the Work under this and other Sections and building into the rough carpentry all items such as sleeves, anchor bolts, inserts and all other items to be embedded in rough carpentry for which placement is not specifically provided under other Sections.
2. The extent of the rough carpentry Work is shown.
3. The types of rough carpentry Work required includes, but is not necessarily limited to, the following:
   a. Wood framing, blocking, furring strips and other miscellaneous wood framing.
   b. Plywood sheathing and mansard decking.
   c. Building paper.
   d. Pressure treatment.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the rough carpentry Work.

C. Related Sections:
1. Section 6B, Heavy Timber Construction.

1.2 QUALITY ASSURANCE

A. Design Criteria:
1. Lumber Standard: Comply with PS-20, except as otherwise specified.
2. Provide plywood roof decking, graded by a recognized agency, complying with requirements of the American Lumber Standards Committee and PS-20.
3. The requirements of this Section shall generally conform to MAG Standard Specification Sections 770, 778 and 779, except as modified, added to, or changed herein. Where there is a conflict between MAG Standard Specification and this Specification the provisions of this Specification shall apply.

B. Codes: Comply with the applicable requirements of governing authorities and the Uniform Building Code for size, spacing and attachment of wood members.

C. Source Quality Control:
1. Factory-mark each piece of lumber and type, grade, mill and grading agency, except omit marking from surfaces to be exposed with transparent finish or without finish.

2. Shop-fabricate rough carpentry Work to the extent feasible and where shop fabrication will result in better workmanship than feasible for on-site fabrication.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. American Lumber Standard Committee, National Grading Rule for Dimension Lumber, PS-20.
2. American Wood Preservers Bureau Standard, LP-2.
3. Occupational Safety and Health Act of 1970.
4. West Coast Lumber Inspection Bureau, Grading Rules.
5. American Lumber Standard Committee, Plywood Standard, PS-1.
6. American Wood Preservers's Association, M4.
7. Federal Specification, TT-W-550, Wood Preservative: Chromated Copper Arsenate Mixture.
8. Maricopa Association of Governments, Uniform Standard Specifications for Public Works Construction.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Copies of chemical treatment manufacturer's instructions for proper use of each type of treated material.
2. For water-borne preservatives, include statement that moisture content of treated materials was reduced to maximum of 19 percent prior to shipment to project site.

B. Certificates: Pressure Treatment: For each type specified, include certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.

1.4 PRODUCT DELIVERY STORAGE AND HANDLING

A. Storage of Materials:
1. Keep materials dry during delivery and storage.
2. Protect against exposure to weather and contact with damp or wet surfaces.
3. Stack lumber, and provide air circulation within stacks.

B. Handling Materials: Handle all treated products as specified in American Wood Preservers's Association, M4.

1.5 JOB CONDITIONS

A. Coordination: Fit rough carpentry Work to other work: scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber, General:
1. Nominal sizes are shown, except as shown by detail dimensions. Provide actual sizes as required by American Lumber Standard Commit-

tee, National Grading Rule for Dimension Lumber PS-20, for the moisture content specified for each use.

a. Provide dressed lumber, S4S, unless otherwise shown or specified.

b. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing.

2. Provide lumber of Douglas Fir complying with the grading, dressing and use types listed in MAG Standard Specification Section 778.1.

B. Plywood Sheathing and Mansard Decking: Provide the following:

1. Exterior Type Sheathing: CC/EXT-APA, 5/8-inch thick, AC/EXT-APA where visible in the finished Work.

2. Mansard Decking; CC/EXT-APA, 3/4-inches thick, torque and groove, Structural Grade I.

3. American Lumber Standard Committee, Plywood Standard, PS-1.

C. Building Paper: Asphalt saturated felt, non-perforated, 30 pounds, ASTM D 226, Type II.

D. Miscellaneous Materials:

1. Fasteners and Anchorages: Provide size and type as recommended by the Uniform Building Code standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices.

2. Provide stainless steel nails for tongue and groove plywood mansard decking.

E. Lumber for Protection and Temporary Support:

1. Size and grades to meet applicable requirements of the Occupational Safety and Health Act of 1970 and structural requirements.

2.2 WOOD TREATMENT

A. Preservative Treatment: Where lumber is specified herein to be treated, comply with the appicable requirements of the American Wood Preservers Bureau (AWPB). Mark each treated item to comply with the AWPB Quality Mark requirements for the specified requirements.

1. Pressure-treat above ground items with water-borne preservatives complying with AWPB LP-2. After treatment, kiln-dry to a maximum moisture content of 19 percent. Treat indicated items and the following:

a. Wood cants, nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers and waterproofing.

b. Wood sills, sleepers, blocking, furring, stripping and similar concealed members and all wood in contact with masonry, plaster, or concrete.

c. Plates, sills, bridging, outriggers, soffit framing, roof decking and all heavy timber construction specified in Section 6B, Heavy Timber Construction.

2. Comply with MAG Standard Specification Section 779.1 and 779.3.

B. Provide chromated copper arsenate Type II or B wood preservative complying with FS TT-W-550.

C. Complete fabrication of treated items prior to treatment, wherever possible. If cut after treatment, coat cut surfaces with heavy brush

coat of same chemical used for treatment. Comply with MAG Standard Specification Section 779.4. Inspect each piece of lumber after drying and discard damaged or defective pieces.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates and supporting structure and the conditions under which the rough carpentry Work is to be installed, and notify the ENGINEER in writing of the conditions detrimental to the Work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

3.2 INSTALLATION

A. General:
   1. Discard units of material with defects which might impair the quality of the Work, and units which are too small to fabricate the Work with minimum joints or the optimum joint arrangement.
   2. Set rough carpentry Work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
   3. Securely attach rough carpentry Work to substrates by anchoring and fastening as shown and as required by recognized standards.
   4. Countersink nail heads on exposed rough carpentry Work and fill holes. Use common wire nails, except as otherwise shown. Use finishing nails for finish Work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood, predrill as required.

B. Wood Grounds, Nailers, Blocking, Sleepers and Bridging:
   1. Provide wherever shown and where required for attachment of other work. Form to shapes as shown and cut as required for true line and level of Work to be attached. Coordinate location with other work involved.
   2. Attach substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown.
   3. Provide permanent grounds of dressed, preservative treated, key-bevelled lumber not less than 1-1/2 inch wide and of the thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

C. Wood Framing: Install plumb and level in accordance with the requirements of the Uniform Building Code.

D. Plywood Sheathing: Install as shown and in accordance with the requirements of the Uniform Building Code.

E. Building Paper: Install over wall plywood sheathing as shown.

F. Plywood Mansard Decking:
   1. Comply with manufacturer's instructions and with AITC recommendations for nailing wood decking.
   2. Comply with Uniform Building Code Table No. 25-J and other regulations to provide diaphragm action.

G. Provide special treated wood framing for eaves, overhangs, roof penetrations and similar conditions.

3.3 PROTECTION

A. Provide environmental conditions as recommended by manufacturers in order to avoid damage or deterioration of wood decking.

+ + END OF SECTION + +

SECTION 6B

HEAVY TIMBER CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, material, equipment and incidentals as shown, specified and required to furnish and install all heavy timber construction Work. The Work also includes:
   a. Providing openings in heavy timber construction to accommodate the Work under this and other Sections and building into the heavy timber construction all items such as sleeves, anchor bolts, inserts and all other items to be embedded in heavy timber construction for which placement is not specifically provided under other Sections.
2. The extent of the heavy timber construction Work is shown.
3. The types of heavy timber construction Work required include, but is not necessarily limited to, the following:
   a. Beams, girders and purlins.
   b. Blocking, bulkheading, crossarms and bracing members.
   c. Timber trusses.
   d. Pressure treatment.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the heavy timber construction Work.

C. Related Sections:
1. Section 6A, Rough Carpentry.
2. Section 7D2, Clay Roofing Tiles.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: Shop Fabricated Timber Wood Trusses: Provide a manufacturer skilled and experienced in the design and fabrication of timber wood trusses similar to the type required.

B. Design Criteria:
1. Timber Standard: Comply with AITC 102, National Design Specification for Stress-Graded Lumber and Its Fastenings, except as otherwise specified.
2. Timber Trusses: Comply with the following:
   a. Top Chord:
      1) Minimum Width: 4-inches.
      2) Minimum Depth: 10-inches.
      3) Uniform Live Load: 20 pounds per square foot.
      4) Uniform Dead Load: Approximately 25 pounds per square foot.
      5) Concentrated Load: 250 pounds; located to produce maximum stress in all members.
   b. Bottom Chord:
      1) Minimum Width: 4-inches.

2) Minimum Depth: 10-inches.
3) Miscellaneous Piping and Equipment Loads: 20 pounds per square foot.
4) Minimum Hanging Load: 500 pounds; located to produce maximum stress in all members. Refer to Drawings and comply with actual conditions of loading. Do not design truss for less than 500 pounds hanging load.

c. Wind Load: 30 pounds per square foot; check design for uplift.
d. Earthquake Zone: 2.
e. Longterm Deflection on Total Load: 2 times allowable deflection, maximum 1/240.
f. Duration Factor: 33 percent.
g. Bridging: Maximum spacing 8 foot-0 inches on centers.
h. Slope: 3 on 12.
i. Additional Concentrated Live Load Contributed By Bridge Crane: 4000 pounds. Truss design shall consider all conditions of bridge crane loading. Coordinate with bridge crane manufacturer supplied.
j. Size all truss members for most severe conditions of loading encountered by any single truss assembly. Provide calculations signed and stamped with the seal of a Registered Professional Engineer licensed to practice in the State of Arizona and recognized as an expect in the required Work.

3. The requirements of this Section shall generally conform to MAG Standard Specification Sections 770, 778 and 779, except as modified, added to, or changed herein. Where there is a conflict between MAG Standard Specifications and this Specification the provisions of this Specification shall apply.

C. Codes: Comply with the applicable requirements of governing authorities and the Uniform Building Code for size, spacing, loading, attachment and design of heavy timber construction Work.

D. Source Quality Control:
1. Factory-mark each piece of timber and type, grade, mill and grading agency, except omit marking from surfaces to be exposed with transparent finish or without finish.
2. Shop-fabricate heavy timber construction Work to the extent feasible and where shop fabrication will result in better workmanship than feasible for on-site fabrication.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. American Lumber Standard Committee, National Grading Rule for Dimension Lumber, PS-20.
2. West West Coast Lumber Inspection Bureau, Grading Rules.
3. Federal Specification, TT-W-550, Wood Preservative: Chromated Copper Arsenate Mixture.
4. National Forest Products Association, National Design Specification for Stress-Grade Lumber and Its Fastenings.
5. ASTM A 153, Zinc Coating (Hot Dip) on Iron and Steel Hardware.
6. ASTM A 307, Carbon Steel Externally and Internally Threaded Standard Fasteners.
7. American Institute of Timber Construction, AITC 102, Standards for the Design of Structural Timber Framing.

8. American Institute of Timber Construction, AITC 105, Recommended Practice for the Erection of Structural Timber Framing.
9. Maricopa Association of Governments, Uniform Standard Specifications for Public Works Construction.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Copies of chemical treatment manufacturer's instructions for proper use of each type of treated material.
2. For water-borne preservatives, include statement that moisture content of treated materials was reduced to maximum of 19 percent prior to shipment to project site.
3. Copies of design calculations showing all loadings, assumed stresses, lumber type and grade for shop fabricated timber wood trusses. Include all details of timber truss and member fastening as well as complete listing of products used.
4. Fabricator's specification and installation instructions for the required Work.
5. Shop Drawings for all heavy timber construction Work showing full dimensions of each member and plans, elevations, sections and details of the entire structural system. Show large scale details not less than 3/4-inch to 1 foot-0 inch scale of connections, connectors and other accessories. Indicate species and stress grade of timber, and other variables in the required Work.

B. Certificates: Submit for approval the following:
1. Pressure Treatment: For each type specified, include certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.
2. Provide shop fabricated timber wood trusses Shop Drawings sealed by a Registered Professional Engineer.

1.4 PRODUCT DELIVERY STORAGE AND HANDLING

A. Storage of Materials:
1. Keep materials dry during delivery and storage.
2. Protect against exposure to weather and contact with damp or wet surfaces.
3. Stack lumber, and provide air circulation within stacks.

B. Handling Materials: Handle all treated products as specified in American Wood Preservers's Association, M4.

1.5 JOB CONDITIONS

A. Protection:
1. Maintain timbers free of undesirable exposure during erection until building enclosure is completed to the extent necessary for protection from weather.

B. Scheduling: Time delivery and installation of heavy timber construction Work to avoid extended on-site storage, and to avoid delaying work of other trades whose work must follow erection of the heavy timber construction Work.

C. Coordination:
   1. Fit heavy timber construction Work to other work. Scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other work.
   2. Provide temporary supports and bracing for pre-engineered and shop fabricated wood trusses during erection.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Timber, General:
   1. Nominal sizes are shown, except as shown by detail dimensions. Provide actual sizes as required by American Lumber Standard Committee, National Grading Rule for Dimension Lumber PS-20, for the moisture content specified for each use.
      a. Provide dressed timber, S4S, unless otherwise shown or specified.
      b. Provide seasoned timber with 19 percent maximum moisture content at time of dressing.
   2. Provide the following grade and species for structural framing including pre-engineered and shop assembled wood timber trusses:
      a. Select structural (stress-rated).
      b. Douglas Fir, complying with the grading, dressing and use types listed in MAG Standard Specification 778.1.

B. Connectors:
   1. Bolts: Comply with National Forest Product Association, National Design Specification for Stress-Grade Lumber and Its Fastenings and with ASTM A 307.
   2. Split-Ring Connectors: Comply with Society of Automotive Engineers Specification SAE-100, and National Forest Product Association, National Design Specification for Stress-Grade Lumber and Its Fastening.
   3. In general, provide size and type as recommended by the Uniform Building Code standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices.
   4. Finish all bolts, anchors, accessory and support assemblies with hot-dip zinc coating complying with ASTM A 153.

C. Provide fabricated structural steel anchors and support assemblies from structural steel shapes, plates and bars, welded into assemblies of the types and sizes indicated.

2.2 WOOD TREATMENT

A. Preservative Treatment: Where timber is specified herein to be treated, comply with the appicable requirements of the American Wood Preservers Bureau (AWPB). Mark each treated item to comply with the AWPB Quality Mark requirements for the specified requirements.
   1. Pressure-treat above ground items with water-borne preservatives complying with AWPB LP-2. After treatment, kiln-dry to a maximum moisture content of 19 percent. Treat indicated items and the following:

a. Timber beams, girders, rafters and purlins and similar members in connection with roofing, flashing, vapor barriers and waterproofing.
b. Timber trusses, bridging and similar members, and all heavy timber in contact with masonry, plaster, or concrete.

B. Provide a chromated copper arsenate Type II or B complying with FS TT-W-550.

C. Complete fabrication of treated items prior to treatment, wherever possible. If cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment. Inspect each piece of lumber after drying and discard damaged or defective pieces.

2.3 FABRICATION

A. To the greatest extent possible, prefabricate timbers prior to delivery.

B. Assemble Work such as timber wood trusses in the shop to the extent feasible for handling, delivery and erection.

C. Fabricate heavy timber wood trusses in the shop using details recommended by National Forest Products Association, National Design Specification for Stress-Graded Lumber and Its Fastening.

D. Fabricate heavy timber wood trusses to the profiles shown on the Drawings, using bolts and split-ring connectors for jointing individual truss members together.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates and supporting structure and the conditions under which the heavy timber construction Work is to be installed, and notify the ENGINEER in writing of the conditions detrimental to the Work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

3.2 INSTALLATION

A. Comply with AITC 105, Recommended Practice for the Erection of Structural Timber Framing.

B. Discard units of material with defects which might impair the quality of the Work, and units which are too small to fabricate the Work with minimum joints or the optimum joint arrangement.

C. Set heavy timber construction Work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.

D. Securely attach heavy timber construction Work to substrates by anchoring and fastening as shown and as required by recognized standards. Install miscellaneous steel connectors, anchors and accessories as

indicated. Make tight connections between members. Install fasteners without splitting of wood, predrill as required.

E. Space heavy timber construction Work as shown and specified.

F. Where treated members must be cut during erection, apply a heavy brush coat of the same treatment, complying with AWPA Standard M4.

G. Handle and temporarily support members in a manner which prevents visible surface damage.

H. Maintain expansion spaces as required by applicable AITC standards.

3.3 REPAIR AND PROTECTION

A. Repair damaged surfaces and finishes after completion of erection, or replace damaged members as directed by the ENGINEER where damage is beyond satisfactory repair at no further expense to the OWNER.

B. Provide manufacturer's suggested environmental conditions for erected heavy timber construction Work, in order to avoid damage or deterioration to heavy timber construction Work.

+ + END OF SECTION + +

SECTION 6D1

MILLWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, material, equipment and incidentals as shown, specified and required to furnish and install all millwork Work. The Work also includes:
      a. Providing openings in millwork to accommodate the Work under this and other Sections and building into the millwork all items such as sleeves, anchor bolts, inserts and all other items to be embedded in millwork for which placement is not specifically provided under other Sections.
   2. The extent of the millwork is shown.
   3. The types of millwork required includes, but is not necessarily limited to, the following:
      a. Interior wood trim.
      b. Custom fabricated plastic laminate window stools.
      c. Adhesives, core materials, and wood blocking and fasteners.
      d. Miscellaneous wood treatments.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the millwork.

C. Related Sections:
   1. Section 6A, Rough Carpentry.
   2. Section 9L, Painting.

1.2 QUALITY ASSURANCE

A. Fabricator Qualifications: Millwork shall be provided by a fabricator with documented experience in the successful fabrication and installation of custom fabricated items of the type specified. Only the highest quality custom fabrication techniques shall be employed for the Work.

B. Design Criteria:
   1. Millwork Standard: AWI "Quality Standards".
   2. Quality Marking: Mark each unit of millwork with mill's or fabricator's identification and grade mark, located on surfaces which will not be exposed after installation.
   3. Fire-Retardant Marking: Mark each unit of fire-retardant treated wood with producer's label and UL label, showing grade and rating. Mark on surface which will not be exposed after installation.
   4. Uniform Building Code.
   5. Plywood: American Plywood Association Grading Specifications PS-1-66.
   6. Plastic Laminate: NEMA LD3-1980.
   7. Design to support a minimum loading of 200 pounds per square foot or 150 pounds per linear foot, whichever is greater, without permanent deflection. No internal supports or stiffeners are shown.

Fabricator shall use details consistent with the requirements of this Section to achieve the load resistance specified.

8. Comply with Formica Corporation Standard Specifications and Details, Custom Grade requirements of the A.W.I. Quality Standards Section 400, and A.W.I. publication Architectural Casework Details.
9. All window stools shall have 180 degree edges.

C. Quality Standard: For interior millwork comply with AWI Section 300 and Section 700.

D. Source Quality Control: Manufacturer's of "or equal" plastic laminate material shall provide exactly the same colors, finishes, dimensions and textures as the manufacturer specified.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. Architectural Woodwork Institute, "Quality Standards".

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. 12-inch long section of each molding and trim.
2. 12-inch by 12-inch color cards of each plastic laminate color within the series specified for final selection by ENGINEER. ENGINEER will select a maximum of one color of plastic laminate for the Work.
3. ENGINEER'S approval will be for color, texture and profile only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
1. Copies of chemical treatment manufacturer's instructions for proper use of each type of treated material.
2. For water-borne preservatives, include statement that moisture content of treated materials was reduced to maximum of 19 percent prior to shipment to project site.
3. Indicate compliance with specified Standard and other specified requirements for materials and workmanship.
4. Plan and sections indicating location for each item of millwork, including large scale details of all intersections, terminations and fastening of the Work.
5. Dimensioned plans, elevations, large scale details, attachment devices and other components of the custom fabricated plastic laminate window stools.
6. Plastic laminate manufacturer's published general fabrication data and data relative to the fabrication of plastic laminate covered casework and handling of plastic laminate.

C. Certificates: Pressure Treatment:
1. For type specified, include certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.
2. Include certification by treating plant that treatment material complies with governing ordinances and that treatment will not bleed through finished surfaces.

3. Submit copies of certificate signed by mill or woodwork shop, certifying that millwork complies with quality grades and other requirements specified. Submit certificate in form recommended by applicable Standards.

1.4 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery of Materials:
   1. Do not deliver millwork until wet work, gypsum wallboard, acrylic stucco and similar operations which could damage, soil, or deteriorate millwork have been completed in installation areas.

B. Storage of Materials:
   1. Protect against exposure to weather and contact with damp or wet surfaces.
   2. If millwork must be stored in other than installation areas, store only in areas meeting requirements specified for installation areas.

C. Handling Materials:
   1. Handle all treated products as specified in American Wood Preservers's Association M4.
   2. Protect millwork during transit, delivery, storage and handling to prevent damage, soiling and deterioration. Keep covered with heavy-duty polyethylene film or other protective covering.

1.5 JOB CONDITIONS

A. Environmental Conditions:
   1. The installer shall advise CONTRACTOR of temperature and humidity requirements for millwork installation areas. Do not install millwork until the required temperature and relative humidity have been stabilized and will be maintained in installation areas.
   2. Maintain temperature and humidity in installation area as required to maintain moisture content of installed millwork within a 1.0 percent tolerance of the optimum moisture content, from the date of installation through the remainder of the construction period. The installer of the millwork shall determine the optimum moisture content and required temperature and humidity conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Millwork, General: Provide Premium Grade closed-grain rift sawn white oak hardwood complying with specified requirements.

B. Plastic Laminate:
   1. Provide forming-grade plastic laminate formulated with special resins to permit a minimum outside post forming bending radius of 5/8-inch, but recommended by the manufacturer for use as a tough durable surface with excellent wear resistance.
   2. Physical Properties: Provide plastic laminate assembly components complying with the following:
      a. Flame Spread, ASTM E 84: 35 maximum.
      b. Smoke Development, ASTM E 84: 50 maximum.

3. Color: Provide complete selection of manufacturer's standard and custom matte colors.
4. Provide manufacturer's recommended backing sheet for all plastic laminate Work.
5. Product and Manufacturer: Provide one of the following:
   a. HGP (Grade -12) Color Trends Collection by Formica Corporation.
   b. Or equal.

C. Plastic Laminate Core Materials:
   1. Custom Fabricated Window Stools: 3/4-inch fir plywood with "B" sanded face veneers bonded with a waterproof adhesive.

D. Complete selection of transparent and semi-opaque oil base stains for final selection by ENGINEER.

2.2 FABRICATION

A. Machine and sand millwork to comply with the requirements of Standards for specified grade.

B. Fabricate millwork to dimensions, profiles and details shown and specified. Rout or groove back of flat trim members.

C. Miter joints by joining, splining and gluing to comply with requirements for the specified grade.

D. Except as otherwise indicated fabricate plastic laminate Work to comply with Architectural Woodwork Quality Standards and Guide Specifications by AWI, Premium Grade, High-Pressure Decorative Laminates, Publication No. LD-3, by NEMA, and laminate manufacturer's published standards and specifications for the Work. No fasteners shall be visible in the finished Work.

E. Comply with details shown and specified for profiles and construction of plastic laminate Work. Where not otherwise shown, comply with applicable Quality Standards and design criteria specified.

F. Fabricate plastic laminate Work with precut openings. Locate openings accurately and finish with plastic laminate.

G. Take field measurements before proceeding with the plastic laminate Work.

H. Comply with plastic laminate manufacturer's written material use recommendations.

I. Do not expose fasteners; use glued joints and concealed fasteners.

J. Ease all exposed edges of plastic laminate sheet.

K. Fabricate all edges of plastic laminate Work with matching plastic laminate.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the substrates and supporting structure and the conditions under which the Work is to be installed, and notify ENGINEER in writing of the conditions detrimental to the Work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Insure that substrate is properly installed and aligned before installation.

3.3 INSTALLATION

A. General:
   1. Discard units of material with defects which might impair the quality of the Work, and units which are too small to fabricate the Work with minimum joints or the optimum joint arrangement.
   2. Set millwork accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
   3. Securely attach millwork to substrates by anchoring and fastening as shown and as required by recognized standards. Countersink nail heads on exposed millwork and fill holes. Make tight connections between members. Install fasteners without splitting of wood, predrill as required.

B. Comply with AWI Finish System No. 3, Premium Grade, open grain finish.

C. Install the Work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch in 8 feet-0 inches for plumb and level and with 1/16 inch maximum offset in flush adjoining surfaces, 1/8 inch maximum offsets in revealed adjoining surfaces.

D. Millwork shall be secured to ground, otherwise fastened in position to hold correct surfaces, lines and levels.

E. Soil, stain and extraneous material, whether caused by millwork handling or from adjacent surfaces, shall be removed.

F. Distribute to best overall advantage the defects allowed in the quality grade specified.

G. Scribe and cut Work to fit adjoining Work, and refinish cut surfaces or repair damaged finish at cuts.

H. Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns, miter at corners, and comply with Quality Standards for joinery.

I. Anchor millwork to anchors or blocking built-in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fasteners heads are required, use fine finishing nail for exposed nailings, countersunk and filled flush with millwork.

3.4 ADJUSTMENT, CLEANING AND PROTECTION

A. Repair damaged and defective millwork wherever possible to eliminate defects functionally and visually; where not possible to repair properly, replace millwork. Adjust joinery for uniform appearance.

B. Clean exposed and semi-exposed surfaces. Touch-up shop-applied finishes to restore damaged or soiled areas.

C. Complete the finishing work specified in Section 9L, Painting, to whatever extent not completed at the shop or prior to installation of millwork.

D. Protection: The installer of the millwork shall advise CONTRACTOR of final protection and maintained conditions necessary to ensure that the Work will be without damage or deterioration at the time of Final Acceptance.

+ + END OF SECTION + +

SECTION 7C1

BUILDING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all building insulation Work.
   2. The extent of each type of building insulation is shown and specified herein.
   3. The types of building insulation Work required includes, but is not necessarily limited to, the following:
      a. Batt-type insulation.
      b. Perimeter insulation.
      c. Loose fill insulation.
      d. Preformed concrete masonry unit core insulation.
      e. Fire safing insulation.
      f. Compression-resistant underslab insulation.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of item that must be installed with the insulations.

C. Related Sections:
   1. Section 4C1, Unit Masonry Construction.
   2. Section 4C3, Concrete Unit Masonry.
   3. Section 6A, Rough Carpentry.
   4. Section 7C10, Exterior Wall Insulation and Finish System.

1.2 QUALITY ASSURANCE

A. Design Criteria: Thermal Conductivity: The thicknesses shown are for the thermal conductivity, k-value at 75 degrees F., specified for each material. Provide adjusted thicknesses as directed for the use of material having a different thermal conductivity.

B. Requirements of Regulatory Agencies: Comply with fire-resistance and flammability ratings and with applicable requirements of the Uniform Building Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ASTM C 177, Test Method for Steady-State Heat Flux Measurement and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   2. ASTM C 303, Density of Preformed Block-type Thermal Insulation.
   3. ASTM C 518, Steady-State Thermal Transmission Properties by Means of Heat Flow Meter.
   4. ASTM C 549, Perlite Loose Fill Insulation.
   5. ASTM D 1621, Compressive Properties of Rigid Cellular Plastics.
   6. ASTM D 2842, Water Absorption of Rigid Cellular Plastics.

7. ASTM E 84, Surface Burning Characteristics of Building Materials.
8. ASTM E 96, Water Vapor Transmission of Materials in Sheet Form.
9 ASTM E 119, Fire Tests of Building Construction and Materials.
10. ASTM E 520, Density of Granular Loose Fill Insulations.
11. Federal Specification, FS HH-I-521F, Thermal (glass fiber) Insulation.
12. Federal Specification, FS HH-I-524C, Thermal (Polystyrene) Insulation Board.
13. Federal Specification, FS HH-I-530A, Insulation Board, Thermal (Urethane).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval copies of manufacturer's specifications and installation instructions for each type of insulation required. Include data substantiating that the materials comply with specified requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Material: Do not allow insulation materials to become wet or soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Glass Fiber Batt-Type Insulation: Provide the following:
   1. Glass fibers and resinous binders formed into flexible blankets faced on one side with a foil-reinforced-Kraft laminate vapor barrier and complying with FS HH-I-521F; Type III and Type I.
   2. Physical Properties:
      a. Density, ASTM C 303: 1.5 pounds per cubic foot.
      b. Thermal Conductivity (k), ASTM C 518: 0.27, BTU/in./hr./s.f./F.
      c. Water Vapor Transmission, ASTM E 96: 0.5 perm inch.
      d. Flame Spread, ASTM E 84: 25.
      e. Smoke Developed, ASTM E 84: 50.
      f. Fuel Contributed, ASTM E 84: 50.
      g. Thickness: Total of 9-1/2-inches; one layer of 6-inch faced plus one layer of 3-1/2-inch unfaced .
   3. Product and Manufacturers: Provide one of the following:
      a. Flame Resistant Foil Faced Fiber Glass Building Insulation by Certain Teed Corporation.
      b. Flame Spread 25 Foil Faced Fiberglas Building Insulation by Owens-Corning Fiberglas Corporation.
      c. Or equal.

B. Loose Fill Insulation: Provide the following:
   1. Inert volcanic glass expanded by a special heat process, treated with a non-flammable silicone, complying with FS HH-I-574b.
   2. Physical Properties:
      a. Density, ASTM C 520: 5-8 pounds per cubic foot.

b. Thermal Conductivity (k), ASTM C 549: 0.32-0.37 BTU/in./hr./s.f./F.
c. Flame Spread, ASTM E 84: 0.
d. Fuel Contribution, ASTM E 84: 0.
e. Smoke Development, ASTM E 84: 0.

3. Product and Manufacturer: Provide one of the following:
a. Permalite by Grefco Incorporated.
b. Or equal.

C. Perimeter Foundation Insulation: Provide the following:
1. Rigid closed-cell, halocarbon-blown polyurethane board, 1-1/2-inches thick and 2 feet-0 inches wide, complying with FS HH-I-530A, Type II.
a. Density, ASTM C 303: 2.1 pounds per cubic foot.
b. Compressive Strength, ASTM D 1621: 40 pounds per square inch.
c. Water Absorption, ASTM D 2842: 0.7 percent by volume.
d. Water Vapor Transmission, ASTM E 96: 0.6 perm inch.
e. Thermal Conductivity (K), ASTM C 518: 0.16 BTU/in./hr./ s.f./F.

2. Product and Manufacturer: Provide one of the following:
a. Urethane by Upjohn Company.
b. O-C Urethane by Owens-Corning Fiberglass Corporation.
c. Or equal.

D. Preformed Concrete Masonry Unit Core Insulation: Provide the following:
1. Individually molded expanded polystyrene core insulation complying with FS HH-I-524C.
2. Physical Properties:
a. Density, ASTM C 303: 1.3 pounds per cubic foot minimum.
b. Water Vapor Transmission, ASTM E 96: 1.4 perm inch.
c. Thermal Conductivity (k), ASTM C 177: 0.26, BTU/in./hr./s.f./F.
d. Compressive Strength, ASTM D 1621: 10-13 pounds per square inch.
e. Flame Spread,ASTM E 84: 5 maximum.
f. Smoke Developed, ASTM E 84: 130 maximum.

3. Product and Manufacturer: Provide one of the following:
a. Korfil Block Insulation by Korfil Incorporated.
b. Or equal.

E. Fire Safing Insulation: Provide the following:
1. Semi-rigid non-asbestos compounds of spun mineral fiber felt, meeting FS HH-I-521F, Type I, Class A and FS HH-I-558B, Form A, Classes 1 and 2. Nominal density of 4 pounds per cubic foot and a thermal conductivity (k) of 0.24.
2. Fire Performance Properties:
a. Flame Spread Rating, ASTM E 84: 15 maximum.
b. Fuel Contributed, ASTM E 84: 1 maximum.
c. Smoke Development, ASTM E 84: 50 maximum.
d. Fire Resistance Rating, ASTM E 119: 3 hours minimum.

3. Product and Manufacturer: Provide one of the following:
a. Thermafiber Fire-Safing Insulation by United States Gypsum.
b. Or equal.

F. Compression-Resistant Underslab Insulation: Provide the following:
1. Rigid-Board: Composed of glass fibers and water-resistant binders formed into rigid, non-combustible boards and bearing an FM Class 1

rating and meeting the requirements of Federal Specification HH-I-558B Form A, Class 1 and 2.

2. Physical Properties:
   a. Thermal Conductance (k), ASTM C 518: 0.23.
   b. Compressive Strength, ASTM C 165: 350 pounds per square inch minimum.
   c. Vapor Transmission, ASTM E 96: 0.02 perms.
   d. Density, manufacturer's certified test: 6 pounds per square foot minimum.
   e. Flame Spread, ASTM E 84: 15 maximum.
   f. Smoke Development, ASTM E 84: 0 maximum.
   g. Thermal Resistance (R): 9.09.
3. Size: 24-inches by 48-inches by 2-inches.
4. Complete selection of manufacturers adhesives and mechanical fasteners. Only fasteners and adhesives recommended by the rigid board manufacturer shall be approved as required by method of installation actually used in the Work.
5. Product and Manufacturer: Provide one of the following:
   a. 705 Series by Owens-Corning Fiberglas Corporation.
   b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and the conditions under which the insulation Work is to be performed, and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the insulation Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. General: Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to the Project conditions, consult the manufacturer's technical representative for specific recommendations before proceeding with the Work.

B. Batt-Type Insulation:
   1. Install batt insulation above ceilings, between rafters as shown. Extend insulation full width, length and height in all areas shown on the Drawings.
   2. Fit tightly around obstructions to form a uniform insulated barrier.

C. Loose Fill Insulation: Pour insulation in cells of all exterior concrete unit masonry to completely fill all void spaces.

D. Board-Type Foundation Insulation:
   1. Install perimeter insulation after concrete footings have been poured.
   2. Extend insulation full thickness as shown along entire perimeter of building except at exterior wall of packed column and crawl space areas. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections which interfere with placement.

3. Apply a single 2 foot-0 inch wide continuous layer of insulation of the required thickness at all slab-on-grade buildings whether or not shown on the Drawings.
4. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Use type adhesive recommended by manufacturer of board-type foundation insulation.
5. Protect insulation on vertical surfaces (from damage during back-filling) by application of one of the types of protection course materials recommended by the insulation manufacturer. Set in adhesive in accordance with the recommendations of the manufacturers of the insulation and the protection course material.
6. Protect top surface of horizontal insulation (from damage during concrete work) by application of one of the types of protection course materials recommended by the insulation manufacturer.

E. Preformed Concrete Masonry Unit Core Insulation:
1. Provide preformed concrete masonry unit core insulation installed in all cores of all exterior perimeter wall concrete unit masonry construction.
2. Install inserts in accordance with manufacturer's written specification.
3. Concrete unit masonry Work containing damaged or mutilated preformed insulation shall not be used in the Work.

F. Fire Safing Insulation: Install fire safing insulation to present a continuous fire barrier at the perimeter of all fire-rated partitions to produce fire-rated construction.

G. Compression-Resistant Underslab Insulation:
1. In areas where horizontal perimeter insulation is shown under floor slabs in the finished Work, install a continuous layer of compression-resistant underslab insulation of the specific thickness under the slab formwork before installing reinforcing steel and slab reinforcement supports.
2. Fit tightly around all obstructions and penetrations in slab formwork to form a uniform insulated barrier.

3.3 ADJUSTMENT AND CLEANING

A. Protect insulations from damage or abuse from other work until Final Acceptance.

+ + END OF SECTION + +

SECTION 7C8

ROOF INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all roof insulation Work.
   2. The extent of roof insulation is shown.
   3. The types of roof insulation Work required includes, but is not necessarily limited to, the following:
      a. Tapered glass fiber board roof insulation.
      b. Miscellaneous materials.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the roof insulation.

C. Related Sections:
   1. Section 6A, Rough Carpentry.
   2. Section 7F3, Elastic Sheet Roofing.
   3. Section 7H1, Flashing and Trim.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Subcontract roof insulation Work to the installer of the associated roofing for undivided responsibility.

B. Design Criteria: The thicknesses shown are for the thermal conductivity, k-value at 75 F specified for each material.

C. Requirements of Regulatory Agencies: Comply with fire-resitance ratings as shown, and as required by governing authorities and the Uniform Building Code and comply with the following roof insulation requirements:
   1. U.L. requirements for Roof Deck Constructions which are rated "UL Construction No. 1".
   2. Factory Mutual requirements for "Class I" construction, for fire hazard and wind resistance.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C 355, Water Vapor Transmission of Thick Materials.
   2. ASTM C 518, Thermal Conductivity of Materials by Means of Heat Flow Meter.
   3. Federal Specification, HH-I-526C, Thermal (Mineral Fiber) Insulation Board.
   4. FM, Approval Guide.
   5. U.L., Building Materials Directory.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for type of insulation required. Include data substantiating that the materials comply with specified requirements.
   2. Weights of all equipment to be used on roof.
   3. Copies of written guarantee, as specified.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Do not deliver roof insulation materials to the project site before time of installation.

B. Storage of Materials: Do not allow roof insulation materials to become wet or soiled, or covered with ice or snow.

C. Handling of Materials: Comply with manufacturer's recommendations for handling, storage and protection.

1.5 JOB CONDITIONS

A. Environmental Requirements: Do not install roof insulation when weather conditions are such that the deck is not completely dry, or where there is no assurance that the roof insulation can be completely covered with the complete roofing system by the end of the day.

B. Protection: Do not overload the building structure with the weight of stored materials or use of equipment.

C. Sequencing:
   1. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the roofing membrane over the roof insulation are at the site and are ready to follow with this Work immediately (same day) behind the tapered flass fiber board roof insulation Work.
   2. Do not install any more tapered glass fiber board roof insulation each day than can be covered with complete roofing system by the end of that working day.

1.6 SUBSTITUTIONS

A. Manufacturer of the primary roofing system shall be a manufacturer who finds the generic types of roof insulation specified herein as acceptable and bondable if installed according to the roofing manufacturer's standards for complete product and performance responsibility.

B. The thickness of the roof insulation and the number of courses shall not vary from what is shown and specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Tapered Glass Fiber Board Roof Insulation: Composed of glass fibers and water-resistant binders formed into rigid, non-combustible boards with glass fiber reinforced asphalt saturated top surface and bearing a FM Class I rating. Size 36-inches by 48-inches. Provide the following physical properties:
   1. Thermal Conductance (k), ASTM C 518: 0.27.
   2. Vapor Transmission, ASTM C 355: Highly permeable.
   3. Meet requirements of Federal Specification HH-1-526C.
   4. Thickness:
      a. Base Layer: 1-1/16-inches.
      b. Intermediate Filler Board: 3-inches.
      c. Tapered Top Layer: Varies from 3-3/4-inches to 0-inches.
   5. Provide minimum slope to drain of 1/4-inch per foot.
   6. Provide custom pre-cut factory-formed corners.

B. Miscellaneous Materials:
   1. Joint Tape: 6-inch wide glass fiber tape.
   2. Adhesive for Bonding Insulation: The type recommended by the insulation manufacturer, and complying with fire-resistance requirements.

C. Product and Manufacturer: Provide one of the following:
   1. Tapered FIBERGLAS Roof Insulation System by Sibo Incorporated.
   2. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and the conditions under which the insulation Work is to be performed, and notify ENGINEER in writing of any unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. General:
   1. Roof insulation system shall be designed and totally precut at the factory.
   2. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to the project conditions, consult the manufacturer's technical representative for specific recommendations before proceeding with the Work.
   3. Coordinate heights of masonry and wood blocking to provide flush transition between roof insulation Work and perimeter wood blocking.
   4. Extend insulation full thickness as shown over entire surface to be insulated.
   5. Cut and fit board-type insulation tightly around obstructions, and fill voids with insulation. Keep back 1/4 inch for all vertical flashings.

B. Laying Board-Type Insulation Units:
   1. Set units in adhesive and mechanically fasten in accordance with the requirements of the applicable fire and insurance ratings and roofing membrane manufacturer's recommendations, and applied in accordance with the recommendations of the manufacturer of the insulation, adhesive and completed roofing system.
   2. Apply three courses of roof insulation at high points and metal gravel stops. Vary number of courses to provide 1/4-inch per foot positive slope to drains. Provide a minimum of two courses of roof insulation at low points. Insulation shall slope from a total thickness of 7-13/16-inches at high points to 4-1/16-inches at low points.
   3. For glass fiber board insulation stagger joints between courses.
   4. Install insulation board with the long joints between boards parallel with incline of deck.
   5. For glass fiber board keep joints continuous in both directions.

3.3 PERFORMANCE

A. Roof insulation Work shall withstand the uplift forces of wind, as defined by the roofing guarantee. Refer to Section 7F3, Elastic Sheet Roofing. Failures of the roof insulation Work in bond or anchorage to the substrate, or within the insulation, will be considered failures of materials or workmanship under the Roofing Guarantee.

3.4 PROTECTION

A. Do not permit construction period traffic over completed roof insulation Work, except as required to install roofing and flashing Work.

B. Protect insulation Work from exposure to moisture, damage and deterioration, primarily by prompt installation of roofing Work to be placed over the roof insulation.

3.5 INSPECTION AND ACCEPTANCE

A. Roof insulation which has become wet, damaged, or deteriorated, as determined by ENGINEER, shall be promptly removed from the job.

B. Correct all improperly sloped, ridged or rough areas in the roof insulation Work to provide insulation acceptable to roofing manufacturer.

+ + END OF SECTION + +

SECTION 7C10

EXTERIOR WALL INSULATION AND FINISH SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all exterior wall insulation and finish system Work.
2. The extent of the exterior wall insulation and finish system is shown.
3. The types of exterior wall insulation and finish system Work required includes, but is not necessarily limited to, the following:
   a. A ready-mixed acrylic-based textured wall coating system including double layers of reinforcing mesh and all additives and components as recommended by the manufacturer for application over rigid insulation board; concrete unit masonry; exterior grade plywood; cement plaster stucco and cast-in-place concrete.
   b. Key coats, ground coats and finish coats of reinforced plaster materials with mechanical finish specified.
   c. Double-layer reinforcing meshes and applicable matrixes for all surfaces receiving rigid insulation board to full height and width.
   d. Single-layer mesh and applicable matrixes for all surfaces not receiving rigid insulation board.
   e. Insulation board.
   f. Mechanically fastened system for existing structures as shown.
   g. All additives and miscellaneous components necessary to complete the Work.
   h. Custom fabrication of all system components as required to reproduce the architectural features shown to the allowable tolerances specified.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed prior to the exterior wall insulation and finish system Work.
2. Review installation procedures under other Sections and coordinate the Work to produce substrate surfaces free from contaminants incompatible with the exterior wall insulation and finish system Work, and substrates acceptable to the exterior wall insulation and finish system installer for completely acceptable product performance.

C. Related Sections:
1. Section 7C1, Building Insulation.
2. Section 9A1, Furring and Lathing.
3. Section 9A3, Cement Plaster.
4. Section 9A6, Acrylic Stucco.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer regularly engaged in exterior wall insulation and finish systems Work, and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Engage an installer approved by the manufacturer.

B. Design Criteria:
   1. Comply with the recommendations of the Plasterer's Manual, by the Portland Cement Association and the applicable Building Code, except where more stringent requirements are shown or specified.
   2. In order to insure complete product compatibility and bondability of the completed exterior wall insulation and finish system Work, CONTRACTOR may, with the approval of ENGINEER, submit manufacturer sub-components of the exterior wall insulation and finish system Work which the manufacturer certifies in writing to ENGINEER, to be more appropriate to the substrate or job conditions encountered. All such approved substitutions shall be at no additional cost to OWNER. No reduction in number of layers or types of reinforcing mesh shall be approved by ENGINEER.
   3. Final selection of products shall be made from manufacturer's complete selection of highest quality products at no additional expense to OWNER.
   4. A fully adhesive-based system is specified herein except that existing substrates shown to receive the Work of this Section shall receive a mechanically fastened track system consisting of horizontal tracks and vertical splines. Where, on new work, acceptability of substrate adhesive bond cannot be determined or made acceptable to the exterior wall insulation and finish system installer, provide exterior wall insulation and finish system manufacturer's standard sheathing dowel system for the Work of this Section.

C. Allowable Tolerances:
   1. Flat or Curved Surfaces: Do exceed 1/8-inch in 8 feet for bow or warp of surface, and for plumb or level.
   2. Color Breaks: Do not exceed 1/8-inch in 8 feet out-of-alignment from color break lines shown on the Drawings.

D. Source Quality Control: Obtain all materials from the same manufacturer. Obtain materials only from manufacturers who will:
   1. Provide the services of a qualified manufacturer's representative at the project site at the commencement of Work and during the time when the mock-up Work is being done to advise on materials, installation and finishing techniques.
   2. Certify long term compatibility of all coatings with the substrates.
   3. Do not use air entraining agents, air entrained lime, or air entrained portland cement.

E. Job Mock-Ups:
   1. Prior to the installation of the exterior wall insulation and finish system Work, but after ENGINEER'S approval of the samples

of each type of material, build free-standing 4 foot by 6 foot sample panels of each type of complete exterior wall insulation and finish system on same substrate material that will be used in the Work, to show a representative installation of each complete exterior wall insulation and finish system Work including final texture and colors. Stage sample panel Work to leave exposed a 12-inch wide band of each component required in the Work. Obtain ENGINEER'S acceptance of visual qualities of the mock-ups before start of exterior wall insulation and finish system Work. Retain and protect mock-up during installation as a standard for judging completed exterior wall insulation and finish system Work. Do not alter approved mock-ups. Build as many sample panels as required to obtain ENGINEER'S acceptance of the Work.

2. Exterior wall insulation and finish system Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material, as required by ENGINEER.

F. Reference Standards: Comply with applicable provisions and recommendations, except as otherwise shown or specified.
1. ASTM C 150, Portland Cement.
2. ASTM C 177, Steady-State Thermal Transmission Properties by Means of Guarded Hot Plate.
3. ASTM C 203, Breaking Load and Calculated Flexural Strength of Preformed Block-Type Thermal Insulation.
4. ASTM C 272, Water Absorption of Core Materials for Structural Sandwich Constructions.
5. ASTM C 303, Density of Preformed Block-Type Thermal Insulation.
6. ASTM C 518, Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter.
7. ASTM C 550, Measuring Trueness and Squareness of Rigid Block Thermal Insulation.
8. ASTM D 696, Coefficient of Linear Thermal Expansion of Plastics.
9. ASTM D 968, Abrasion Resistance of Organic Coatings by the Falling Abrasive Tester.
10. ASTM D 1621, Compressive Properties of Rigid Cellular Plastics.
11. ASTM D 1623, Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
12. ASTM E 72, Strength Tests of Panels for Building Construction.
13. ASTM E 84, Surface Burning Characteristics of Building Materials.
14. ASTM E 96, Water Vapor Transmission of Materials.
15. ASTM E 330, Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. 12-inch by 12-inch samples of each type of complete exterior wall insulation and finish system showing finished colors and textures on substrate simulating each actual project substrate.
2. Each component material to be used in the Work.
3. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for each component of the exterior wall insulation and finish systems for each substrate.
   2. Manufacturer's complete selection of standard and custom colors and textured finish coats.
   3. Fully coordinated Shop Drawings showing 1/4-inch scale elevation of all walls to recieve the Work of this Section and all termination details at 1-1/2 inch scale between this Work and the work of other sections. Also include details of system components and control joint locations and details.

C. Test Reports: Submit for approval certified laboratory test reports for required preformance tests.

D. Certification: Certify that all coatings are compatible with substrates as specified.

E. Maintenance Manual: Submit copies of bound maintenance manual for the exterior wall insulation and finish Work. Include instructions for cleaning, repair and general maintenance Work. Include manufacturer's data on all components of the exterior wall insulation and finish Work and name, address and telephone number of manufacturer, installer and local product distributer.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in exterior wall insulation and finish system manufacturer's original unopened packages.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number, color and date of manufacture.
      c. Mixing instructions, shelf life and curing time when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by ENGINEER, and his requiring its removal from the site. Supply new material conforming to the specified requirements at no additional cost to OWNER.

B. Storage of Materials:
   1. Store materials so as to preclude the inclusion of foreign materials.
   2. Store in accordance with manufacturer's recommendations in a clean, dry, well-ventilated area.
   3. Store materials out of direct sunlight and at a temperature of not less than 40 F.

C. Handling:
   1. Handle materials carefully to prevent inclusion of foreign materials.
   2. Do not open containers or mix components until necessary preparatory Work has been completed and installation will start immediately.
   3. Do not expose combustible or sensitive material to excessive heat or open flame.

4. Materials shall be used in the Work only when the material being incorporated into the Work bears the same name and formulation as the container or package in which it is contained.
5. CONTRACTOR shall not change containers or use material from unmarked or incorrectly labeled containers.
6. Failure to comply with this requirement will be cause for ENGINEER requiring the product to be removed from the site and the area wherein the product has been incorporated to be removed and rebuilt with material complying to the specified requirements. This requirement shall govern even if CONTRACTOR certifys or proves that the material was appropriate for incorporating into the Work.

1.5 JOB CONDITIONS

A. Environmental Conditions:
1. Proceed with the exterior wall insulation and finish system Work only when weather conditions will permit unrestricted use of materials and quality control of the Work being installed, complying with the Specification requirements and with the recommendations of the exterior wall insulation and finish systems materials manufacturer.
2. Do not proceed with the installation of exterior wall insulation and finish system under adverse weather conditions, or when temperatures are below 40 F or expected to fall below 40 F within 24 hours after installation.
3. Do not apply in hot sun or on heated walls unless walls are cooled first by hosing with clean water until cool.
4. Under extremely windy or hot conditions, where too rapid drying occurs, cure finished surface by fog spraying with water. Comply with manufacturer's recommendations to prevent color variation.
5. Proceed only when CONTRACTOR and his installer are willing to guarantee the Work as required and without additional reservations and restrictions.

B. Scheduling:
1. Proceed with the exterior wall insulation and finish system Work only after all unit masonry construction, cast-in-place concrete and framing for projections through the substrate construction are completed.
2. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the exterior wall insulation and finish system Work are at the site and have sufficient materials and resources to complete the Work in a manner which shall reveal no inconsistancies of texture, color or allowable tolerance in the finished Work greater than that which has been approved on the sample panel by ENGINEER.

C. Protection:
1. Do not allow finish system Work to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining materials.

2. Draw all color break lines accurately and to the tolerances specified.
3. Protect materials against damage by construction traffic.

1.6 GUARANTEE

A. CONTRACTOR shall execute his own written guarantee direct to OWNER warranting all exterior wall insulation and finish system Work weather and watertight, color fast, and non-crazing, cracking or delaminating for a period of three years after the date of conditional acceptance thereof by OWNER. Imperfections, by reason of defective materials, workmanship or arrangement of the various parts shall be made good to the satisfaction of OWNER at CONTRACTOR'S expense.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Insulation Board: Provide the following:
   1. Rigid: 100 percent virgin expandable polystyrene modified resin bead board with bead fusion of 80 percent minimum with no visible voids.
   2. Molded blocks air dried for minimum of six weeks with less than 0.5 percent residual pentane prior to fabrication.
   3. Dimension Tolerances, ASTM C 550:
      a. Length: ±1/16 inch.
      b. Width: ±1/16 inch.
      c. Thickness: ±1/16 inch.
      d. Squareness: ±1/16 inch.
      e. Flatness: ±1/32 inch.
   4. Physical Properties:
      a. Density, ASTM C 303: 0.91-1.10 lbs/cu.ft.
      b. Thermal Resistance, (R at 75 F), ASTM C 177 and ASTM C 518: R=3.85 s.f./F/hr/BTU.
      c. Thermal Conductivity (k at 40 F), ASTM C 177 and ASTM C 518: U=0.25 BTU/in.hr/s.f./F.
      d. Coefficient of Thermal Expansion, ASTM D 696: 3.5×10^{-5} in/in./F.
      e. Compressive Strength (10% deflection), ASTM D 1621: 13-17 psi.
      f. Flexural Strength, ASTM C 203: 28-35 psi.
      g. Tensile Strength, ASTM C 1623: 16-20 psi.
      h. Water Vapor Transmission, ASTM E 96: 1.2-2.2 perms.
      i. Water Vapor Absorption, ASTM C 272: Less than 2 percent.
      j. Flame Spread, ASTM E 84: 5.
      k. Smoke Developed, ASTM E 84: 40-85.
   5. Thicknesses: 2-inches and as required to provide architectural features shown.
   6. Rigid insulation shall be as approved by the exterior wall insulation and finish system manufacturer for complete product system responsibility. Where rigid insulation is part of a track system rigid insulation shall have routed edges to receive track and spline flanges.

7. Whre rigid insulation board is shown with non-standard profiles provide custom fabricated rigid polystyrene resin boards fabricated to the profiles shown, complying with the tolerances specified. Provide continuous pre-molded inside and outside corner shapes.
   a. Product and Manufacturer: Provide one of the following:
      1) Custom Foam Products by Treadway Industries Incorporated.
      2) Custom Foam Products by Associated Foam Manufacturers, Incorporated.

B. Primers: Provide the following primers and sealers for the substrate encountered and as recommended by the manufacturer of the complete exterior wall insulation and finish system:
   1. Over Ground Coat: Provide manufacturer's recommended acrylic co-polymer emulsion primer with titanium dioxide extenders and calcium carbonate and quartz fillers, as an adhesion and water-resistance-enhancing intermediary coat over the ground coat. Provide primer tinted to match finish coat. Primer shall prevent efflorescence which may otherwise be present due to portland cement additives and to improve water resistance of the completed Work.
   2. Over Exterior Grade Plywood Sheathing: Provide a solvent based, unpigmented co-polymer resin surface sealer and adhesion intermediary to provide uniform absorption.
   3. Over Concrete Unit Masonry: Provide an acrylic co-polymer emulsion primer, with titanium dioxide extenders and calcium carbonate and quartz fillers, tinted to match the color of the finish coat.
   4. Over Portland Cement Plaster and Cast-In-Place Concrete: Provide a solvent based acrylic polymer substrate hardener and sealer capable of consolidating and preventing saponification.

C. Adhesives: Provide the following adhesives as required for the substrate encountered and as recommended by the manufacturer of the complete exterior wall insulation and finish system:
   1. Over Primed and Sealed Exterior Grade Plywood Sheathing: Provide acrylic co-polymer emulsion primer, with titanium dioxide extenders and calcium carbonate and quartz fillers, tinted to match the color of the finish coat.
   2. Over Primed Concrete Unit Masonry and Primed and Hardened Cast-In-place Concrete: Same as ground coat specified under 2.1.D.1. below.

D. Ground Coats: Provide the following ground coat as required for the substrate encountered and as recommended by the manufacturer of the complete exterior wall insulation and finish system:
   1. Over Primed Cast-In-Place concrete and Primed Concrete Unit Masonry: Provide a water based co-polymer emulsion, capable of bridging hairline cracks in masonry and concrete, containing quartz sands and other special fillers and requiring the addition of 20 percent by weight of portland cement. Use to level and smooth concrete and concrete unit masonry as specified.

E. Reinforcing Meshes: Provide the following two types:
   1. Heavy Duty Reinforcing Mesh:
      a. Alkali-resistant glass fiber double strand interwoven mesh made from twisted multi-end strands.
      b. Glass fibers coated with a minimum of 20 grams of styrene butadiene per square yard.
      c. Product and Manufacturer: Provide one of the following:
         1) Armor Mat by STO Energy Conservation Incorporated.
         2) Or equal.
   2. Standard Reinforcing Mesh:
      a. Alkali-resistant glass fiber symmetrically interlaced, made from twisted multi-end strands.
      b. Glass fibers coated with a minimum of 20 grams of styrene butadiene per square yard.
      c. Product and Manufacturer: Provide one of the following:
         1) Reinforcing Fiber Mesh by STO Energy Conservation Incorporated.

F. Textured Wall Finish: Provide a ready-mixed water-based co-polymer acrylic wall coating capable of achieving a uniform textured stucco effect, containing marble aggregate, fine pigments and fillers. Comply with the following:
   1. Particle Size: 2.0 millimeter.
   2. Color: Complete selection of manufacturer's standard and custom colors. ENGINEER shall select a maximum of 5 different colors or tones.
   3. Texture: Textured stucco effect. Final exact texture to be selected by ENGINEER from manufacturer's complete selection of available textured finishes.
   4. Weather Resistance: Extremely resistant.
   5. Hardness: Very resistant to mechanical stress. Scratch and impact resistant.
   6. Flexibility: Very flexible; capable of bridging normal shrinkage cracks.
   7. Manufacturer's of "or equal" products and systems shall provide exactly the same complete selection of standard and custom colors and textures as the manufacturer specified.
   8. Product and Manufacturer: Provide the following:
      a. STOLIT by STO Energy Conservation Incorporated.

G. Track System: Provide the following:
   1. Manufacturer's recommended plastic holding-frame system consisting of 96-inch long horizontal tracks and 22-inch long vertical splines.
   2. Manufacturer's suggested metal hit anchors minimum 1/4-inch diameter and 2-inches long. Provide stainless steel nail for hit anchors.

H. Miscellaneous Materials: Provide the following:
   1. Sheathing Dowels: Plastic, wing-tipped type fasteners with a thermal cap to prevent uneven thermal and vapor diffusion.
   2. Concrete Block Dowels: Plastic expansion type anchors with a thermal cap to prevent uneven thermal and vapor diffusion.
   3. Water: Free from injurious amounts of impurities and potable.
   4. Portland Cement: ASTM C 150, Type I.

2.2 MIXES

A. Stir co-polymer based adhesive, ground coat and leveler following manufacturer's written instructions, prior to the addition of Type I portland cement.

B. Add 20 percent portland cement by weight to co-polymer based adhesive, ground coat and leveler.

C. Batch material as recommended by the manufacturer and add premeasured amounts of portland cement slowly to co-polymer based adhesive, ground coat and leveler material.

D. Anti-freeze, acclerators and rapid binders shall not be approved.

E. Primer: Mix thoroughly with 10 percent by weight of clean water.

2.3 FABRICATION

A. Product and Manufacturer: Provide the following:
   1. Heavy-duty exterior insulation systems by STO Energy Conservation Incorporated.

B. Fabricated System Physical Properties: Provide the following:
   1. Structural Load Testing of Mechanically Fastened System, ASTM E 330 and ASTM E 72: 40 psf negative pressure with no apparent damage or failure.
   2. Mildew Resistance, MIL 80B: No growth of mildew.
   3. Rain Test, MIL E5272: No weight gain or other deleterious effects.
   4. Accelerated Weathering, Federal Test Standard 141 Method 6151: 2000 hours, no change.
   5. Abrasion Resistance, ASTM D 968: 500 liters, no deleterious effects.
   6. Salt Spray Resistance, ASTM B 117: 300 hours, no deleterious effects.
   7. Impact Resistance, ASTM E 72: No cracks.

C. Custom fabricate exterior wall insulation and finish system to provide all arrises, returns, reveals and architectural features shown on the Drawings. Comply with allowable tolerances specified.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates to receive exterior wall insulation and finish system Work, and the conditions under which the Work is to be performed, and notify ENGINEER in writing of any conditions detrimental to the proper and timely completion of the Work and preformance of the exterior wall insulation and finish systems. Do not proceed with the exterior wall insulation and finish systems Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Prime and seal all exterior grade plywood sheathing with primer specified and coordinate fastener selection, adhesives and finishes as required by exterior wall insulation and finish system manufacturer.

B. Prime all concrete unit masonry, portland cement plaster and cast-in-place concrete using specified primers following manufacturer's written instructions.

C. Tint primers to match finish color of wall following manufacturer's written instructions.

3.3 INSTALLATION

A. General: General rules for application of finishes shall be as follows:
   1. Using a clean rust free high speed mixer, thoroughly stir finish to a uniform consistency (small amounts of clean water may be added to aid workability).
   2. Avoid application in direct sunlight.
   3. Apply finish in a continuous application always working to a wet edge.
   4. Finish may be applied over calk joints, but not over expansion joints.
   5. Apply aggregate and textured finish coats following manufacturer's printed instructions.

B. Over all primed and sealed substrate not shown as receiving insulation board:
   1. Level specified ground coat and embed standard reinforcing mesh into the wet ground coat.
   2. Overlap mesh seams a minimum of 2-1/2-inches and smooth surface with a large stainless steel trowel. Allow to dry 24 hours.
   3. Apply ground coat primer, tinted to match the finish coat, over the entire surface receiving the finish coat at the rate of approximately 0.05-0.06 pounds per square foot or more as required to visually eliminate construction joints. Let dry thoroughly before applying finish coat.
   4. Apply finish coat to provide colors and textures approved by ENGINEER using a clean plastic trowel following manufacturer's written instructions.

C. Over all primed and sealed substrates shown as receiving insulation board:
   1. Level uneven surfaces using specified ground coat.
   2. Apply standard reinforcing mesh starter strip to the substrate at base line the termination of expanded polystrene board using specified ground coat material and following manufacturer's written instructions.
   3. Provide starter strip wide enough to adhere 4-inches of mesh onto the substrate, and be able to wrap around board edge and cover approximately 4-inches on the outside surface of the expanded polystrene board. Follow this procedure at all exposed expanded polystrene board edges.

4. Using specified adhesive apply adhesive to the back of the expanded polystrene board using a 5/8-inch notched trowel. Provide uniform ribbons of adhesive applied horizontally with the building walls.
5. Place expanded polystrene board horizontally on the walls starting from a level base line. Stagger vertical joints and interlock polystrene board at all inside and outside corners.
6. Apply firm pressure over entire surface of the boards to insure uniform contact. Sufficient pressure must be applied to flatten the ribbons of adhesive to result in a minimum of 50 percent adhesion.
7. Butt all joints tightly together to eliminate all thermal breaks. Prevent adhesive from getting between joints of expanded polystrene board. Allow adhesive to cure as recommended by the manufacturer.
8. All open joints in the expanded polystrene board layer shall be filled with an approved spray foam.
9. Rasping of the expanded polystrene board surface shall be required to achieve a smooth even surface, remove possible ultraviolet ray damage, meet tolerances specified, and to provide architectural features shown on the Drawings.
10. At all areas where the exterior wall insulation and finish system Work meets dissimilar material or terminates cut back the expanded polystrene board from the adjoining material a minimum of 1/4-inch to form a calk joint and calk so that no water can penetrate through or behind the system. Follow manufacturer's applicable printed details. Prior to sealant installation all expanded polystrene board edges shall be coated with ground coat and exterior wall insulation and finish coat and manufacturer's recommended primer.
11. Ground coat material shall be stirred to a uniform consistency. Apply ground coats, using a stainless steel trowel, to a uniform thickness of approximately 1/8-inch each. Work horizontally or vertically in strips of 40 inches, and immediately imbed the heavy duty reinforcing mesh into the wet ground coat. While ground coat is still wet, totally embed the heavy duty reinforcing mesh and feather out seams and edges. The finish thickness of the ground coat shall be such that the heavy duty reinforcing mesh is fully embedded yet mesh outline may be visible.
12. Do not overlap heavy duty reinforcing mesh. Tightly abut mesh with gaps no greater than 1/8-inch at seams. Allow to dry before applying standard reinforcing mesh.
13. Using a stainless steel trowel apply another layer of specified ground coat material over the cured heavy duty reinforcing mesh application to a uniform thickness of 1/16-inch. Work horizontally or vertically in strips, 40 inches and immediately embed the standard fiberglass of mesh into this wet ground coat. Mesh shall be double wrapped at all corners and overlapped not less than 2-1/2 inches at mesh joints. Avoid wrinkles in the mesh. The finish thickness of the ground coat shall be such that the reinforced fiberglass mesh is fully imbedded yet mesh outline may be visible. Allow ground coat to thoroughly dry before applying finish. Apply finish coat directly over the ground coats with primer, only after the ground coat has thoroughly dried to provide colors and textures approved by the ENGINEER. Finish shall be applied by troweling using a clean plastic trowel, depending on finish specified as recommended by the manufacturer.

14. Apply tinted ground coat primer specified before finish coat Work begins. Follow manufacturer's written instructions.

D. Mechanically Fastened Track System:
   1. Establish a horizontal line at the base of the substrate. Install starter track using manufacturer's recommended fasteners 12 inches on center.
   2. Apply 24-inch by 24-inch grooved rigid board insulation into tracks by aligning grooves with track flanges.
   3. Install vertical splines between rigid boards.
   4. For second row install horizontal holding tracks into grooves on top edge of first row and fasten holding tracks to substrate with manufacturer's recommended fasteners 12 inches on center. Stagger vertical joints in rigid insulation such that joint above is at center of rigid board below.
   5. Correct uneveness by using plastic shims at track fastener locations.
   6. Butt all rigid board insulation joints tightly to eliminate thermal breaks. Fill all open joints with manufacturer's recommended spray foam.
   7. Install stucco and reinforcings as specified in 3.3.C above.

E. Mechanical Fasteners: Provide the following:
   1. Where recommended by manufacturer for substrate conditions encountered install mechanical fasteners as recommended by the manufacturer.
   2. Spacing and selection of fasteners shall be as recommended in manufacturer's written installation instructions.

F. Install backer rod (25 percent compression) in calk joint openings to provide a depth equal to the width of the joint. Install a manufacturer's approved sealant and tool flush with the ground coat surface. Allow sealant to set per manufacturer's specifications prior to applying finish coat.

G. Expansion Joints: The exterior wall insulation and finish system Work does not require control or expansion joints except when the substrate has an existing control joint, expansion joint, or live building crack, or where the system is applied to dissimilar substrates. These joints shall extend through the full thermal system and shall be calked with a approved expansion joint sealant against a backer rod. On expansion joints, the reinforcing fiberglass mesh and ground coat shall completely wrap the edges of the insulation board so that the expansion joint calk is not in direct contact with the insulation board.

3.4 ADJUSTMENT, CUTTING AND PATCHING

A. Cut, patch, and repair exterior wall insulation system and finish coat Work as required and as necessary to accommodate and provide acceptable substrate for other work. Repair cracks and indented surfaces. Point-up finish surfaces around items which are built into or penetrate exterior wall insulation system and finish coat Work.

B. Repair or replace the Work to eliminate blisters, buckles, check cracking, dry outs, excessive pinholes, and similar imperfections. Repair or replace the Work as necessary to comply with specified tolerances and required visual effects.

C. Protect exterior wall insulation and finish system Work so as to be clean and undamaged at the time of Final Acceptance.

D. ENGINEER may require additional finish coats if, in the opinion of ENGINEER, the finish is inconsistent in color, texture, or has holidays, areas of unusual porosity or other imperfections.

E. Only the installer shall repair or replace deteriorated or defective Work.

F. Clean the exterior wall insulation and finish system Work as recommended by the manufacturer.

3.5 CLEANING AND PROTECTION

A. Remove temporary covering and whatever other provisions were made to minimize spattering of ground, primer and finish coats on other work. Promptly remove ground primer and finish coats from surfaces which are not to be finished as part of the Work of this Section. Repair surfaces which have been stained, marred or otherwise damaged during the exterior wall insulation and finish system Work. When exterior wall insulation and finish system Work is completed, remove unused materials, containers, and equipment and other debris caused by the Work of this Section.

B. Protect exterior wall insulation and finish system Work from deterioration and damage during remainder of construction period.

+ + END OF SECTION + +

SECTION 7D2

CLAY ROOFING TILES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all clay roofing tile Work.
   2. The extent of clay roofing tile Work is shown.
   3. Clay roofing tile Work required includes, but is not necessarily limited to, the following:
      a. Clay straight barrel mission roofing.
      b. Roofing felt, asphalt, mortar and similar items required to complete the Work.
      c. Miscellaneous specialty shop fabricated clay tile shapes.
      d. Twisted wire tie clay roofing tile fastening system and other fasteners, wind lock clips and incidentals.
      e. Miscellaneous underlayments, fasteners, clay trim and clay closure shapes and other accessories.

B. Coordination:
   1. Review installation requirements and procedures under other Sections and coordinate with work that is related to this Section.
   2. Coordinate installation of required wood nailing strips, and blocking for acceptable installation.

C. Related Sections:
   1. Section 6A, Rough Carpentry.
   2. Section 7F3, Elastic Sheet Roofing.
   3. Section 7H1, Flashing and Trim.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer who is a recognized roofing contractor, skilled and experienced in the type of roofing specified, and equipped to perform workmanship in accordance with recognized standards so that there will be undivided responsibility for the performance of the Work.

B. Design Criteria:
   1. Except as otherwise shown, comply with recommendations of the clay roofing tile manufacturer.
   2. Clay roofing tile felt underlayments and flashings shall be permanently watertight, and shall not deteriorate in excess of manufacturer's published limitations.

C. Requirements of Regulatory Agencies: Comply with applicable requirements as required by the Uniform Building Code, unless more restrictive requirements are specified.

D. Source Quality Control: Obtain clay roofing tile from only one manufacturer, who publishes complete information on the specified roofing system, and offers to guarantee the completed roofing installation as required.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C 144, Aggregate for Masonry Mortar.
   2. ASTM C 270, Mortar for Unit Masonry.
   3. ASTM D 312, Asphalt for Use in Constructing Built-up Roof Coverings.
   4. ASTM D 3378, Asbestos Base Sheet for Use in Construction of Built-Up Roofs.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Adequate quantity of clay roofing tiles to establish complete color range of flame flashed clay roofing tiles.
   2. Each piece of the roof tile fastening and hold-down system to be used in the Work.
   3. ENGINEER'S review will be for color and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of Shop Drawings showing completely dimensioned and coordinated roof plans and details of construction and erection, including all flashings and special shapes required.
   2. Manufacturer's specifications indicating product information correlated to specified requirements, manufacturer's installation instructions, maintenance instructions and other data as may be required by ENGINEER.

C. Certifications: Submit certifications as specified.

D. CONTRACTOR'S Review: Accompanying approval request, submit to ENGINEER a written statement signed by CONTRACTOR and the roofing and flashing installer, stating that the Drawings and Specifications for roofing and flashing have been reviewed with an agent of the roofing material manufacturer and that he is in agreement that the selected systems are proper, compatible and that the details shown are not in conflict with the roofing manufacturer's roofing and flashing details. Show by copy of transmittal form that a copy of the statement has been transmitted to the manufacturer.

E. Statement of Application: Upon completion of the Work, submit a statement to ENGINEER signed by CONTRACTOR and clay roofing tile installer stating that the Work complies with the requirements of these Specifications and the installation methods comply with the manufacturer's printed instructions and were proper and adequate for the condition of installation and use.

F. Guarantee: CONTRACTOR shall execute his own written guarantee direct to OWNER warranting all clay roofing tile and flashing weather and watertight and perfect for a period of two years after date of conditional

acceptance thereof by OWNER. Imperfections, by reason of defective materials, workmanship or arrangement of the various parts shall be made good to the satisfaction of OWNER at CONTRACTOR'S expense.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Transport and deliver tiles on manufacturer's original pallets and in a manner to avoid physical damage.
   2. Clearly identify manufacturer, trade name, style and color of palletized material.
   3. Deliver setting materials in original containers with manufacturer's labels intact and legible.
   4. Deliver fasteners in manufacturer's original, unopened containers clearly identifying manufacturer and the contents.
   5. Deliver underlayment in original, undamaged wrapping with manufacturer's label describing material and a trade name in legible condition.

B. Storage of Materials:
   1. Tiles:
      a. Stack palletized tiles not more than two pallets high.
      b. Stack loose tile on butt end on blocking and straight as possible in level rows not more than two tiles high.
      c. Do not store tiles in flat position.
   2. Store rolls of underlayment on ends and protect from the weather.
   3. Store cementitious materials in weathertight spaces; keep free from moisture.
   4. Aggregate:
      a. Store in well drained area to minimize change in moisture content.
      b. Prevent contamination by other materials.
   5. Store fasteners in original, unopened containers until used.
   6. Protection:
      a. Cover stored materials with tarpaulin or other suitable covering to prevent soiling or exposure to weather.
      b. Fasten coverings to prevent removal by wind.

C. Handling of Materials: Do not stack tiles on roof in quantities exceeding six tiles high on 12 inch centers at every third course on slope.

1.5 JOB CONDITIONS

A. Scheduling:
   1. Do not proceed with the clay roofing tile Work until substrate construction, wood nailing strips, blocking, flashings and other construction to receive the Work of this Section is completed.
   2. Schedule the installation of flashing and trim to coincide with the installation of the clay tile roofing. Coordinate the Work with Section 7H1, Flashing and Trim.
   3. Do not proceed with the Work until all material required for the Work is at the project site and has been prepared for use.

B. Weather Condition Limitations:
   1. Proceed with clay roofing tile and associated Work only when weather conditions will permit unrestricted use of materials and quality control of the Work, complying with the requirements and recommendations of the roofing materials manufacturers.
   2. Proceed only when the installer is willing to guarantee the Work as required and without additional reservations and restrictions.
   3. Do not set clay roofing tiles in mortar when the ambient temperature is less than 40 F or when such temperature is expected within 24 hours.
   4. Do not start setting clay roofing tiles until other trades have completed work requiring traffic on or across roof surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Clay Roofing Tiles: Provide clay tiles manufactured from hard burned clay or shale complying with the following:
   1. Type: Straight Barrel Mission.
   2. Size: 18-inches long by 8-inches wide by 1/2-inch thick.
   3. Weight: 1060 pounds per square minimum; 1220 pounds per square maximum.
   4. Color, all Clay Roofing Tiles and Special Shapes: Flame flashed red. Provide a natural, integral flame flash finish.
   5. Texture: Smooth.
   6. Special Shapes: Complete selection of manufacturer's hard burned clay barrel roll ridge caps, end band rakes, eave closures, booster tiles and top fixtures as required to complete the Work. Provide all special shapes as required for a complete installation as determined by ENGINEER.
   7. Water Absorption: 15 percent maximum.
   8. Breaking Strength, Individual Tiles: 1000 pounds minimum.
   9. Product and Manufacturer: Provide one of the following:
      a. No. 8 Mix Cordova Clay Mission Roofing by Gladdings, McBean & Company, Division of Pacific Coast Building Products Incorporated.
      b. Red Fireflash Clay Mission Roofing by Ludowici-Celadon Division of CSC Incorporated.
      c. Or equal.

B. Clay Roofing Tile Underlayment:
   1. Non-perforated, heavy weight asphalt coated fiberglass base sheet, fully coated both sides.
   2. Product and Manufacturer: Provide one of the following:
      a. GAFGLAS #75 Base Sheet by GAF Corporation.
      b. Or equal.

C. Asphalt: Provide the following:
   1. ASTM D 312, Type IV; softening point 220 F.
   2. Asphalt Quality: Provide only virgin residual petroleum-process asphalt, which has not been modified by the addition of softening oils or other compounds to modify the softening point, and which has been accurately air-blown (oxidized) to establish the required softening point.

D. Fasteners:
   1. Provide the following for clay roofing tile underlayment:
      a. Provide industry standard type of stainless steel nails with minimum pull-out strength of 40 pounds.
      b. Provide either self-capped nails with flat caps minimum 1- inch in diameter or separate nailing discs of 30 gage galvanized sheet metal approximately 1-3/8-inch in diameter, formed to prevent dishing.
      c. Provide annular ring or spiral groove type mails with 12 gage shank, of sufficient length to penetrate plywood deck.
   2. Provide the following for clay roofing tiles:
      a. Provide a clay roofing tile fastening and hold-down system which is approved by the Uniform Building Code and which results in a minimally penetrated roofing membrane while locking together the rows of tiles to prevent wind damage, earthquake damage or shifting of clay roofing tile from other causes.
      b. Provide a system of twisted 0.084-inch diameter stainless steel wire ties 18 gage brass wood deck anchors and 10 gage copper nails of sufficient length to penetrate the substrate 3/4-inch. Provide individual tie wires of 0.037-inch stainless steel.
      c. Wind Lock Clips: 10 gage by 1/2-inch brass; 2-inch head lap.
      d. Product and Manufacturer: Provide one of the following:
         1) Twisted Wire Tyle-Tye System by Newport Fastener Company, Incorporated.
         2) Or equal.

E. Mortar: ASTM C 270, Type O; Integrally colored to match final clay tile colors.

F. Sand: ASTM C 144.

G. Water: Potable.

2.2 FABRICATION

A. Shop fabricate all clay roofing tile shapes.

B. Provide preformed clay straignt barrel mission S-tile with holes for ties before firing.

C. Provide complete selection of all clay closure and trim shape as available from manufacturers specified.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and the conditions under which the clay roofing tile Work is to be performed, and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Certify, in writing, to ENGINEER that all through wall metal flashings, other flashings and wood nailers and blocking have been properly installed to provide acceptable clay tile roofing Work.

C. Commencement of Work shall indicate acceptance of the substrate and interface conditions by CONTRACTOR and installer and of the completed Work to receive guarantee as specified.

3.2 PREPARATION

A. Clean the substrate of dust, debris, substances and interferences detrimental to the Work.

B. Clay Roofing Tile: Where clay roofing tile is shown or specified to come in contact with mortar comply with the following:
   1. Immerse clay roofing tiles in water as recommended by the manufacturer of the clay roofing tiles.
   2. Use wetting methods which ensure that each clay roofing tile is nearly saturated but surface dry when laid.
   3. Lay remainder of field tiles dry.

3.3 INSTALLATION

A. Felt Underlayment:
   1. Starting at low end of roof with an 18 inch width of felt lay a single thickness of underlayment felt parallel to eaves with double thickness at hips and ridges. Install following felts at full width.
   2. Lap horizontal joints 2-1/2 inches and vertical joints 6 inches with vertical joints staggered.
   3. Nail felts at 9 inch centers and down the longitudinal center of each felt nail two rows of nails with rows spaced approximately 11 inches apart and nails staggered on approximately 18 inch centers and along edges and 19 inches staggered throughout the field.
   4. Fasten felt to imbedded nailers using nails.
   5. Extend felt up 6 inches at abutting vertical walls and parapets.
   6. Lap felt not less than 4 inches under edges as built-in gutters, valleys, and metal flashings.
   7. Starting at the low end of roof embed second ply of felt full width in bed of hot asphalt applied at the rate of 25 pound per square. Overlap subsequent plies by 19 inches and embed in hot asphalt.
   8. Nail adjacent to the top of each second ply at 12 inches on centers. Blind nail laps on 3 inch centers staggered.

B. Metal Flashings: See Section 7H1, Flashing and Trim.

C. Clay Roofing Tiles:
   1. Mark underlayment with chalk lines parallel to eaves, spaced to provide uniform courses with not less than 3 inch head lap.
   2. Lay eave starters to project beyond edge of sheathing as indicated and secure in place.
   3. Install twisted tie lines using manufacturer's written instruc-

tions, and Shop Drawings. Use all fasteners, anchors and hold- down clips specified. Locate anchors along twisted tie at ridge, eave and midpoint of wire length. After fastening wood deck anchors bend over tabs through loop of twisted wire and cover with roofing mastic.

4. Lay tiles so butt edges form straight lines, parallel to eaves.
5. Secure clay tiles to twisted wire with individual wire ties. Pass wire through hole of the tile, secured on itself with a double twist and then secured to a loop at least one full space above the tile top. Install one windlock clip for each tile secured by individual wire tie.
6. Set first row of tops after gable roll in cement mortar. Double cover tiles at eaves using a booster tile set in cement mortar.
7. Where tile joins hips and ridges, fill voids with cement mortar. Cap hips and ridges with cover tiles and point neatly with cement mortar.
8. Clean mortar from exposed surfaces of tiles immediately using sponge and clean water.
9. Form open valleys 5 inches wide at the top and increase in width at the rate of 1 inch per 8 foot of valley.
10. Where tiles overlap metal flashings, fasten tiles to deck using stainless steel wire and daubs of roofing cement.
11. Where field cutting of tile is necessary comply with the following:
    a. Cut tile accurately as necessary to produce needed shapes.
    b. Cut using a power driven saw, equipped with a carbide or diamond tipped blade.

3.4 PROTECTION

A. Protect other Work from spillage or splatter of roofing materials. Replace other work which is soiled or otherwise damaged by the performance of the clay roofing tile and associated Work.

B. Upon completion of Work, remove excess materials and broken tiles from the project site.

3.5 FINAL ACCEPTANCE

A. Only the original installer shall repair or replace deteriorated or defective Work.

B. Replace broken or unacceptable Work, as determined by ENGINEER, at no additional expense to OWNER.

+ + END OF SECTION + +

SECTION 7F3

ELASTIC SHEET ROOFING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all elastic sheet roofing Work.
   2. The extent of elastic sheet roofing is shown.
   3. Elastic sheet roofing Work required includes, but is not necessarily limited to, the following:
      a. Loosely applied elastomeric roofing with ballast.
      b. Walkway protection pavers.
      c. Elastomeric base flashing and finish coat.
      d. Miscellaneous specialty elastomeric shop fabrications and incidentals.
      e. Miscellaneous materials.

B. Coordination:
   1. Review requirements and procedures under other Sections and coordinate with work that is related to this Section.

C. Related Sections:
   1. Section 7C8, Roof Insulation.
   2. Section 7H1, Flashing and Trim.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer who is a recognized roofing contractor, skilled and experienced in the type of roofing specified, and equipped to perform workmanship in accordance with recognized standards so that there will be undivided responsibility for the performance of the Work. The roofing installer shall be an approved roofing applicator who has qualified for appointment and has been trained by the manufacturer. Submit proof of acceptability of installer by manufacturer to ENGINEER.

B. Design Criteria:
   1. Except as otherwise shown, comply with recommendations of the roofing manufacturer.
   2. Elastic sheet roofing, base and other flashings shall be permanently watertight, and not deteriorated in excess of manufacturer's published limitations.

C. Requirements of Regulatory Agencies:
   1. Comply with applicable insurance rating bureau requirements as required by the Uniform Building Code, unless more restrictive requirements are specified.

2. Provide materials and roofing systems which have been tested listed and labeled by Underwriter's Laboratories Incorporated for Class "A" rating, and bear the UL label on each package or are shipped to the project with a UL certificate of compliance.
3. Provide materials and roofing systems which have been tested, listed and FM labeled for class "1" rating.

D. Source Quality Control: Obtain elastic sheets from only one manufacturer, who publishes complete information on the specified roofing system, and offers to guarantee the completed roofing installation as required.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM D 312, Asphalt for Use in Constructing Built-up Roof Coverings.
2. ASTM D 395, Tests for Rubber Property-Compression Set.
3. ASTM D 412, Tests for Rubber Properties in Tension.
4. ASTM D 471, Test for Rubber Property-Effects of Liquid.
5. ASTM D 542, Tests for Index of Refraction of Transparent Organic Plastics.
6. ASTM D 573, Test for Rubber Deterioration in an Air Oven.
7. ASTM D 624, Test for Rubber Property - Tear Resistance.
8. ASTM D 746, Test for Brittleness Temperature of Plastics and Elastomers by Impact.
9. ASTM D 1149, Test for Rubber Deterioration - Surface Ozone Cracking in a Chamber (Flat Specimens).
10. ASTM D 2240, Test for Rubber Property - Durometer Hardness.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Copies of Drawings showing completely dimensioned plans and details of construction and erection including all flashing details coordinated with Section 7H1, Flashing and Trim, all roof penetration locations, roof penetration details and all paver patterns and mechanical clip locations.
2. Manufacturer's specifications indicating product information correlated to specified requirements, manufacturer's installation instructions, maintenance instructions and other data as may be required by ENGINEER.

B. CONTRACTOR'S Review: Accompanying approval request, submit to ENGINEER a written statement signed by CONTRACTOR and the roofing and flashing installer, stating that the Drawings and Specifications for roofing and flashing have been reviewed with an agent of the roofing material manufacturer and that he is in agreement that the selected systems are proper, compatible and that the details shown are not in conflict with the roofing manufacturer's roofing and flashing details. Show by copy of transmittal form that a copy of the statement has been transmitted to the manufacturer.

C. Statement of Application: Upon completion of the Work, submit a statement to ENGINEER signed by CONTRACTOR and roofing installer stating that the Work complies with the requirements of these Specifications and the installation methods comply with the manufacturer's printed instructions and were proper and adequate for the condition of installation and use.

D. Guarantee:
   1. CONTRACTOR shall execute his own written guarantee direct to OWNER warranting all roofing and flashing weather and watertight and perfect for a period of two years after date of conditional acceptance thereof by OWNER. Imperfections, by reason of defective materials, workmanship or arrangement of the various parts shall be made good to the satisfaction of OWNER at CONTRACTOR'S expense.
   2. In addition to above CONTRACTOR shall provide OWNER with manufacturer's standard 10 year warranty.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's standard unopened packages and containers.

B. Comply with manufacturer's instructions for storage and handling.

1.5 JOB CONDITIONS

A. Scheduling:
   1. Do not proceed with the base flashing and elastic roofing Work until curb and substrate construction, blocking and other construction to receive the Work of this Section is completed.
   2. Schedule the installation of base flashing and trim to coincide with the installation of the elastic sheet roofing. Coordinate the Work with Section 7H1, Flashing and Trim.

B. Weather Condition Limitations: Proceed with roofing and associated Work only when weather conditions will permit unrestricted use of materials and quality control of the Work, complying with the requirements and recommendations of the roofing materials manufacturer. Proceed only when the installer is willing to guarantee the Work as required and without additional reservations and restrictions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ethylene Propylene Diene Monomer Synthetic Rubber Sheeting: Provide black synthetic rubber sheeting. Comply with the following:
   1. Thickness:
      a. 0.060-inches for base flashings.
      b. 0.060-inches for loosely applied system.
   2. Hardness Durometer A, ASTM D 2240: 60 ±10 points.
   3. Tensile Strength, ASTM D 412: 1305 pounds per square inch minimum.
   4. Elongation at Break, ASTM D 412: 250 percent minimum at 75 F.
   5. Brittleness Temperature, ASTM D 746: -75 F.
   6. Tear Resistance, ASTM D 624: 175 pounds per linear inch minimum.
   7. Flame Resistance, ASTM D 542: No flame.
   8. Resistance to Heat Aging, Change in Original Properties after 70 hours at 212 F, ASTM D 573: Hardness +10 points maximum, Elongation -40 percent maximum, Tensile Strength -15 percent maximum.

9. Resistance to Oil Aging, Change in Volume after 70 hours Immersion in ASTM No. 33 oil at 212 F, ASTM D 471: +80 percent.
10. Resistance to Ozone, Condition after Exposure to 100 ppm Ozone in Air for 100 hours at 100 F, ASTM D 1149: No cracks.
11. Resistance to Permanent Set, Compression Set after 22 hours at 158 F, ASTM D 395: +10 percent maximum.
12. Resistance to Water, Change in Weight after 7 days Immersion at 158 F, ASTM D 471: 1.48± .05 Specific Gravity.

B. Liquid-applied Chlorosulfinated Polyethylene: Supplied as a finish coat, complying with the following:
1. Resistance to Ozone, 50 percent Elongation, 3 ppm for one week at 104 F, ASTM D 1149: No cracks visible (7X magnification).
2. Solids Content: 25 percent by volume, or 35 percent by weight.
3. Low Temperature Brittleness, ASTM D 746: -40 F.

C. Ballast: Smooth, rounded, river washed stone from 3/4-inch to 1-1/2-inch in diameter applied at the rate of 1,000 pounds per square, spread evenly over the surface without adhesive. Provide granite or other stone capable of withstanding exposure without deterioration.

D. Walkway Protection Pavers: Provide the following:
1. 1-1/2-inches thick by 11-3/4-inches wide by 16-1/2-inches long; interlocking extruded 5000 pounds per square inch precast concrete pavers weighing 12 pounds per square foot maximum.
2. Provide water absorption less than 5 percent by weight.
3. Density: 145 pounds per cubic foot.
4. Pavers shall exhibit integral bi-directional drainage capabilities, with 25 percent bearing area minimum and not requiring the use of separate pedestals or other point supports.
5. Complete selection of manufacturer's recommended 20 gage aluminum alloy mechanical clips and anchor materials.
6. Product and Manufacturer: Provide one of the following:
   a. Ballast Pavers by Westile Incorporated.
   b. Or equal.

E. Ventilation Domes: Provide the following:
1. Product and Manufacturer: Provide one of the following:
   a. Lexsuco OWV Roof Vent by B.F. Goodrich, Incorporated.
   b. Or equal.

F. Miscellaneous Materials: Provide the following:
1. Bonding Adhesive: Neoprene contact type.
2. Splicing Cement: Neoprene.
3. Lap Sealant: Self curing, gun-type.
4. Sealer Tape: Neoprene.
5. Deck Primer: As recommended by sheet manufacturer.
6. Asphalt: ASTM D 312, Type II (flat). Softening Point: 160F-175F.
7. Protection Board: As recommended by the roofing manufacturer for use beneath walkway protection pavers.

G. Product and Manufacturer (Loosely applied with ballast): Provide one of the following:
1. "Sure-Seal" Design "B" by Carlisle Syn Tec Systems Division of Carlisle, Corporation.
2. Or equal.

2.2 FABRICATION

A. Shop fabricate all special flashings shown using sheeting specified.

B. Use manufacturer's standard sheet seaming system for "plastic welding" or lapped joints to create seams of strength equal to sheet strength.

C. Include edge sealer to cover exposed sheet edges.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and the conditions under which the roofing and base flashing Work is to be performed, and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER. Commencement of the Work shall mean acceptability of the substrate and interface conditions by the installer and CONTRACTOR.

3.2 PREPARATION

A. Clean the substrate of dust, debris, substances and interferences detrimental to the Work. Where necessary to remove sharp projections, concrete surfaces shall be ground.

B. Fill voids, joints and rough areas in the substrate with elastomeric sealant or other underlayment compound recommended by the sheet manufacturer.

C. Test the substrate for excessive moisture as recommended by the roofing manufacturer.

3.3 INSTALLATION

A. General
   1. Begin installation only in the presence of the roofing manufacturer's technical representative.
   2. Cut sheets to the maximum size possible, in order to minimize seams and to accommodate contours of the deck.
   3. Lap sheets and bond joints using the seaming system recommended by the manufacturer.
   4. Cover top edges of each sheet at seams with uniform fillet of special sealant.
   5. Install ventilation domes as recommended by the roofing manufacturer.

B. Loose Laid Ballast System:
   1. Bond elastic sheet roofing to vertical surfaces at edges of the membrane and at penetrations through the membrane. CONTRACTOR shall bond the membrane into rain drainage work. Apply matching adhesive tape where recommended to reinforce the attachment.

2. Install flashings. Apply ballast course in uniform thickness, at rate of 1,000 pounds per square, exercising extreme care to minimize possibility of damage to membrane.
3. Install walkway protection pavers in modified bond configuration with mechanical clips to provide 90 pound uplift capabilities with 80 mile per hour wind resistance. Use protection layer as recommended by elastic sheet roofing manufacturer.
4. Apply chlorosulfinated polyethylene to all flashings extending above the ballast course.

3.4 PROTECTION

A. Protect other work from spillage of roofing materials, and prevent materials from entering and clogging drains and conductors. Replace other work which is soiled or otherwise damaged by the performance of the roofing and associated Work.

3.5 FINAL ACCEPTANCE

A. Only the original installer shall repair or replace deteriorated or defective Work.

+ + END OF SECTION + +

SECTION 7H1

FLASHING AND TRIM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all flashing and trim Work.
   2. The extent of the flashing and trim is shown and specified.
   3. The types of flashing and trim Work required includes, but is not necessarily limited to, the following:
      a. Flashing and counterflashing at penetrations in and perimeters of roofing.
      b. Metal through-wall precast concrete coping flashing.
      c. Roof louvers.
      d. Base, drip, valley and counterflashing.
      e. Exposed cap flashing reglets.
      f. Screened continuous under-eave soffit-louver-strips.
      g. Miscellaneous flashings not supplied by other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the flashing and trim Work.

C. Related Sections:
   1. Section 4C1, Unit Masonry Construction.
   2. Section 6A, Rough Carpentry.
   3. Section 10C, Louvers and Vents.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer for metal through-wall flashing who is a recognized sheet metal contractor, skilled and experienced in the type of flashing and trim Work required, and equipped to perform workmanship in accordance with recognized standards so that there will be undivided responsibility for the performance of the metal through-wall flashing Work.

B. Design Criteria:
   1. Except as otherwise shown or specified, comply with the recommendations and instructions of the manufacturer of the flashing and trim Work being installed.
   2. Mansard ventilation system shall be designed to supply 1 square inch of free air ventilation for each 2.08 square feet of attic floor area. Provide 60 percent of ventilation at eaves and 40 percent of ventilation at roof peak. Provide minimum quantities of each item specified to meet this criteria based on Shop Drawing data of manufacturer selected.
   3. Flashing and trim Work shall be permanently watertight, and not deteriorate in excess of manufacturer's published limitations.

C. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.
   1. Aluminum Association, Designation System for Aluminum Finishes.
   2. ASTM B 29, Pig Lead.
   3. ASTM B 32, Solder Metal.
   4. ASTM B 117, Salt Spray (F06) Testing.
   5. FS O-F-506C, Flux, Soldering, Paste and Liquid.
   6. FS SS-C-153, Cement, Bituminous, Plastic.
   7. FS QQ-L-201, Lead Sheet.
   8. SSPC - Paint 12, Specification for Cold-Applied Solvent Type Bituminous Mastic Coating.

1.3 SUBMITALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications, installation instructions and general recommendations for flashing and trim Work required. Include manufacturer's data substantiating that the materials comply with the requirements.
   2. Complete Shop Drawings showing all flashing and trim details coordinated with adjacent Work.
   3. Complete Shop Drawings for under-eave soffit-louver-strips, insulation baffles, roof louvers and attic ventilation calculations as specified.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Deliver flashing and trim materials in manufacturer's original, unopened containers and rolls with labels intact and legible.

B. Storage of Materials:
   1. Store materials in an area protected from construction traffic.
   2. Store materials in same package in which they were shipped.

C. Handling of Materials: Protect flashing and trim from dents, scratches, warps or bends.

1.5 JOB CONDITIONS

A. Scheduling: Schedule the installation of flashing and trim Work to coincide with the installation of architectural precast concrete copings, preformed roof panels, soffit construction and other adjoining and substrate Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Metal Through-Wall Flashing: Provide sheet stainless steel, Type 316 complying with ASTM A 176, with No. 2D dead soft, fully annealed finish. Provide thickness of 26 gage.

B. Cap, Drip, Eave, Valley, Base and Counterflashing: Provide the following:
   1. Manufacturer's standard hard temper zinc alloy smooth sheet and strip, 0.027-inches thick, which weathers to a dark gray patina (not

an applied coating) weighing not less than 5.7×10^{-6} pounds per square inch. Provide the following physical and chemical properties:

a. Chemical Analysis:
   1) Copper: 0.7-0.9 percent.
   2) Titanium: 0.08-0.14 percent.
   3) Zinc: 0.61-0.68 percent.
   4) Other Metals:
      a) Lead: Less than 0.01 percent.
      b) Cadmium: Less than 0.01 percent.
      c) Iron: Less than 0.01 percent.
      d) Tin: Less than 0.001 percent.
      e) Total: Less than 0.10 percent.

b. Physical Properties:
   1) Tensile Strength:
      a) Rolling Direction: 21,700 pounds per square inch maximum.
      b) Transverse Direction: 29,730 pounds per square inch minimum; 35,530 pounds per square inch maximum.
   2) Creep: At 60 F and 10,150 pounds per square inch in the rolling direction creep shall not exceed 10^{-3} percent per hour.

2. Product and Manufacturer: Provide one of the following:
   a. Microzinc 80 Roof Flashing and Trim by W.P. Hickman Company.
   b. Or equal.

C. Screened Continuous Under-Eave Soffit-Louver-Strips: Provide white painted aluminum under-eave louvers with insect screening. Provide the following:
1. Size: 2-3/4-inches by 8 feet-0 inches.
2. Free Area: 92 percent.
3. Product and Manufacturer: Provide one of the following:
   a. SAL-8W by Ampcor Anderson Metal Products Company.
   b. Or equal.

D. Roof Louvers: Provide aluminum roof louvers with insect screening as follows:
1. Opening: 9-1/2-inch diameter.
2. Flashing Dimension: 16-1/2-inches by 18-inches.
3. Free Area: 50 percent.
4. Height: 4-1/4-inches.
5. Color: Gray baked enamel finish.
6. Product and Manufacturer: Provide one of the following:
   a. RVA-50 by Ampcor Anderson Metal Products Company.
   b. Or equal.

E. Exposed Cap Flashing Reglets for Stucco Finish: Provide springlock-type reglets as follows:
1. Provide microzinc 80, 0.020-inch, flange-mounted reglet with wind-lock clips, especially for stucco application. Provide manufacturer's full line of required accessories including stainless steel drive pins, neoprene washers and pads.
2. Provide microzinc 80, 0.020-inch counterflashing as specified in 2.1.B. above. Profile as shown.
3. Provide reglets without exposed fasteners of any kind.

4. Reglets shall not rely upon friction-fit for securing counterflashing into reglet.
5. Product and Manufacturer: Provide one of the following:
   a. Type ST-Stucco by Fry Reglet Corporation.
   b. Or equal.

F. Miscellaneous Materials:
1. Stainless Welding Rods: Type recommended by stainless steel sheet manufacturer for the type of metal sheets furnished.
2. Nails, Screws and Rivets: Same material as flashing sheet, or as recommended by manufacturer of flashing sheet.
3. Cleats: Same metal and gage as sheet being anchored, 2 inches wide, punched for 2 anchors.
4. Bituminous Coating: SSPC-Paint 12, cold-applied solvent-type bituminous mastic coating for application in dry film thickness of 15 mils per coat.
5. Sealants: Refer to Section 7J1, Calking and Sealants.
6. Roofing Cement: FS SS-C-153, Type I (asphaltic).

2.2 FABRICATION

A. Fabricated Metal Flashing: Shop fabricate metal flashing and trim Work to comply with profiles and sizes shown, and to comply with manufacturer's recommended details. Except as otherwise shown or specified, provide soldered flat-lock seams, and fold back metal to form a hem on the concealed side of exposed edges. Comply with metal producers' recommendations for tinning, soldering and cleaning flux from metal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and the conditions under which the flashing and trim Work is to be performed, and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with flashing and trim Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Before installing flashing and trim Work, verify shapes, and dimensions to be covered.

B. Prepare substrates as recommended by the sheet metal manufacturer.

3.3 INSTALLATION

A. General:
1. Provide thermal expansion for running trim Work, flashing and other items exposed for more than 15 feet-0 inches continuous length. Maintain a watertight installation at expansion seams. Locate

expansion seams at the following maximum spacings for each general flashing use:

a. Flashing and Trim: At 10 feet - 0 inch intervals, and 2 feet - 0 inch each side of corners and intersections.

2. Fabricate and install the Work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat flat-locked seams with minimum exposure of solder, welds and sealant. Except as otherwise shown, fold back the sheet metal to form a hem on the concealed side of exposed edges.
3. On sloping surfaces, for slopes of not less than 6 inches in 12 inches, lap unsealed flashings a minimum of 6 inches. For slopes less than 6 inches in 12 inches use soldered flat locked seams.

B. Installation of Stainless Steel Flashing: Provide welded joints. Provide upturned, 1/2-inch wide hooked flanges, and weld between adjoining sheets; lay seam flat.

C. Exposed Cap Flashing Reglets for Stucco Finish:
1. Install reglets onto masonry substrate as recommended by the reglet manufacturer.
2. Install counterflashing with positive pressure against base flashing. Provide counterflashing with positive air break at top to prevent capillary action.
3. System shall employ only mechanical interlocking features for securing counterflashing to reglet.
4. No screws or exposed fasteners shall be permitted in the finished Work.
5. Overlap counterflashing horizontally a minimum of 3 inches.
6. Overlap microzinc 80 base flashing a minimum of 4 inches vertically.

D. Roof Louvers: Install roof louvers onto plywood sheathing as stated in manufacturer's written installation instruction.

3.4 ADJUSTMENT AND CLEANING

A. Protect flashing and trim Work until Final Acceptance of the Work.

B. Do not permit workmen, or others, to step directly on flashing sheets in place, or to place or move equipment over flashing and trim surfaces. Protect surfaces during installation of permanent covering work and adjoining Work.

C. Neutralize excess flux as work progresses with 5 percent to 10 percent washing soda solution and rinse throughly.

D. Clean exposed surfaces of flashing and trim Work promptly after completion of installation, including removal of strippable coating. Comply with recommendations of flashing and trim manufacturers.

+ + END OF SECTION + +

SECTION 7I

ROOF ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all roof accessories Work.
   2. The types of roof accessories Work required includes, but is not necessarily limited to, the following:
      a. Custom fabricated double leaf equipment access roof hatch with sealed double domes skylights in each leaf.
      b. Miscellaneous standard and optional accessories.

B. Related Sections:
   1. Section 7F3, Elastic Sheet Roofing.
   2. Section 7H1, Flashing and Trim.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the roof accessories Work.
   2. Engage a firm which can show successful experience in the fabrication and erection of roof accessory systems of scope and type similar to the required Work.

B. Installer Qualifications:
   1. Engage a single installer regularly engaged in roof scuttle installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
   2. Engage a single installer for the entire roof accessories Work with undivided responsibility for performance and other requirements.

C. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as shown or specified.
   1. American Wood Preservers Bureau (AWPB) (LP-2), Softwood Lumber, Timber and Plywood Pressure Treated with Water-Borne Preservatives for Above Ground Use.
   2. ASTM A 570, Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality.
   3. ASTM B 221, Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
   4. NAAMM, Metal Finishes Manual.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval copies of manufacturer's drawings, rough-in diagrams, specifications and installation instructions for roof accessory required. Include data substantiating that products comply with the requirements.

1.4 JOB CONDITIONS

A. Coordinate the installation of roof accessories Work with roofing and flashing to obtain complete and permanent waterproof construction.

B. Conform to applicable OSHA and Uniform Building Code, latest edition requirements.

1.5 GUARANTEE

A. CONTRACTOR shall furnish a written guarantee obtained from the manufacturer of the roof hatch. Guarantee shall state the following:
   1. Roof hatch is to operate properly and be free of defects in material and workmanship for a period of five years from date of purchase.
   2. Should any part fail to function, or break in normal use during this period, manufacturer shall furnish a new part at no charge to OWNER.

PART 2 - PRODUCTS

2.1 FABRICATION, GENERAL

A. Provide manufacturer's standard products except as otherwise shown or specified.

B. Fabricate units to withstand 40 pounds per square foot live loading.

2.2 PRODUCTS

A. Custom Fabricated Double Leaf Equipment Access Roof Hatch with Sealed Double Domed Skylights in Each Leaf:
   1. General:
      a. Provide manufacturer's custom units, modified as necessary to comply with the requirements. Custom fabricate units wherever necessary for size, type and profile, using manufacturer's standard detailing to the extent applicable.
      b. Shop fabricate each unit complete with framing, gaskets, structure, curbs, flashing, well liner, hardware, accessories, anchorage provisions and other components. Disassemble only to the extent required for delivery and installation.
   2. Roof Scuttle Materials:
      a. Aluminum: Sheet and extrusions of the alloys and tempers specified by the manufacturer for strength, durability and proper application of finish.
         1) Cover and Curb: 11 gage, 6063-T5 alloy, with 3-inch beaded flange.
         2) Cover Liner: 18 gage, 3003-H-14 alloy.
         3) Custom Finish: Class I high density anodic coating, Aluminum Association Designation A41 Clear Anodized color.

b. Insulation: One inch glass fiber, between aluminum panels.
c. Gaskets: Fingered design; polyvinyl chloride.
d. Equip units with standard self-lifting mechanisms, two per leaf. Provide stainless steel hardware including hold-open dam and cover release, pintle hinges, compression spring operators enclosed in telescopic tubes, latch, and operating handles for inside and outside operation.
e. Construct units for live loading specified, using manufacturer's standard gages of metal and fabrication details. Provide fully welded construction.
f. Provide 12-inch high aluminum curbs with 1-inch thick fiberglass insulation, 3-1/2-inch flange and integral cap flashing.
g. Glazing Frame, Dome retainer, Trim: Extruded aluminum.

3. Plastic Skylights:
   a. Sheet Thicknesses: Provide 3/16-inch thick acrylic sheet except where additional thickness is required for light transmittances, or to resist 40 pounds per square foot external loading and 20 pounds per square foot internal loading pressures; comply with thickness recommendations of AAMA Bulletin No. 1601.1.
   b. Plastic: Cast acrylic with abrasion-resistant coating on exterior surface, for 2 percent maximum haze increase of 100 rev. on 500g Taber abraser (ASTM D 1044); 14,500 pounds per square inch flexural strength; 180 F (82 C) continuous service temperature.
   c. Profile: Dome double-sheet insulating units with average 1-inch minimum air space between sheets, manufacturer's standard hermetic edge seal.
   d. Color, Exterior Sheet: White translucent sheet, 50 percent light transmittance (ASTM D 1003).
   e. Color, Interior Sheet: Colorless transparent sheet.
   f. Provide sealed double dome-type skylights for all Work and maintain maximum skylight size possible considering loading and clearance for operating and support mechanisms.
4. Size: Provide units for clear opening size of 78-inches by 96-inches.
5. Product and Manufacturer: Provide the following:
   a. GD-50 Custom by The Bilco Company.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the substrates to receive roof accessories and the conditions under which the roof accessories Work is to be performed, and notify ENGINEER in writing of any conditions detrimental to the proper and timely completion of the Work and preformance of the roof accessories. Do not proceed with the Work until unstatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Separate metal surfaces of roof accessories Work from dissimilar metals, and from wood and cementitious substrates, by a thick coating of fibrated bituminous compound or other separation as recommended by the roof accessories manufacturer.

B. Bed flanges of set-on accessories in mastic or compound which is compatible with roofing and flashing.

C. Anchor roof accessories Work permanently to the substrate, by approved methods which are adequate for the sizes and locations of units.

3.3 CLEANING AND PROTECTION

A. Clean surfaces of roof accessories Work as required to prevent deterioration and uneven weathering.

B. Protect roof accessories Work from damage until Final Acceptance by OWNER.

+ + END OF SECTION + +

SECTION 7J1

CALKING AND SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all calking and sealants Work.
2. The extent of the calking and sealants is shown or specified herein.
3. The types of calking and sealant Work required includes, but is not necessarily limited to, the following:
   a. All joints between concrete unit masonry and wood.
   b. All joints between concrete unit masonry and hollow metal frames and louvers.
   c. All concrete unit masonry control joints.
   d. All metal to metal joints.
   e. All joints between wood and metal.
   f. All joints between precast concrete plank units.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the calking and sealants Work.
2. Coordinate the final selection of calking and sealants to be compatible with all calking and sealant substrates specified.

C. Related Sections:
1. Section 7C10, Exterior Wall Insulation and Finish System.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations, except as otherwise shown or specified.
1. ASTM C 510, Test for Staining and Color Change of Single or Multi-component Joint Sealers.
2. ASTM C 661, Test for Identation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
3. ASTM C 793, Test for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
4. ASTM C 794, Test for Adhesion-in-Peel of Elastomeric Joints Sealants.
5. Federal Specification, FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component for Calking, Sealing, and Glazing in Buildings and Other Structures.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval copies of manufacturer's specifications, recommendations and installation instructions for each type of sealant, calking compound and associated miscellaneous material

required. Include manufacturer's published data, indicating that each material complies with the requirements and is intended for the applications shown.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in calking and sealant manufacturer's original unopened containers.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number, color and date of manufactures.
      c. Mixing instructions, shelf life and curing time when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by ENGINEER, and his requiring its removal from the site. Supply new material conforming to the specified requirements at no additional cost to OWNER.

B. Storage of Materials:
   1. Store materials so as to preclude the inclusion of foreign materials.
   2. Do not store or expose materials to temperature above 90 F or store in direct sunshine.
   3. Do not use materials which are outdated as indicated by shelf life.
   4. Store sealant tape in a manner which will not deform the tape.
   5. In cool or cold weather store containers where temperature approximates 75 F for 16 hours before using.
   6. When high temperatures prevail store mixed sealants in a cool place.

C. Handling: Handle materials carefully to prevent inclusion of foreign materials.

1.5 JOB CONDITIONS

A. Environmental Conditions:
   1. Do not proceed with installation of calking and sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
   2. Proceed with the Work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength.
   3. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.

B. Protection: Do not allow calking and sealants to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or the calking and sealant materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Exterior and Interior Joints in Vertical Planes:
   1. Two-Component Urethane Sealant:
      a. Urethane-based, 1-part elastomeric sealant complying with the following:
         1) FS TT-S-00230C: Type 1 (non-sag) Class A.
         2) Movement Capability: ±25 percent.
      b. Product and Manufacturer: Provide one of the following:
         1) Sonolastic NP I by Sonneborn Division of Contech Incorporated.
         2) Dymonic by Tremco.
         3) Or equal.

C. Provide colors selected by ENGINEER from calking and sealant manufacturer's standard color charts. Manufacturers supplying sealants other than those specified above must provide the same colors available from those specified.

D. Miscellaneous Materials:
   1. Joint Cleaner: Provide the type of joint cleaning compound recommended by the sealant and calking manufacturer, for the joint surfaces to be cleaned.
   2. Joint Primer and Sealer: Provide the type of joint primer and sealer recommended by the calking and sealant manufacturer, for the joint surfaces to be primed or sealed.
   3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended by the calking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to the substrate or joint filler must be avoided for proper performance of calking and sealant. Provide self-adhesive tape wherever applicable.
   4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with calking and sealant by the calking and sealant manufacturer. Provide size and shape of rod which will control the joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide a highly compressible backer to minimize the possibility of sealant extrusion when joint is compressed.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and the conditions under which the calking and sealant Work is to be performed, and notify ENGINEER in writing of any conditions detrimental to the proper and timely completion of the Work and performance of the sealants. Do not proceed with the calking and sealant Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 JOINT SURFACE PREPARATION

A. Clean joint surfaces immediately before installation of sealant compound. Remove dirt, insecure coatings, moisture and other substances which would interfere with bonds of sealant compound as recommended by sealant manufacturer's written instructions.

B. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's written instructions indicate that alkalinity does not interfere with sealant bond and performance.
   1. Etch with 5 percent solution of muriatic acid.
   2. Neutralize with dilute ammonia solution.
   3. Rinse thoroughly with water and allow to dry before sealant installation.

C. If necessary, clean porous materials such as concrete and masonry by grinding, sand blasting or mechanical abrading. Blow out joints with oil-free compressed air, or by vacuuming joints prior to application of primer or sealant.

D. Roughen joint surfaces on vitreous coated and similar non-porous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or wool to produce a dull sheen.

3.3 INSTALLATION

A. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

B. Prime or seal the joint surfaces wherever recommended by the sealant manufacturer. Do not allow prime or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to application of sealants.

C. Apply masking tape before installation of primer, in continuous strips in alignment with the joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.

D. Do not install sealants without backer rods or bond breaker tape.

E. Roll the back-up rod stock into the joint to avoid lengthwise stretching. Do not twist, braid, puncture or prime backer-rods.

F. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

G. Install sealants to depths as recommended by the sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead.
   1. For vertical joints subjected to normal movement and sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.

H. Remove excess and spillage of compounds promptly as the Work progresses.

I. Cure sealants and calking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

3.4 ADJUSTMENT AND CLEANING

A. Repair sealant installation at leaks or, if leakage is excessive, replace sealant installation as directed.

B. Clean adjacent surfaces of sealant or soiling resulting from the Work. Use solvent or cleaning agent recommended by the sealant manufacturer. Leave all finish work in a neat clean condition.

C. Protect the sealants during the construction period so that they will be without deterioration, soiling, or damage at the time of OWNER'S Final Acceptance.

+ + END OF SECTION + +

SECTION 8A1

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all hollow metal doors and frames Work.
2. The extent of hollow metal doors and frames is shown.
3. The types of hollow metal doors and frames Work required includes, but is not necessarily limited to, the following:
   a. Flush doors and frames.
   b. Custom designed and fabricated cylinder access hollow metal doors and frames with monorail cutout.
   c. Fire-rated flush doors and frames.
   d. Stick system.
   e. Transoms and panels.
   f. Miscellaneous fabrications and trim.

B. Coordination:
1. Review installation procedures under other Sections and coordinate them with the Work specified herein.
2. Where hollow metal door and frame Work require the building-in of plates, inserts and other items, furnish required inserts to avoid delay in the Work of other trades. Provide setting drawings, templates, and directions for installation of plates, inserts and anchors, required by the Work of this Section but installed under other Sections of the Work.

C. Related Sections:
1. Section 8C6, Access Doors.
2. Section 8H1, Finish Harware.
3. Section 8I, Glazing.
4. Section 9L, Painting.

1.2 QUALITY ASSURANCE

A. Design Criteria: Provide the following:
1. For hollow metal door and frame Work shown with heights above 10 foot-0 inches provide internal steel tubes and stiffeners designed to limit top to bottom out of plane warp at strike side of door to 1/8-inch maximum based on a design moment of 12 foot kips with forces applied at top and bottom of door leafs.
2. Oversize Assemblies: Wherever hollow metal assemblies are larger than size limitations established by NFPA, provide manufacturer's certification that assembly has been constructed with materials and methods equivalent to labeled construction.

B. Manufacturer Qualifications: Provide hollow metal doors and frames and accessories manufactured by a single firm specializing in the production of this type of Work and complying with all applicable standards of the Steel Door Institute, recommended specifications for Standard Steel Doors and Frames (S.D.I. 100).

C. Requirements of Regulatory Agencies:
   1. Fire-rated Assemblies: Wherever a fire-resistance classification is shown or scheduled for hollow metal doors and frames Work (3-hour, 1-1/2 hour, and similar designations), provide fire- rated hollow metal doors and frames Work investigated and tested as a fire door assembly, complete with type of fire door hardware to be used. Identify each fire door and frame with recognized testing laboratory labels, indicating applicable fire rating of both door and frame.
   2. Construct assemblies to comply with NFPA Standard No. 80, and applicable provisions of the Uniform Building Code.
   3. Temperature Rise Rating: Wherever a temperature rise rating is required by governing authorities provide doors for ratings shown and in accordance with UL10(b).
   4. Codes: Comply with the applicable requirements of governing authorities and codes for the types of doors and frames specified.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. ASTM A 153, Zinc Coating on Iron and Steel Hardware.
   2. ASTM A 366, Carbon Steel Cold-Rolled Sheet.
   3. ASTM A 525, Steel Sheet, Galvanized by the Hot-Dip Process - General.
   4. ASTM A 526, Steel Sheet, Galvanized by the Hot-Dip Process - Specifications.
   5. ASTM A 568, Carbon Steel and High Strength Low Alloy Hot Rolled Sheet, Hot Rolled Strip and Cold-Rolled Sheet.
   6. ASTM A 569, Steel, Carbon Hot-Rolled Sheet and Strip.
   7. NFPA Standard No. 80, Fire Doors and Windows.
   8. U.L. Building Materials Directory.
   9. Steel Door Institute Standard Steel Doors and Frames.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Shop Drawings for the fabrication and installation of hollow metal doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections.
   2. Schedule of doors and frames using same reference numbers for details and openings as those on the Drawings.

B. Test Reports: Submit for approval the following:
   1. Certification of Labeled Construction Fire Doors and Frames: Furnish for approval certification of label construction for doors not requiring labels but requiring labeled construction.
   2. Certified laboratory test reports for specified performance tests.

1.4 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver hollow metal doors and frames cartoned or crated to provide protection during transit and job storage.
   2. Inspect hollow metal Work upon delivery for damage. Minor damage may be repaired provided the finish items are equal in all respects to new Work and acceptable to ENGINEER; otherwise, remove and replace damaged items as directed.

B. Storage of Materials:
   1. Store doors and frames at the building site under cover.
   2. Place units up off the floors in a manner that will prevent rust and damage.
   3. Avoid the use of non-vented plastic or canvas shelters which could create a humidity chamber. If the cardboard wrapper on the door becomes wet, remove the carton immediately.
   4. Provide a 1/4 inch space between stacked doors to promote air circulation.

1.5 SCHEDULING

A. Coordinate with other Work by furnishing Shop Drawings, inserts and similar items at the appropriate times for proper sequencing of construction without delays.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Frames: Hot-Rolled Steel Sheets and Strips: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM A 568.

B. Door Faces: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526, with ASTM A 525, G60 zinc coating, mill phosphatized.

C. Supports and Anchors: Sheet metal, hot-dip galvanized after fabrication complying with ASTM A 153, Class C or D as applicable.

2.2 FABRICATION, GENERAL

A. Fabricate hollow metal units to be rigid, neat in appearance and free of defects, warp or buckle. Accurately form metal to required sizes and profiles. Wherever practicable, fit and assemble units in the manufacturer's plant. Clearly identify Work, that cannot be permanently factory-assembled before shipment, to assure proper assembly at the project site. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible. Filler to conceal manufacturing defects is not acceptable.

B. Exposed Fasteners: Unless otherwise specified, provide coutersunk flat Phillips or Jackson heads for exposed screws and bolts.

C. Finish Hardware Preparation: Provide the following:
   1. Prepare hollow metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115, Specifications for Door and Frame Preparation for Hardware.
   2. Reinforce hollow metal units to receive surface-applied and recessed finish hardware.
   3. Locate finish hardware as shown on approved Shop Drawings, in accordance with hardware templates provided by hardware manufacturer and in accordance with National Association of Architectural Metal Manufacturers, Hardware Locations for Custom Hollow Metal Doors. Refer to Section 8H1, Finish Hardware.

D. Shop Painting: Provide the following:
   1. Clean, treat and paint exposed surface of fabricated hollow metal units, including galvanized surfaces.
   2. Clean steel surfaces of mill scale, rust, oil grease, dirt and other foreign materials before the application of the shop coat of paint.
   3. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC-PT 2), hot phosphate solution (SSPC-PT 4) or basic zinc chromate-vinyl butyral solution (SSPC-PT 3).
   4. Refer to Section 9L, Painting for field applied primer and finish paint for exterior or interior exposed ferrous, non-ferrous, or galvanized surfaces.
   5. Apply shop coat of prime paint within time limits recommended by pretreatment manufacturer. Apply a uniform dry film thickness of not less than 1.5 mils.
   6. Finish shall be rust inhibitive primer capable of humidity test in accordance with ASTM B 117 as certified by an independent laboratory.

2.3 DOORS

A. Door Types: Provide the following:
   1. Flush design doors, 1-3/4-inches thick except where thicker doors are required to meet design criteria specified, seamless hollow construction, unless otherwise shown or specified.
   2. Fire-rated doors in accordance with Underwriters' Laboratory Standard, UL 10(b), and NFPA Pamphlet No. 80.
   3. For a UL 1-1/2 hour (B) classification provide doors with a temperature rise rating of not more than 250 F maximum to 30 minutes of exposure.

B. Door Construction: Provide the following:
   1. Fabricate doors of two outer stretcher-leveled steel sheets galvanized with a G60 zinc coating of 0.60 ounces per square foot in accordance with ASTM A 525 and A 526 and not less than 16 gage. Construct doors with smooth, flush surfaces without visible joints or seams or exposed faces or stile edges, except around glazed or louvered panel inserts. Provide continuously welded seams for all door construction. No fillers shall be used.

2. Reinforce inside of doors with phenolic resin impregnated kraft 1-inch hexagonal cell honeycomb core completely filling the inside of the door and laminated to the inside of both face panels with an adhesive. The honeycomb material shall have a crushing strength not less than 4000 pounds per square foot and the lamination shall withstand not less than 1100 pounds per square foot in shear.
3. Door reinforcement may be modified in fabrication method approved by ENGINEER in order to provide a UL labeled fire rated door.
4. Reinforce tops and bottoms of doors with flushed mounted minimum 16 gage horizontal steel channels welded continuously to the outer sheets.
5. Edge profiles shall be provided on both stiles of doors as follows: beveled 1/8 inch in 2 inches.

C. Finish Hardware Reinforcement: Provide the following:
1. Refer to Section 8H1, Finish Hardware.
2. Hardware supplier shall furnish hollow metal door and frame manufacturer approved hardware schedule, hardware templates, and samples of physical hardware where necessary to insure correct fitting and installation.
3. Preparation includes sinkages and cut-outs for mortise and concealed hardware.
4. Provide reinforcements for both concealed and surface applied hardware:
   a. Drill and tap mortise reinforcements at factory, using templates.
   b. Install reinforcements with concealed connections designed to develop full strength of reinforcements.
5. Reinforce doors for required finish hardware, with minimum gages as follows:
   a. Hinges: Steel plate 1/4-inch thick by 1-1/2-inches wide by 8-inches longer than hinge secured by not less than 6 spot or projection welds.
   b. Mortise Locksets and Dead Bolts: 12 gage steel plate, secured with not less than 2 spot or projection welds.
   c. Surface-Applied Closers: 1/4-inch thick steel plate, secured with not less than 6 spot or projection welds.
   d. Push Plates and Bars: 16 gage steel sheet secured with not less than 2 spot or projection welds.
   e. Automatic Door Bottoms: Reinforce for mortise-type units with 14 gage steel, and 16 gage for surface-applied units.
   f. Flush Bolts, Chain Bolts and Slide Bolts: 12 gage steel sheet, secured with not less than 2 spot or projection welds.

D. Product and Manufacturer: Provide one of the following:
1. Series CH with DURA-WELD seams by Pioneer Industries, Division of SOS Consolidated, Incorporated.
2. Or equal.

2.4 FIRE-RATED DOORS

A. Provide the same construction specified above under door construction and within UL requirements as specified.

B. Provide fire-rated doors in accordance with Underwriters' Laboratories Standard, UL 10(b), and NFPA No. 80. For a UL 1-1/2 hour (B) classification provide doors with a temperature rise rating of not more than 450 F or 650 F maximum to 30 minutes of exposure.

C. Product and Manufacturer: Provide one of the following:
   1. Series CH Underwriters' Label Doors with DURA-WELD seams by Pioneer Industries, Division of SOS Consolidated, Incorporation.
   2. Or equal.

2.5 HOLLOW METAL PANELS

A. Provide hollow metal panels of the same materials, construction, and finish as specified for hollow metal doors.

B. Provide integral recessed bevel with top of door.

2.6 FRAMES

A. Frame Types: Provide the following:
   1. Hollow metal frames for doors, transoms, sidelights, and other openings of size and profile as shown or specified.
   2. Fire-rated frames in accordance with UL Standards UL 10 (b) and UL 63 and NFPA Pamphelt No. 80 and as listed in UL.
   3. Provide stick system for interior window frames assembled as interior windows as shown.

B. Frame Construction: Provide the following:
   1. Fabricate frames of full-welded unit construction, with corners mitered, reinforced, continuously welded full depth and width of frame with exposed welds ground flush and smooth.
   2. Form frames of hot rolled prime quality carbon steel in accordance with ASTM A 568 and A 569 and galvanized with a G60 zinc coating of 0.60 ounces per foot in accordance with ASTM A 153, A 525, and A 526 or cold rolled steel sheets in accordance with ASTM A 366 and galvanized in accordance with ASTM A 153, A 525 and A 526.
   3. Gage thickness of steel: not less than 14 for all doors except custom designed and fabricated cylinder access door which shall be not less than 12 gage.
   4. Finish Hardware Reinforcement: Reinforce frames for required finish hardware with minimum gages as follows:
      a. Hinges and Pivots: Steel plate 1/4-inch thick by 1-1/2-inches wide by 8-inches longer than hinge, secured by not less than 6 spot or projection welds.
      b. Strike Plate Clips: Steel plate 10 gage thick by 1-1/2- inches wide by 3-inches long.
      c. Surface-Applied Closers: 1/4-inch thick steel plate, secured with not less than 6 spot or projection welds.
   6. Head Reinforcing:
      a. For frames over 4 feet-o inches wide, in masonry openings, provide continuous channel or angel stiffener to match metal of frame, not less than 12 gage for full width of opening, welded to inside of frame at head.
      b. Where installed in masonry, leave vertical mullions in frames open at the top so they can be filled with grout.

7. Jamb Anchors: Furnish jamb anchors as required to secure frames to adjacent construction, formed of not less than 16 gage galvanized steel.
   a. Masonry Construction: Adjustable, corrugated or perforated, T-shaped to suit frame size with leg not less than 2-inches wide by 10-inches long. Furnish at least 3 anchors per jamb up to 7 feet-6 inches height; 4 anchors up to 8 feet-0 inch jamb height; one additional anchor for each 24 inch or fraction thereof over 8 feet-0 inch height. Alter specification requirements in order to furnish UL construction where required.
   b. Cast-In-Place Concrete or In-Place Masonry: Anchor frame jambs with minimum 3/8-inch concealed bolts into expansion shields or inserts at 6 inches from top and bottom and 24 inches on centers. Reinforce frames at anchor locations. Apply removable stop to cover anchor bolts.
8. Floor Anchors: Provide floor anchors for each jamb and mullion which extends to floor, formed of not less than 14 gage galvanized steel sheet, clip type anchors, with 2 holes to receive fasteners, welded to bottom of jambs and mullions.
9. Head Strut Supports: Provide 3/8-inch by 2-inch vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
10. Plaster Guards: Provide minimum 26 gage plaster guards or dust cover boxes to match metal of frame, welded to frame, back of finish hardware cutouts where mortar or other materials might obstruct hardware installation.
11. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.
12. Rubber Door Silencers: Drill stop to receive 3 silencers on single-door frames and 4 silencers on double-door frames. Install plastic plugs to keep holes clear during construction.
13. Product and Manufacturer: Provide one of the following:
   a. Series F-14 and F-12 by Pioneer Industries, Division of SOS Consolidated, Incorporated.
   b. Or equal.

C. Fire-Rated Frames: Provide the following:
1. Same construction specified above under frame construction and within UL and NFPA requirements as specified above.
2. Product and Manufacturer: Provide one of the following:
   a. Series F-14 Underwriters' Label Frames by Pioneer Industries, Division of SOS Consolidated Incorporation.
   b. Or equal.

D. Stick Systems: Provide the following:
1. Same construction specified above for frame construction.
2. Product and Manufacturer: Provide one of the following:
   a. Series S-14 Stick System by Pioneer Industries, Division of SOS Industries, Incorporated.
   b. Or equal.

2.7 DOOR LOUVERS

A. Fabricate louvers and mount flush into doors without overlapping mountings on surface of door facing sheets. Provide internal support as recommended by louver manufacturer. Prime paint after fabrication.

B. Interior Louvers: Sightproof, stationary type, constructed of inverted Y-shaped blades formed of 20 gage cold-rolled steel, not less than 1-3/8 inches thick. Assembly units by welding. Grid all wells smooth and finish to match door.

2.8 STOPS AND MOULDINGS

A. Provide stops and mouldings around solid, glazed and louvered panels in hollow metal units and in frames to receive glass, where specified.

B. Form fixed stops and mouldings integral with frame. Provide fixed stops on inside of hollow metal units exposed to exterior and on corridor side of interior units.

C. Provide removable stops and molds at other locations, formed of not less than galvanized 20 gage steel sheets. Secure with countersunk machine screws spaced uniformly not more than 12 inches on center. Form corners with butted hairline joints.

D. Coordinate width of rabbet between fixed and removable stops with type of glass or panel and type of installation indicated. Refer to Section 8I, Glazing.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the substrate and conditions under which hollow metal doors and frames are to be installed and notify ENGINEER in writing of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install hollow metal units and accessories in accordance with the final Shop Drawings, manufacturer's data, and as shown and specified.

B. Place frames at fire-rated openings in accordance with NFPA Standard No. 80.

C. Frames that are bowed, twisted or otherwise unacceptable shall be removed from the jobsite and replaced with properly constructed frames.

D. Setting Masonry Anchorage Devices:
   1. In masonry construction, building in of anchors and grouting of frames is included in Section 4C1, Unit Masonry Construction.
   2. Provide masonry anchorage devices and machine screws where required for securing hollow metal frames to masonry construction.

3. Set anchorage devices opposite each anchor location, in accordance with details on approved Shop Drawings and anchorage device manufacturer's instructions. Leave drilled holes rough, not reamed, and free from dust and debris.
4. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so shown on final Shop Drawings.

E. Secure frames to concrete framing with reinforcement concealed in hollow metal frames.

F. Placing Frames:
1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Remove spreader bars only after frames have been properly set and secured.
2. Make field splices in frames as detailed on approved Shop Drawings, welded and finished to match factory work.

G. Protective Coating: Protect inside, concealed, faces of door frames in plaster or masonry construction using fibered asphalt emulsion coating. Apply over shop primer approximately 1/8-inch thick and allow to dry before handling.

H. Door Installation:
1. Fit hollow metal doors accurately in their respective frames, with the following clearances:
   a. Jambs and Head: 3/32 inch.
   b. Meeting Edges, Pairs of Doors: 1/8 inch.
   c. Bottom: 3/4 inch, where no threshold or carpet.
   d. Bottom: At threshold, 1/8 inch.
2. Place fire-rated doors with clearances as specified in NFPA Standard No. 80.
3. Finish hardware installation is specified under Section 8H1, Finish Hardware.

3.3 ADJUSTMENT AND CLEANING

A. Final Adjustments: Check and readjust operating finish hardware items in hollow metal Work just prior to Final Inspection. Leave Work in complete and proper operating conditions.

B. Prime Coat Touch-Up: Immediately after erection, sand and apply touch-up of compatible air-drying primer.

C. Protection: Protect installed hollow metal doors and frames against damage from other construction work.

+ + END OF SECTION + +

SECTION 8C6

ACCESS DOORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install all access doors Work.
   2. The extent of access doors is shown.
   3. The types of access door Work required includes, but is not necessarily limited to, the following:
      a. Fire-rated wall doors.
      b. Ceiling doors in cement plaster ceilings.

B. Coordination:
   1. Furnish inserts and anchoring devices which must be built into other work for the installation of access doors.

C. Related Sections:
   1. Section 8A1, Hollow Metal Doors and Frames.
   2. Section 8H1, Finish Hardware.

1.2 SUBMITTALS

A. Shop Drawings: Submit for approval copies of manufacturer's technical data and installation instructions for each type of access door assembly. Transmit copy of each instruction to the installer. Provide setting drawings, templates, instructions and directions for installation of anchorage devices.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION

A. General:
   1. Furnish access door assemblies manufactured as an integral unit, complete with all parts and ready for installation.
   2. Provide wall access door and frame with UL 1-1/2 hour "B" rating.

B. Product and Manufacturer: Provide the following:
   1. Stainless Steel Fire Rated Access Door and Ceiling Door by Inryco, Incorporated.
   2. Or equal.

C. Frames:
   1. Fabricate from 16 gage stainless steel with No. 4 finish for wall doors and 16 gage cold rolled steel for ceiling access doors.
   2. Fabricate frame with exposed flange approximately 1-inch wide around perimeter of frame.

D. Flush Panel Doors:
   1. Fabricate wall door panels from not less than 20 gage sheet stainless steel with No. 4 finish, and with concealed spring hinges set to open to 175 degrees.
   2. Fabricate ceiling access door panels of not less than 18 gage cold rolled steel with concealed hinge allowing 90 degree operation.

E. Locking Devices:
   1. Provide knurled knob and mortise cylinder operation master keyed to match cylinder locksets specified in Section 8H1, Finish Hardware. Provide the number of locks required to hold door in flush, smooth plane when closed.
   2. Provide automatic panel closer for wall doors.

F. Wall Doors Size: 16-inches by 16-inches.

G. Ceiling Door Size: 24-inches by 24-inches.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the areas and conditions under which access doors are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Comply with manufacturer's instructions for installation of access doors.

B. Coordinate installation with work of other trades.

C. Set frames accurately in position and securely attach to support with face panels plumb or level in relation to adjacent finish surfaces.

3.3 ADJUSTMENT AND CLEANING

A. Adjust hardware and panels after installation for proper operation.

B. Remove and replace panels or frames which are warped, bowed or otherwise damaged.

+ + END OF SECTION + +

SECTION 8E2

ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentials as shown, specified and required to furnish and install all aluminum windows Work.
   2. The extent of the aluminum windows is shown.
   3. The types of aluminum window Work required includes, but is not necessarily limited to, the following:
      a. Casement aluminum windows.
      b. Intermediate mullions and all accessories and fasteners.
      c. Hardware, panning, fasteners, supports and trim.
      d. Miscellaneous materials.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed prior to the aluminum window Work.

C. Related Sections:
   1. Section 8I, Glazing.

1.2 QUALITY AND ASSURANCE

A. Design Criteria: Except as otherwise shown or specified, the requirements for aluminum windows, and the terminology and standards of performance and fabrication workmanship, are those specified and recommended in AAMA 101, and the applicable general recommendations published by Architectural Aluminum Manufacturer's Association, National Association of Architectural Metal Manufacturers and Aluminum Association.

B. Source Quality Control: Provide aluminum window units produced by a single firm, capable of showing prior successful production of units similar to those required.

C. Requirements of Regulatory Agencies:
   1. Performance and Testing: Except as otherwise specified, comply with the air infiltration tests, water resistance tests and applicable load tests specified in AAMA 101 for the type and classification of window unit required in each case.
   2. Comply with Section 3 "Optional Performance Specifications" of AAMA 101. Provide uniform load structural test pressure of 60 pounds per square foot.
   3. Design wind velocity at project site is 40 pounds per square foot.
      a. Air Infiltration Test: ASTM E 283: Maximum infiltration 0.37 cubic feet per minute per linear foot of operating ventilator when tested at 6.24 pounds per square foot differential pressure.

b. Water Penetration Test: ASTM E 331: No water penetration for 15 minutes when window is subjected to rate of flow of 5 gallons per hour per square foot with differential pressure across window unit of six pounds per square foot.
c. Wind load test: ASTM E 330: Minimum 40 pounds per square foot positive and negative load for 10 seconds. Maximum deformation of frame or sash member L/175 of span length.
d. Testing: Wherever manufacturer's standard window units comply with the requirements and have been tested in accordance with the specified tests, provide certification by the manufacturer of compliance with such tests; otherwise, perform the required tests through a recognized testing laboratory or agency and provide certified test results.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. Architectural Aluminum Manufacturer's Association (AAMA) 302.8, Specification for Aluminum Windows.
2. AAMA 701.2, Woven Pile Weatherstrip.
3. AAMA 101, Voluntary Specifications for Aluminum Prime Windows and Sliding Glass Doors.
4. AAMA GS-001, Voluntary Guide Specifications for Aluminum Architectural Windows.
5. ASTM B 221, Aluminum-Alloy Extruded Bars, Rods, Shapes and Tubes.
6. ASTM E 283, Rate of Air Leakage Through Windows.
7. ASTM E 330, Structural Performance of Exterior Windows, Curtain Walls, and Doors Under the Influence of Wind Loads.
8. ASTM E 331, Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Differential.
9. Federal Specification, RR-W-365, Wire Fabric (Insect Screening).
10. National Association of Architectural Metal Manufacturers, Metal Finishes Manual.

1.3 SUBMITTALS

A. Samples: Submit for approval samples of each required aluminum finish, on 12-inch long sections of extrusion shapes as required for the window units. Where color or texture of finish will vary slightly for the Work, include 2 or more sections in each sample, to show the limits of such variations. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
1. Fabrication and installation of aluminum window units and associated components of the Work. Include wall elevations at 1/4 inch scale, typical unit elevations at 1 inch scale and full-size detail sections of every typical composite member. Show anchors, hardware, operators and other components not included in manufacturer's standard data. Including glazing details.
2. Copies of manufacturer's Specifications, recommendations and standard details for aluminum window units, including fabrication, finishing, hardware and other components of the Work. Include certified test laboratory reports as necessary to show compliance with the requirements.

C. Guarantee: Submit for approval copies of written guarantee signed by the manufacturer, installer and CONTRACTOR, agreeing to replace aluminum window units which fail in materials or workmanship within 3 years of the date of Final Acceptance. Failure of materials or workmanship shall include, but not be limited to, excessive leakage or air infiltration, excessive deflections, faulty operation of sash, deterioration of finish or metal in excess of normal weathering, and defects in hardware, weatherstripping and other components of the Work.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:
   1. Store windows in upright position off ground on dunnage.
   2. Protect from weather and damage.
   3. Store in designated areas as close as possible to point of installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: Alloy and temper, ASTM B 221, 6063-T5 and not less than 1/8-inch thickness at any location for main frame sash members and tube supports. Vertical mullions and support clips as recommended by the window manufacturer.

B. Fasteners: Stainless steel, guaranteed by the manufacturer to be non-corrosive and compatible with the aluminum window members, trim, hardware, anchors and other components of the window units.
   1. Do not use exposed fasteners, except where unavoidable for the application of hardware. Match the finish of the metal surrounding the fastener, unless otherwise specified.
   2. Provide Phillips flat-heat machine screws for exposed fasteners, unless specified.

C. Glazing Gaskets: Neoprene or EPDM.

D. Glass and Glazing Materials: Refer to Section 8I, Glazing.

E. Wire Fabric Insect Screen: 18 by 14 mesh of 0.01-inch diameter aluminum wire, complying with FS RR-W-365, Type VII.

F. Hardware:
   1. Casement Windows: Mullion mounted white bronze two-point casement keeper with concealed stainless steel strike. Two-point tandem casement sash locks one set per window leaf shall be fastened with stainless steel screws threaded into hardened metal grommet fasteners.
   2. Heavy-duty 6-bar hinges with stainless steel balance arms. Provide sliding pivots with nylon friction-adjustable shoe in a stainless steel track.
   3. Concealed limited opening device.

4. Rotor operators ("washability casement package" with 5-1/2-inches of corner access).
5. Product and Manufacturer: Provide one of the following:
   a. Truth Division Sealed Power Corporation.
   b. Or equal.

2.2 WINDOW OPERATION

A. General: The following paragraphs define the operating arrangement for required types of sash (ventilators) in window units, and specify minimum provisions for each type.
   1. Casement Windows: Swing-out, top and bottom hinged sash.

B. Product and Manufacturer: Provide one of the following:
   1. TR-3130 Series (C-HC40 Outswing) by Traco A Three Rivers Aluminum Company.
   2. Or equal.

2.3 WINDOW CLASSIFICATION (GRADE)

A. Monumental Windows: Provide window units complying with the requirements of AAMA 101, Section 3, Classification HC, Optimal Performance Class 40 for "Monumental" buildings, and complying with the following:
   1. Extruded aluminum glazing stops of 0.062-inch minimum wall thickness, except 0.050-inch minimum for snap-on type.
   2. Hardware and anchors of non-magnetic stainless steel and white bronze.
   3. Fabricate units with all main corners and intersections of frame and sash mitered. Provide double tubular frame with hydraulically crimped gusset corner construction. Mortise or cope secondary members to fit, and weld in place with hairline joints.
   4. Provide metal thickness as required to withstand performance requirements, but not less than 0.078-inch for frame members.
   5. Provide means of drainage for water and condensation which may accumulate in members of the window units.

2.4 FABRICATION AND ACCESSORIES

A. General: Provide specified manufacturer's standard fabrication and accessories, except to the extent more specific or more stringent requirements are specified. Include complete system for assembly of components and anchorage of window units, and prepare sash for glazing.

B. Sizes and Profiles: The required sizes for window units and the profile requirements are shown. The details shown are based upon standard details by one or more manufacturers. It is intended that similar details by other manufacturers will be acceptable, provided they comply with the size requirements, and with minimum/maximum profile requirements as shown.

C. Coordination of Fabrication: Wherever possible check actual window openings in the construction Work by accurate field measurement before fabrication, and show recorded measurements before fabrication, and show recorded measurements on final Shop Drawings. However, coordinate

fabrication schedule with construction progress as directed by CONTRACTOR to avoid delay of the Work. Where necessary, proceed with fabrication without field measurements, and coordinate installation tolerances to ensure proper fit of window units.

D. Provide insect screen unit for each operable exterior sash. Locate screen units on inside of sash. Wherever possible, design window units and hardware to accommodate screens in a tight-fitting removable arrangement, with a minimum of exposed fasteners and latches.

E. Fabricate screen frames of extruded aluminum tubular-shaped members of 0.040-inch minimum wall thickness, with mitered or coped joints and concealed mechanical fasteners, with removable PVC spline-anchor concealing the edge of the screen fabric, and finished to match the window unit, unless otherwise indicated.

F. Provide serrated sash for preshimmed glazing tape.

G. Provide extruded aluminum surface applied muntins, and custom aluminum panning as shown.

2.5 ALUMINUM WINDOW FINISHES

A. Exposed Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded material. Comply with the following:
   1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
   2. Prepare a chemical conversion coating on the surface, using phosphates or chromates followed by a cold water rinse. Seal with a chromic acid rinse and dry, except where panel manufacturer recommends another method to achieve greater coating reliability.
   3. Apply a base prime coat of epoxy paint to the prepared surface in its coil form, by reverse roller coating. Fully cure in a gas-fired oven to a dry film thickness of 0.2 - 0.4 mils.
   4. Apply finish coating over the primer by roller coating for coil material and airless or Ransburg Elastrostatic Hand Spray for extrusions and fuse at a peak metal temperature of 440 F for a dry film thickness of 0.7 mils for coil coating and 1.2 mils for spray coating so that the total dry film is approxmately 1.0 mil thick for coil material and 1.5 mils thick for extruded material.
   5. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to ENGINEER:
      a. Weathering, ASTM D 659: Chalking, not more than No. 8, after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      b. Color Change, ASTM D 2244: No greater than 5 N.B.S units after removal of external deposits and after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      c. Humidity Resistance, ASTM D 2247; few scattered blisters no larger than ASTM No. 4, after 1000 hours.
      d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16 inch creep from areas scribed to bare metal after 500 hours.

e. Dry Adhesion: No pick-off when tape tested over 1/16 inch cross hatch.
f. Wet Adhesion: No pick-off when tape tested over 1/16 inch cross hatch; extruded material only.
g. Boiling Water Adhesion: No pick-off when tape tested over cross hatch area after 1 hour immersion in distilled boiling water.
h. Water Immersion: No pick-off when tape tested over cross hatch area after immersion in aerated distilled water 80 ±10F after 500 hours.
i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67 minimum.
j. Gloss, ASTM D 523: 30±5 reflectivity at 60 F.
k. Pencil Hardness: F minimum.
l. Dry Film Thickness: Primer, 0.2-0.4 mils, polyvinylidene fluoride based coating, 0.7-1.5 mils.
m. Solvent Resistance: 100 Double MEK rubs minimum.
n. Flexibility, ASTM D 1737: No cracking prior to metal fracture.
o. Acid Resistance, ASTM D 1308: 16 hour spot test with 5% hydrochloric acid - no effect.
p. Alkali Resistance, ASTM D 1308: 16 hour spot test with 5% sodium hydroxide - no effect.

B. Product and Manufacturer: Provide one of the following:
1. Kynar 500 Fluropon and Kynar 500 TR1-X by DeSoto Incorporated.
2. Or equal.

C. Provide the following colors:
1. Aluminum Window Mullions, Muntins and Adaptors: Complete selection of standard, bright and metallic colors.
2. Snap Covers and Closures: Complete selection of standard, birght and metallic colors.
3. Exposed Fasteners: Color and finish to match substrate.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the substrate and conditions under which aluminum window Work is to be installed and notify ENGINEER in writing of any conditions detremental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Comply with manufacturer's specifications and recommendations for the installation of window units, hardware, operators, and other components of the Work.

B. Set units plumb, level and true to line, without warp or rack of frames or sash. Anchor securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

C. Refer to Section 7J1, Calking and Sealants for compounds, fillers and gaskets to be installed concurrently with window units.

3.3 ADJUSTMENT AND CLEANING

A. Adjust operating sash and hardware to provide a tight fit at contact points and at weatherstripping for smooth operation and weathertight closure.

B. Refer to Section 8I, Glazing for glass installation requirements.

C. Clean aluminum surfaces promptly after installation of windows, exercising care to avoid damage of the finish. Remove excess glazing and sealant compounts, dirt and other substances. Lubricate hardware and other moving parts.

D. Advise CONTRACTOR of protective treatment and other precautions required through the remainder of the construction period, to ensure that window units will be without damage or deterioration, other than normal weathering, at the time of Final Acceptance.

+ + END OF SECTION + +

SECTION 8H1

FINISH HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all finish hardware Work.
2. The extent of finish hardware is specified and in schedules. Finish hardware is defined to include all items known commercially as finish hardware, as required for swing doors, except special types of unique and non-matching hardware specified in the same Section as the door and door frame.
3. The types of finish hardware Work required includes, but is not necessarily limited to, the following:
   a. Mortise hinges.
   b. Locksets.
   c. Latchsets.
   d. Panic exit devices.
   e. Door closers.
   f. Holders and stops.
   g. Stops.
   h. Stripping and seals.
   i. Dust-Proof strikes.
   j. Thresholds.
   k. Silencers.
   l. Door pulls and plates and protection plates.
   m. Surface bolts with concealed mounting.
   n. Flush bolts.
   o. Astragals.
   p. Coordinators.
   q. Miscellaneous items.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the finish hardware.

C. Related Sections:
1. Section 8A1, Hollow Metal Doors and Frames.
2. Section 8DS, Door Schedule.

1.2 QUALITY ASSURANCE

A. Supplier Qualifications: The finish hardware supplier shall have in his employ a member of the American Society of Architectual Hardware Consultants who shall be responsible for the complete finish hardware contract.

B. Design Criteria:
   1. Where the finish, shape, size or function of a member receiving finish hardware is such as to prevent the use of, or make unsuitable the types specified, furnish similar types having as nearly as practicable the same operation.
   2. If finish hardware for any location is not specified, provide finish hardware equal in design and quality to adjacent finish hardware for comparable openings.
   3. Furnish finish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements, as necessary for proper installation and function.
   4. Unless otherwise specified, comply with the National Builders Hardware Association, "Recommended Locations for Builders Hardware".
   5. Provide statuary bronze finish hardware, or matching finish hardware as specified, for all doors and frames.

C. Requirements of Regulatory Agencies:
   1. Provide finish hardware for fire-rated openings in compliance with NFPA No. 80. This requirement takes precedence over other requirements for such finish hardware.
   2. Provide only finish hardware which has been tested, listed and labeled by UL for the types and sizes of doors required, and complies with the requirements of the door and door frame labels. Modify scheduled finish hardware, as required, to meet UL requirements.
   3. Codes: Comply with the applicable requirements of governing authorities and codes for the types of finish hardware specified.

D. Source Quality Control: To the greatest extent possible, obtain each type of finish hardware from only one manufacturer.

E. Reference Standards: Comply with the applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. FS TT-S-001657, Sealing Compound - Single Component, Butyl Rubber Based, Solvent Release Type.
   2. National Fire Protection Association, Standard for Fire Doors and Windows No. 80.
   3. UL, Building Materials Directory.
   4. UL, List of Inspected Fire Protection Equipment and Materials.
   5. UL, Hardware, Automatic Flush or Surface Bolts.
   6. National Builders Hardware Association, Recommended Locations for Builders Hardware.

1.3 SUBMITTALS

A. Samples: Submit for approval each item of finished hardware with specified finish.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's data for each item of finish hardware. Include whatever information may be necessary to show compliance with requirements, and include instructions for installation and for maintenance of operating parts and exposed finishes. Wherever needed, furnish templates to fabricators of other work which is to receive finish hardware.

2. Copies of the finish hardware schedule. Include a separate key schedule, showing clearly how OWNER'S final instructions on keying of locks have been fulfilled. Finish hardware schedules are intended for coordination of the Work. Review and acceptance by ENGINEER does not relieve CONTRACTOR of his exclusive responsibility to fulfill the requirements as shown and specified.
3. Based on the finish hardware requirements specified, organize the final finish hardware schedule into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other work (such as hollow metal frames) which may be critical in the Project construction schedule. Furnish final draft of schedule after samples, manufacturer's data sheets, coordination with Shop Drawings for other work, delivery schedules and similar information have been completed and accepted.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver finish hardware sufficiently in advance of its setting for proper inspection.
2. Pack each piece of finish hardware separately, complete with screws, keying, instructions and templates, tagged to correspond with the approved finish hardware schedule.

B. Storage of Materials:
1. Provide secure lock-up for finish hardware stored at the site, but not yet installed.
2. Store finish hardware in manufacturers' original packages.

C. Handling of Materials: Control the handling and installation of finish hardware items which are not immediately replaceable, so that the completion of the Work will not be delayed by finish hardware losses, both before and after installation.

1.5 JOB CONDITIONS

A. Scheduling: Delivery individually packaged finish hardware items at the proper time to the proper locations for installation.

1.6 SUBSTITUTIONS

A. Do not make substitutions after ENGINEER'S approval of final finish hardware schedule.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION

A. General:
1. Hand of Door: The Drawings show the swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish each item of finish hardware for proper installation and operation of the door swing as shown.

2. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels.
3. Base Metals: Produce finish hardware units of the basic metal and forming method specified, using the manufacturer's standard metal alloy, composition, temper and hardness. Do not substitute materials or forming methods for those specified.
4. Fasteners: Manufacture finish hardware to conform to published templates, generally prepared for machine screw installation. Do not provide finish hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
5. Furnish screws for installation, with each finish hardware item. Provide Phillips flat-head screws except as otherwise specified. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces on other Work, to match the finish of such other Work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
6. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of finish hardware, base material or fastener.
7. Provide concealed fasteners for finish hardware units which are not exposed when the door is closed, except to the extent no standard manufacturer units of the type specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other Work under any condition, except where it is not possible to adequately reinforce the Work and use machine screws or concealed fasteners of another standard type to satisfactorily avoid the use of through bolts.
8. Tools for Maintenance: Furnish a complete set of specialized tools as needed for OWNER'S continued adjustment, maintenance, removal and replacement of finish hardware.

B. Mortise Hinges: Provide the following:
1. Templates and Screws: Provide only template-produced units.
2. Base Metal: Fabricate hinges from bronze and finish to match the latch and lock set.
3. Number of Hinges: Except as otherwise specified, provide 2 hinges on each door leaf of less than 60-inches height; provide one additional hinge for next 30-inches of door height or fraction thereof; provide two additional hinges for each 30-inches or fraction thereof for doors above 90-inches tall.
4. Hinge Size: Except as otherwise specified or as required to comply with UL and NFPA, provide hinges of the following sizes:
   a. Interior and Exterior Doors, maximum 36-inches wide: 4-1/2-inch heavy weight (0.180-inch).
   b. Wide Exterior and Interior Doors:
      1) Maximum 47-inches Wide: 5-inch heavy weight (0.190- inch).
      2) 48-inches Wide and Over: 6-inch heavy weight (0.203-inch).
5. Types of Hinges: Provide full-mortise type, ball-bearing hinges swaged for mortise applications, inner leaf beveled, square cornered, unless manufacturer's recommendations indicate that half-mortise, half-surface, full-surface or other type should be used for the frame and door type or condition.

6. Hinge Pins: Except as otherwise specified, provide hinge pins as follows:
   a. Pins: Bronze.
   b. Exterior Doors: Non-removable pins.
   c. Tips: Hospital tips and matching plug, finished to match leaves.
7. Product and Manufacturer: Provide one of the following:
   a. FBB 199H by The Stanley Works.
   b. T4B3386H by McKinney Manufacturing Company.
   c. Or equal.
8. Comply with UL, List of Inspected Fire Protection Equipment and Materials and NFPA No. 80 requirements.

C. Mortise Locks and Latch Sets: Provide the following:
1. Strikes: Provide manufacturer's standard wrought box strike, for each location and use shown. Provide bronze curved lip strikes, unless otherwise recommended by manufacturer, finished to match lock or latch set trim.
2. Lock Throw: Provide minimum of 3/4-inch anti-friction latch bolt and 1-inch dead bolt throw wherever available on manufacturer's functions specified. Comply with UL requirements for throw of latchbolts and deadbolts on rated fire openings.
3. Materials: Provide the following materials:
   a. Latch Bolt: Extruded brass.
   b. Dead Bolt: Forged brass.
   c. Case: Cast iron with corrosion resistant finish, or heavy gage wrought brass.
   d. Cylinders: Brass.
   e. Scalp: Bronze finished to match trim specified.
   f. All components shall be of marine quality wherever possible.
4. Backset: Provide minimum backset of 2-3/4-inches.
5. Modify specified locks and latches to comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials and NFPA No. 80 requirements.
6. Finish: US 10B (to match statuary bronze).
7. Product and Manufacturer: Provide one of the following:
   a. Heavy-Duty Mortise Lock 9700 Series 799L Design with LE2 Escutcheon (US 10B) by Corbin Division of Emhart Corporation.
   b. Heavy-Duty Mortise Lock A7000 Series LusMo-LE (US 10B) by Russwin, Division of Emhart Corporation.
   c. Or equal.

D. Panic Exit Devices: Provide the following:
1. Exit Doors: Where required by governing regulations or where shown or scheduled, provide panic exit devices, of the type required, including UL labels if required by governing regulations.
2. Fire Doors: Where shown or specified as a fire rated door, provide units listed and labeled by UL to comply with the rating and size of door shown.
3. Strikes: Provide manufacturer's standard wrought bronze box strike, and complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA No. 80 requirements.
4. Lock Throws: Provide minimum of 3/4-inch latch bolt throw complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA No. 80 requirements.

5. Provide mortise type exit devices as specified.
6. Provide the following materials:
   a. Latch Bolt: Brass.
   b. Case: Cast iron with corrosion resistant finish, or heavy gage wrought brass.
   c. Cylinders: Brass.
   d. Front: Bronze.
   e. Chassis: Brass.
   f. Crossbar: Bronze, 0.062-inches minimum thickness, with steel reinforcing tube.
   g. Concealed bolts: Minimum 1/2-inch diameter stainless steel.
7. Backset: Provide minimum backset of 2-3/4-inches.
8. Finish: US 10B Light Statuary Bronze, Oxidized and Fully Relieved, Oil Rubbed.
9. Product and Manufacturer: Provide one of the following:
   a. 3127 52BL Design (US 10B) by Corbin Division of Emhart Corporation.
   b. 796½ 8416 Modera (US 10B) by Russwin Division of Emhart Corporation.
   c. Or equal.

E. Cylinders and Keying System: Provide the following:
1. Provide a greatgrandmaster keying system.
2. Equip all locks with manufacturer's special 6-pin tumbler cylinder, with construction master key feature, which permits voiding of construction keys without cylinder removal.
3. Comply with ENGINEER'S instructions for masterkeying and, except as otherwise specified, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.
4. Key Material: Provide keys of nickel silver only.
5. Key Quantity: Furnish 3 keys for each lock and 5 keys for each master and grandmaster system. Provide one extra key blank for each lock.

F. Door Closers: Provide the following:
1. Provide all doors, both active and inactive, with door closers, unless otherwise specified. Provide custom designed and fabricated cylinder access door's mandoor with a door closer. Do not provide door closers at head of double door of custom designed and fabricated cylinder access doors.
2. Size of Units: Except as otherwise specified, comply with the manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather, and anticipated frequency of use.
3. Where parallel arms are specified, and for closers on exterior doors, provide closer unit one size larger than recommended for use with standard arms.
4. Use parallel arm arrangement for doors that would otherwise have the door closer appearing in finished corridors or entries.
5. Comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials, and NFPA No. 80 for doors requiring door closers. Modify closers specified as required.
6. Provide hold open feature for all non-fire rated doors unless otherwise specified.

7. Select all arms to clear weatherstripping, and overhead door holders.
8. Provide long arm to allow door to swing 180 degrees where long arm will eliminate floor mounted stops and as shown on the Drawings.
9. Provide closers with spring power adjustment feature capable of increasing spring power 50 percent minimum in all closer sizes.
10. Provide closer with delayed closing action feature. Position valve at top of closer.
11. Provide individual regulating valves for closing and latching speeds, and separate adjustable backcheck valve.
12. Material: Provide the following materials:
    a. Metallic Cover: Bronze US 10B.
    b. Case: Cast iron.
    c. Other Parts: Steel.
13. Finish: Color coordinate all arms and other accessories.
14. Product and Manufacturer: Provide one of the following:
    a. 110 Series Door Closers by Corbin, Division of Emhart Corporation.
    b. DA 2810 Series Door Closers by Russwin, Division of Emhart Corporation.
    c. Or equal.
15. Highly Corrosive Atmospheres: Provide the following:
    a. Where scheduled herein provide surface mounted stainless steel door closers with manufacturer's standard mounting for conditions encountered.
    b. Product and Manufacturer: Provide one of the following:
        1) 1600SS by Norton Security Products, Division of Scovill Industries.
        2) Or equal.

G. Holders and Stops: Provide the following:
1. Provide concealed, unless otherwise specified as surface mounted, overhead holders and stops on all exterior doors, at mandoor of custom designed and fabricated cylinder access doors, and as specified; with hold open feature. Comply with UL and NFPA requirements.
2. Material: Provide the following materials:
    a. Shock Absorber Spring: Heavy tempered steel.
    b. All other Parts: Extruded bronze.
3. Coordinate placement of overhead holder and stop with arm and bracket selection for door closers, for non-interference.
4. Two types of holders and stops are required as follows:
    a. For all doors leave with maximum width of 3 foot-0 inches provide the following:
        1) Product and Manufacturer: Provide one of the following:
            a) GJ100 Series Heavy Duty Concealed Overhead Door Holder by Glynn Johnson Corporation.
            b) 690 Series Heavy Duty Concealed Overhead Door Holder by Sargent and Company.
            c) Or equal.
    b. For custom designed and fabricated cylinder access doors (both active and inactive leafs) provide the following:
        1) Design extra heavy-duty surface mounted door holders and connections where they are fastened to other materials, to resist a superimposed load of 30 pounds per square foot acting on the plane of the doors.

2) Provide extra heavy-duty units at head of each leaf which shall engage and release door automatically by roller cam action with a provision at the end of the arm to regulate the hold-open tension or place it in a neutral position.
3) Provide 3/4-inch diameter steel arm all other parts shall be cast bronze.
4) Provide all manufacturer recommended door reinforcements and coordinate the furnishing of hardware templates required for the installation of the units.
5) Finish: US 10B (to match statuary bronze).
6) Product and Manufacturer: Provide one of the following:
   a) GJ79HD by Glynn Johnson Corporation.
   b) Or equal.

H. Stops: Provide the following:
1. Interior Doors: Provide the following:
   a. All doors shall have stops. Provide wall stops for all interior doors wherever possible. Provide long arms on closers where possible in order to avoid use of floor stops.
   b. Materials: Chassis with grey rubber tip.
   c. Finish: US 10B (to match statuary bronze).
   d. Concealed stainless steel fasteners as required by the substrate.
   e. Product and Manufacturer: Provide one of the following:
      1) 2400 wall mounted concave series and 3380 floor mounted dome type series by Sargent and Company.
      2) WB60MX wall mounted concave series type series by Glynn Johnson Corporation.
      3) Or equal.
2. Exterior Doors: Provide the following for exterior custom designed and fabricated cylinders access doors shown:
   a. For custom designed and fabricated cylinder access doors provide the following:
      1) Semi-automatic cast bronze extra heavy-duty floor mounted door holder one per leaf.
      2) Activation of holder accomplished by flipping engagement tongue forward. Released by firmly pushing door.
      3) Finish: US 10B (to match statuary bronze).
      4) Product and Manufacturer: Provide one of the following:
         a) GJ F10X by Glynn Johnson Corporation.
         b) Or equal.

I. Stripping and Seals: Provide the following:
1. Perimeter weather stripping at all exterior doors and as specified.
2. Continuity of Stripping: Except as otherwise specified, it is required that the stripping at each opening be continuous and without unnecessary interruptions at door corners and hardware.
3. Replaceable Seal Strips: It is required that the resilient or flexible seal strip of every unit be easily replaceable and readily available from stocks maintained by the manufacturer.
4. Provide bumper type weather stripping at jambs and head, including a resilient insert and metal retainer strip, surface-applied, of the following metal, finish and resilient bumper material:
   a. Housing: Extruded aluminum with bronze anodized finish; 0.062-inch minimum thickness of main walls and flanges.
   b. Seals: Closed cell extruded sponge neoprene.

5. Product and Manufacturer: Provide one of the following:
   a. No. 293AV by Pemko Manufacturing Company.
   b. No. 129VDUR by Reese Enterprises, Incorporated.
   c. Or equal.
6. Provide automatic drop-seal sound-stripping door-bottom unit of manufacturer's standard design, with operating seal bar of the following material, retained in an extruded metal bar, and capable of operating to close a 3/4-inch gap (from door bottom to floor or threshold). House mechanism and operating bar in the following metal housing, for mounting on doors as follows:
   a. Housing: Extruded aluminum, 0.062-inch thick, with bronze anodized finish on exposed surfaces.
   b. Seal: Closed-cell sponge neoprene.
   c. Mounting: Surface-mounted, except as otherwise indicated. Mount on stop-face of doors, except mount on hinge-face of swing-in exterior doors.
7. Product and Manufacturer: Provide one of the following:
   a. No. 430AS by Pemko Manufacturing Company.
   b. No. 330 by Reese Enterprises, Incorporated.
   c. Or equal.

J. Dust-Proof Strikes: Provide the following:
1. Provide dust-proof strikes which incorporate a slotted plunger raised to flush position by spring tension for all flush bolts.
2. Provide 5/8-inch inside diameter dust-proof strikes; threshold mounting.
3. Product and Manufacturer: Provide one of the following:
   a. DP-2 by Glynn Johnson Corporation.
   b. Or equal.

K. Thresholds: Provide the following:
1. Provide thresholds on all exterior doors and interior as scheduled under Section 8DS, Door Schedule.
2. Metal: Extruded bronze.
3. Surface Pattern: Grooved tread, manufacturer's standard.
4. Provide countersunk stainless steel screws and expansion shields.
5. Width: 5-inches wide and full width of opening.
6. Construction:
   a. Single-piece, complying with manufacturer's recommendations.
7. Profile: Provide manufacturer's standard unit which conforms with the minimum size and profile requirements specified.
   a. For doors equipped with panic hardware, including floor bolts, provide profile with stop bar of proper size and shape to function as the strike plate for the floor bolts.
8. Thickness: 1/4-inch minimum.
9. Product and Manufacturer: Provide one of the following:
   a. 171B by Pemko Manufacturing Company.
   b. 655 by Zero Weatherstripping Company, Incorporated.
   c. Or equal.

L. Silencers: Provide the following:
1. Provide silencers for all non-fire rated door frames.
2. Product and Manufacturer: Provide one of the following:
   a. No. 3446 by Sargent and Company.
   b. No. 33 by Russwin, Division of Emhart Corporation.
   c. Or equal.

M. Door Pulls and Plates and Protection Plates: Provide the following:
   1. Provide heady-duty surface mounted door pulls with pull plates for each leaf of the custom designed and fabricated cylinder access foors.
   2. Door pulls shall be bronze US 10B (to match statuary bronze) and have 1-inch diameter 12-inch ling handles which project 2-3/4-inches from pull plate surface.
   3. Pull plates shall be 4-inches by 16-inches, bronze US 10B (to match statuary bronze).
   4. Provide all concealed fasteners.
   5. Pulls shall be fastened to plates at factory.
   6. Product and Manufacturer: Provide one of the following:
      a. 12301/PL4016 by Glynn Hohnson Corporation.
      b. Or equal.
   7. Protection Plates: One armor plate per leaf of each custom designed and fabricated cylinder access door; bronze 48-inches high, full width of door; US 10B (to match statuary bronze).
   8. Product and Manufacturer: Provide one of the following:
      a. Bronze Armor Plate by Glynn Johnson Corporation.
      b. Or equal.

N. Surface Bolts and Concealed Mounting: Provide the following:
   1. Exposed surface mounted flush bolts shall be provided for custom designed and fabricated cylinder access door as follows:
      a. Provide custom length top locking bolts with strike 44-inch long and bottom threshold mounted locking bolts for each leaf of door.
      b. Strikes at head and threshold as recommended by surface mounted flush bolt manufacturer. Stop strip side mounting. Reinforce door frame as recommended by surface bolt manufacturer (minimum 1/4-inch thick steel plate.
      c. Surface bolts with 1-inch minimum length throw and all concealed mounting.
      d. All items of brass with US 10B (to match statuary bronze) finish.
   2. Product and Manufacturer: Provide one of the following:
      a. 1600L4410B brass and GJ1641L by Glynn Johnson Corporation.
      b. Or equal.

O. Flush Bolts: Provide the following concealed flush bolts:
   1. Flush bolts on the inactive leaf of all pairs of doors, unless otherwise specified. Custom designed and fabricated cylinder access doors shall have surface mounted bolts as specified.
   2. Provide flush bolts at the top and bottom of door.
   3. Material: Provide the following materials:
      a. Flush Bolt Levers: Forged brass.
      b. Flush Bolt Plate: Forged brass.
      c. Flush Bolt Guide and Strike: Wrought brass.
      d. Flush Bolt Rods: 1/2-inch round rods, bronze, 12-inches minimum lingth.
      e. Bolt Head: Brass.
      f. Finish: US 10B (to match statuary bronze).
   4. Provide extension flush bolts with 5/8-inch throws and with top bolt not over 6-foot 0-inches above finished floor. Provide bottom flush bolt 12-inches ling.
   5. Product and Manufacturer: Provide one of the following:
      a. GJFB6 Extension Flush Bolts by Glynn Johnson Corporation.
      b. Or equal.

6. Where required by governing authorities provide automatic flush bolts bearing the UL label.
7. Product and Manufacturer: Provide one of the following:
   a. GJFB7 Automatic Flush Bolts by Glynn Johnson Corporation.
   b. Or equal.

P. Astragals: Provide the following:
1. Provide metal astragal bar, not less than 1/8-inch by 2-inches, for exposed flat head screw mounting on active leaf of all pairs of doors.
2. Provide steel astragal with primed finish.
3. Product and Manufacturer: Provide one of the following:
   a. No. 357 series by Pemko Manufacturing Company.
   b. No. 183 series by Reese Enterprises, Incorporated.
   c. Or equal.

Q. Coordinators: Provide the following:
1. Provide coordinator device on all pairs of doors requiring automatic flush bolts. Comply with UL, List of Inspected Fired Protection Equipment and Material, and NFPA No. 80 requirements.
2. Provide manufacturer's standard carry bar and strike on all pairs of doors equipped with coordinator. Provide manufacturer's recommended reinforcements and mounting brackets.
3. Materials: Forged brass.
4. Finish: US 10B (to match statuary bronze).
5. Product and Manufacturers: Provide one of the following:
   a. COR-65 by Glynn Johnson Corporation.
   b. Or equal.

R. Sealants: Provide butyl rubber sealant complying with FS TT-S-001657 for use with thresholds.

2.2 HARDWARE FINISHES

A. Provide matching finishes for finish hardware units at each door or opening, to the greatest extent possible. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of finish hardware exposed at the same door or opening. In general, match all items to the manufacturer's standard finish for the latch and lock set for color and texture.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate to receive finish hardware, and ascertain the conditions under which the Work will be performed, and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the finish hardware Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Templates: Furnish finish hardware templates to each fabricator of doors, frames and other work to be factory-prepared for the installation

of finish hardware. Upon request, check the Shop Drawings of such other work, to confirm that adequate provisions are made for the proper installation of the finish hardware.

3.3 INSTALLATION

A. Mount finish hardware units at heights recommended in, "Recommended Locations for Builders' Hardware," by National Builders Hardware Association, except as otherwise specified or required to comply with governing regulations.

B. Install each finish hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install finish hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.

C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

F. Screw thresholds to substrate with No. 10 or larger stainless steel screws, of the proper type for permanent anchorage.

G. Set thresholds in a bead of butyl rubber sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant.

3.4 ADJUSTMENT AND CLEANING

A. Adjust and check each operating item of finish hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with the type lubrication recommended by manufacturer (graphite-type if no other recommended). Replace units which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.

B. Final Adjustment: Where finish hardware installation is made more than one month prior to Final Acceptance or occupancy of a space or area, return to the Work during the week prior to Final Acceptance or occupancy, and make a final check and adjustment of all finish hardware items in such space or area. Clean and relubricate operating items as necessary to restore proper function and finish of finish hardware and doors. Adjust door control devices to compensate for final operating of heating and ventilating equipment.

C. Instruct OWNER'S personnel in proper adjustment and maintenance of finish hardware during the final adjustment of finish hardware.

D. Finish hardware which is blemished or defective will be rejected even though it was set in place before defects were discovered. Remove and replace with new finish hardware. Repair all resultant damage to other work.

E. Continued Maintenance Service: Approximately 6 months after the acceptance of finish hardware in each area, the installer, accompanied by the representative of the latch and lock manufacturer, shall return to the project and re-adjust every item of hardware to restore proper function of doors and finish hardware. Consult with and instruct OWNER'S personnel in recommended additions to the maintenance procedures. Clean and lubricate operational items wherever required. Replace finish hardware items which have deteriorated or failed due to faulty design, materials or installation of finish hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance or the finish hardware.

3.5 SCHEDULES

A. Scheduled items for each door are generic and rely on information specified above. The listing of hardware types provided is only a general guideline for the final finish hardware schedule. CONTRACTOR shall submit a finish hardware schedule acceptable to all codes and testing agencies.

+ + END OF SECTION + +

SECTION 8I

GLAZING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all glass and glazing Work.
2. The extent of glass and glazing is shown.
3. The types of glass and glazing Work required includes, but is not necessarily limited to, the following:
   a. Glazing exterior windows.
   b. Glazing hollow metal door vision panels.
   c. Glazing interior stick system.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed or coordinated with the glass and glazing Work.
2. Review products specified under other Sections and coordinate the selection of those items to match the Work of this Section.

C. Related Sections:
1. Section 8A1, Hollow Metal Doors and Frames.
2. Section 8E2, Aluminum Windows.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: The installer of the glass and glazing materials shall be a firm with documented experience in the application of the types of glass and glazing required.

B. Manufacturer Qualifications:
1. The manufacturer of the glass and glazing materials shall be a firm with documented experience in manufacturing the types of glass specified.
2. Obtain glazing materials from manufacturers who will, if required, send a qualified technical representative to project site, for the purpose of advising the installer of proper procedures and precautions for the use of the materials.

C. Design Criteria: For glass size, type and thickness comply with the following:
1. Uniform Building Code.
2. Consumer Product Safety Commission, Part 1201, Safety Standards for Architectural Glazing Materials.
3. Glass manufacturer's recommended load tables.
4. Provide complete selection of glass manufacturer's tinted reflective glass tones for selection by ENGINEER.

D. Requirements of Regulatory Agencies:
   1. Wherever a fire-resistance classification is shown or scheduled for doors or interior windows, (1-hour, 2-hour, 3-hour), provide glass complying with the requirements established by UL and other governing authorities.
   2. Safety Glass: Comply with ANSI Z97.1, with label on each piece of glass as required.

E. Allowable Tolerances: Provide tongless temper glass by manufacturer's special process which will insure the strictest possible tolerance; glass shall not exceed the following flatness tolerances (either face, any direction, any location except for 2-inch wide border area) based on 1/4-inch glass thickness with inversely proportionate tolerances of other thicknesses:
   1. For 3-foot run: 1/8-inch bow.
   2. For 7-foot run: 1/4-inch bow.
   3. For 10-foot run: 3/8-inch bow.

F. Source Quality Control:
   1. To the greatest extent possible, provide all glass and glazing materials from one manufacturer.
   2. Manufacturer's of "or equal" products shall be able to supply the same selection of tinted reflective glass colors, light reflectances, shading coefficients and aesthetic effects as provided by the manufacturer specified.

G. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.
   1. ANSI Z97.1, Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings.
   2. ASTM D 1667, Sponge Made from Closed-Cell Polyvinylchloride, or Copolymers Thereof.
   3. Consumer Product Safety Commission, Part 1201, Safety Standard For Architectural Glazing Materials.
   4. FS-DD-G-451d, Glass, Plate, Sheet, Figured (Float, Flat, For Glazing, Corrugated, Mirror and Other Uses).
   5. FS-DD-G-1403B, Glass, Plate (Float), Sheet, Figured, and Spandrel (Heat Strengthened and Fully Tempered).
   6. FS-TT-S-00227E(3), Sealing Compound, Elastomeric Type, Multi-Component (For Caulking, Sealing, and Glazing in Buildings and Other Types of Construction).
   7. Flat Glass Marketing Association (FGMA), Glazing Manual.
   8. U.L., Building Materials Directory.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. 12-inch square samples of each type of tinted reflective insulating glass available from the manufacturer for final selection by ENGINEER. Label each sample with manufacturer's product data and intended aesthetic effect. ENGINEER's review of samples will be for color, texture and aesthetic effect only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.
   2. Insulating glass samples need not be hermetically sealed, but edge construction must be included.

3. 12-inch long samples of each color for each type of glazing sealant or gasket exposed to view. Install sample between two strips of material similar to or representative of channel surfaces where sealant or gasket will be used, held apart to represent typical joint widths. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications, and installation instructions for each type of glass, glazing sealant or compound, gasket and associated miscellaneous material required.
   2. Manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the applications shown.
   3. Plan showing location of each type of glass specified and details of glazing system. Include manufacturer's recommendations for glazing.

C. Certificates: Submit certification that all glass and glazing materials subject to the applicable standards of the Consumer Product Safety Council, Safety Standard for Architectural Glazing Material are in compliance. The certification must be issued in conformance to procedures stated in the standard.

1.4 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery of Materials: Deliver glass with manufacturer's labels intact. Do not remove labels until glass has been installed. Keep glass free from contamination by materials capable of staining glass. Deliver glazing compounds and sealants in manufacturer's unopened, labeled containers.

B. Handling of Materials: Protect glass from edge damage at all times during handling, installation and operation of the building.

1.5 JOB CONDITIONS

A. Environmental Conditions: Do not proceed with installation of liquid glazing sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation. Proceed with glazing only when forecasted weather conditions are favorable to proper cure and development of high early bond strength. Wherever channel action is affected by ambient temperature variations, install glazing sealants only when temperatures are in the middle third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation or compression, and bond stress will not be excessive at extremely low or high temperatures. Coordinate time schedule to avoid delay of project.

1.6 WARRANTY

A. Reflective Coating: Submit copies of written guarantee agreeing to repair or replace glass which fails to perform as specified, including peeling and damage due to normal weather conditions or appear to deteriorate in any other manner not clearly specified by submitted

manufacturer's data as an inherent quality of the material for the exposure indicated, for a period of 10 years. Provide guarantee signed by the installer and CONTRACTOR.

PART 2 - PRODUCTS

2.1 GLASS

A. Clear Wired Glass: Provide the following:
   1. FS-DD-G-451d, Type III, Class 1, Kind A (flat), Form 1, wired and polished both faces, Mesh m1, welded square; 1/4-inch thick except as otherwise shown or specified.
   2. Product and Manufacturer: Provide one of the following:
      a. Polished Plate Wire Glass by PPG Industries, Incorporated.
      b. Or equal.

B. Clear Tempered Insulating Glass: Provide the following:
   1. Manufacturer's standard units of 2 sheets of 1/4-inch thick tempered plate glass, ANSI, 1.97.1, FS-DD-G-14503B, Type I, Quality q3; the outer sheet of clear tempered glass; heat-strengthened by manufacturer's standard process to achieve a flexural strength of 4-1/2 times normal glass strength; permanently and hermetically sealed together at edges with spacers and sealant; to provide a dehydrated air space 1/2-inch thick with -60 F dew point; fabricated to the sizes and shapes shown.
   2. Product and manufacturer: Provide one of the following:
      a. Clear Tempered Twindow by PPG Industries, Incorporated.
      b. Or equal.

C. Bronze Tinted Heat Strengthened Reflective Insulating Glass: Provide the following:
   1. Manufacturer's heat strengthened standard units of 2 sheets of 1/4-inch thick heat strengthened plate glass, FS-DD-G-1403B, Type I, Class 1, Quality q3, the outer sheet of bronze tinted heat strengthened reflective glass, the inner sheet of clear heat strengthened glass; permanently and hermetically sealed together at edges with spacers and sealant edge binding; to provide a dehydrated air space 1/2-inch thick with -60 F dew point; fabricated to the sizes and shapes shown.
   2. Provide the following physical properties:
      a. Daylight Transmittance: 12 percent.
      b. Reflectance: Out - 17 percent; In - 47 percent.
      c. U Factor: 0.31 BTU per hour per square foot per degree F minimum.
   3. Aesthetic Effect: Rose Cinnabar.
   4. Product and Manufacturer: Provide one of the following:
      a. Heat Strengthened Solarban 575-20(2) Bronze Twindow by PPG Industries, Incorporated.
      b. Or equal.

2.2 GLAZING SEALANTS AND TAPES

A. General:
   1. Colors: Provide black or other natural color wherever no other color is available. Wherever material is not exposed to view, provide manufacturer's standard color which has the best overall

performance characteristics for the application shown. Provide manufacturer's standard colors as shown or, if not shown, provide color selected by ENGINEER from manufacturer's standard colors to either blend or contrast with adjoining surfaces.

2. Hardness shown and specified is intended to indicate the general range necessary for overall performance. Consult the manufacturer's technical representative to determine the actual hardness recommended for the conditions of installation and use. Except as shown or specified, provide glazing materials within the following ranges of hardness (Shore A, fully cured, at 75 F):
   a. 15 to 35 for elastomeric compounds and tapes used with rigid stops and frames for large glass sizes (in excess of 100 united inches). Provide material sufficiently hard to withstand exposure to abrasion and vandalism.
   b. 25 to 50 for rubber-like curing compounds used with rigid stops and frames for medium and small glass sizes (less than 100 united inches). Provide materials sufficiently hard to withstand impact of moving sash and doors.
   c. 35 to 60 for molded gaskets used with rigid stops and frames, depending upon strength needed for application or insertion of units.
3. Compatibility: Before purchase of the specified glazing materials, investigate compatibility with the channel surfaces, joint fillers and other materials in the glazing channel. Provide only materials and manufacturer's recommended variation of the specified materials which are known to be fully compatible with the actual installation condition, as shown by manufacturer's published data or certification.

B. Exterior One-Part Silicone Rubber Sealant:
   1. Silicone rubber-based, one-part elastomeric sealant, complying with the following:
      a. FS TT-S-001543, Type 2 (non-sag) Class A.
      b. Provide acid-type wherever both joint faces are metal, glass, plastic or other non-porous material.
      c. Dynamic Movement Capability, FS TTS-001543: ±25 percent.
   2. Product and Manufacturer: Provide one of the following:
      a. Silglaze with primer by General Electric Company.
      b. Proglaze with primer by Tremco Incorporated.
      c. Or equal.

C. Preformed Butyl Rubber Glazing Sealant:
   1. Preformed tape of polymerized butyl or mixture of butyl and polyisobutylene with inert fillers with built-in spacer of synthetic rubber, solvent-based with minimum 95 percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, AAMA 804.1.
   2. Products and Manufacturers: Provide one of the following:
      a. Polyshim Tape by Tremco Manufacturing Company.
      b. PTI 303 Spacer Rod Tape by Protective Treatments, Incorporated.
      c. Or equal.

2.4 MISCELLANEOUS GLAZING MATERIALS

A. Setting Blocks: Neoprene, 70-90 durometer hardness, with proven compatibility with sealants used as recommended by the glass manufacturer.

B. Spacers: Neoprene, 40-50 durometer hardness, with proven compatibility with sealants used as recommended by the glass manufacturer.

C. Compressible Filler Rod: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, proven to be compatible with sealants used, flexible and resilient, with 5-10 pounds per square inch compression strength for 25 percent deflection.

D. Cleaners, Primers and Sealers: Type recommended by sealant, gasket and glass manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glazing is to be performed, and notify ENGINEER in writing of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PERFORMANCE

A. Watertight and airtight installation of each piece of glass is required. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and air- tight, deterioration of glazing materials and other defects in the Work.

B. Glass manufacturer's recommended glazing channel dimensions are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. CONTRACTOR is responsible for correct glass size for each opening, within the tolerances and necessary dimensions established.

3.3 INSTALLATION

A. General:
   1. Comply with combined recommendations of glass, window and sealant manufacturer and other materials used in glazing, except where more stringent requirements are shown or specified, and except where manufacturer's technical representatives direct otherwise.
   2. Comply with Flat Glass Marketing Association, Glazing Manual, except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass and glazing materials.
   3. Inspect each piece of glass immediately before installation, and eliminate any which have observable edge damage or face imperfections.
   4. Unify appearance of each series of lights by setting each piece to match others with their predominant bow in the same direction convex to the exterior. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.

5. Cut and install tinted and reflective glass as recommended in manufacturer's technical bulliten.
6. Do not attempt to cut, seam, nip or abrade glass on site which is tempered, heat strengthened, or coated.

3.4 PREPARATION FOR GLAZING

A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

B. Apply primer or sealer to joint surfaces wherever recommended by sealant and glass manufacturer.

3.5 GLAZING

A. Tape and Sealant Glazing:
   1. Cut glazing tape to length and set against permanent stops. Install horizontal strips first, extending over width of opening, before applying vertical strips. Place setting blocks at quarter points. Remove paper backing from tape. Position glass on setting blocks and press against tape for full contact.
   2. Place glazing tape on free perimeter of glass. Seal butt joints of tape with joint sealant.
   3. Install removable stop, avoiding displacement of tape, and exert pressure on tape for full continuous contact. Calk space above glazing tape to top of glazing stop. Tool exposed surfaces of calking compounds to provide a substantial "wash" away from the glass.
   4. Clean and trim excess glazing materials from the installation, and eliminate stains and discolorations.
   5. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead.

B. Gasket Glazing: Install glass in gaskets as recommended by the glass and window manufacturer. Refer to Sections 8A1, Hollow Metal Door Frames, and Section 8J2, Aluminum Window Walls.

3.6 FIELD QUALITY CONTROL

A. Test for water leaks. Flood the joint exposure with water directed from a 3/4-inch hose held perpendicular to wall face, 2 feet-0 inch from joint, connected to a water system with 30 pounds per square inch minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.

B. Test approximately 5 percent of total glazing system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct tests in the presence of ENGINEER, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.

C. Repair glazing installation at leaks or, if leakage is excessive, replace glazing sealants as directed.

D. Wherever nature of observed leakage indicates the possibility of inadequate glazing joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints have been fully cured, followed by natural exposure through both extreme temperatures, and returned to the range of temperature in which it is feasible to conduct testing. Repair or replace Work as required and directed.

3.7 ADJUSTMENT AND CLEANING

A. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

B. The installer shall advise CONTRACTOR of procedures required for the protection of glass and glazing sealants and compounds during the construction period, so that they will be without deterioration or damage, other than normal weathering, at the time of OWNER'S acceptance.
   1. Furnish specific instructions on the precautions and provisions required to prevent glass damage resulting from the alkaline wash from concrete surfaces and similar sources of possible damage.

C. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.

D. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.

E. Maintain glass in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash-off) to the deterioration of glazing materials and other work.

F. Wash and polish glass on both faces not more than 4 days prior to OWNER'S Final Acceptance of the Work in each area. Comply with glass manufacturer's recommendations.

+ + END OF SECTION + +

SECTION 9A1

FURRING AND LATHING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all furring and lathing Work. The Work also includes:
      a. Providing openings in furring and lathing to accomodate the Work under this and other Sections and building into the furring and lathing all items such as sleeves, anchor bolts, inserts and all other items to be embedded in furring and lathing for which placement is not specifically provided under other Sections.
   2. This Section specifies the furring and lathing Work for cement plaster work specified in Sections 9A3, Cement Plaster.
   3. The extent of furring and lathing, hereby defined to include bases for thick-coat plastering and mortar beds, and metal support systems to receive lathing and similar applied sheet materials, is shown.
   4. The types of furring and lathing Work includes, but is not necssarily limited to, the following:
      a. Runner channel ceiling suspension systems.
      b. Metal furring.
      c. Metal lathing.
      d. Accessories for thick-coat plastering.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with prior to the furring and lathing Work.

C. Related Sections:
   1. Section 7C10, Exterior Wall Insulation and Finish System.
   2. Section 9A3, Cement Plaster.
   3. Section 9A6, Acrylic Stucco.

1.2 QUALITY ASSURANCE

A. Manufacturer: Provide products as manufactured by one of the following:
   1. United States Gypsum Company.
   2. Gold Bond Building Products, Division of National Gypsum Company.
   3. Or equal.

B. Design Criteria: Ceiling and wall support system shall limit deflection of finished ceilings and walls to less than L/360 of span.

C. Allowable Tolerances: For flat surfaces: do not exceed 1/4 inch in 10 feet-0 inches for bow, warp, plumb and level.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. ANSI A42.3, Lathing and Furring for Portland Cement and Portland Cement-Lime Plastering, Exterior (Stucco) and Interior.
   2. ASTM A 90, Tests for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
   3. ASTM A 123, Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
   4. ASTM A 525, Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements.
   5. ASTM A 659, Specification for Steel, Carbon (0.16 maximum to 0.25 maximum, percent) Hot-Rolled Sheet and Strip, Commercial Quality.
   6. Metal Lath Association, Metal Lath Reinforcement for Plaster Bases Other Than Metal Lath.
   7. Metal Lath Association, Specifications for Metal Lathing and Furring.
   8. FS QQ-L-101C, Lath, Metal (And Other Metal Plaster Bases).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval copies of manufacturer's product specifications and installation instructions for each item and each system required in the Work. Include reports and other data as may be required to show compliance with these specifications.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver products and materials in original unopened packages, containers, or bundles with manufacturer's label intact and legible.

B. Storage of Materials: Store metallic materials and accessories indoors, off floor.
   1. Remove items delivered in broken, damaged, rusted, or unlabeled condition from project site immediately.

C. Protection of Materials: Protect metal lath, metal suspension materials, metal studs and metal accessories from dampness or wetting.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Manufacturer's Recommendations: Except where otherwise shown or specified, including the requirements of governing regulations and applicable standards, provide the type, weight, grade and finish of materials, and include for each system the clips, fasteners, ties, reinforcing, stiffeners, shoes, tracks, hangers, brackets, anchors, accessories and trim as recommended by the manufacturer for the application shown or specified.

2. Metal and Finishes: Provide manufacturer's standard galvanized finish on steel products as follows:
   a. Hot-dip Galvanized Finish: ASTM A 525, G 90, for 18 gage and lighter formed metal products, ASTM A 123, galvanized after fabrication, for 16 gage and heavier products.
   b. Exposed Plastering Accessories: Provide solid zinc alloy accessories except where fully concealed in plaster.
3. Wire Tires: Galvanized soft steel wire, 16 gage minimum.

B. Ceiling Suspension/Furring Materials:
1. Runner Channels: 1-1/2-inches, 0.475-pounds per foot cold-rolled or 1.12 pounds per foot hot-rolled.
2. Cross Furring: 3/4-inch by 0.3-pounds per foot cold-rolled channel.
3. Hangers: Wire or rod type of size to comply with ANSI A42.4.
4. Hanger Supports: Sized for pull-out resistance of 5 times calculated hanger loading.

C. Metal Lathing Materials:
1. General: Where not otherwise specified, comply with Metal Lath Association, Specifications for Metal Lathing and Furring, and Technical Bulletin 101, for selection of metal lath for each application specified.
2. Product Standards: Comply with FS QQ-L-101C.
3. Exterior Diamond Mesh Lath: 3.4-pounds per square yard; self-furring type. Manufacturer's recommended base for cement plaster stucco finish and contour plastering. Galvanized as specified.

D. Plastering Accessories and Trim: Provide 26 gage units, G90 galvanized steel for interior use and solid zinc for exterior use of the pattern/profile as shown, manufacturer's standard where not otherwise shown, and coordinate depths with depths of plaster as shown. Include corner beads, exterior corner reinforcement wire, casing beads, joints, caps, screeds, moldings control and expansion joints and similar units as indicated, or required.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine areas to receive furring and lathing Work, including grounds and other accessories which act as grounds, or screeds, and shall notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Ceiling Anchorages: Coordinate Work with structural ceiling work to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling hangers. Refer to Paragraph 1.1.B. herein for the requirements of coordination with others.

3.3 INSTALLATION

A. General: Comply with manufacturer's installation instructions and recommendations.
   1. Comply with Metal Lath Association, Specification for Metal Lathing and Furring, except where otherwise shown or specified.

B. Isolation: Where lathing and metal support system abuts building structure horizontally, isolate the Work from structural movement sufficiently to prevent transfer of loading into the Work from the building structure. Install slip or cushion type joints to absorb deflections but maintain lateral support.
   1. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

C. Fixture Support Framing: Install supplementary framing, blocking and bracing where Work is shown or required to support fixtures, equipment, services, casework, heavy trim and furnishings and similar work requiring attachment and support.

D. Wire Tieing: Except as otherwise specified, tie interior furring with 16 gage wire.

E. Splicing Members: Lap furring members 8 inches and runner channels 12 inches, and wire-tie near each end of lap. Splice plastering accessories by use of concealed splines, anchored to prevent offsets.

F. Installation of Ceiling Suspension:
   1. Space runner channels 4 feet-0 inches on centers; and space hangers along channels 4 feet-0 inches on centers.
   2. Secure hangers to channels and to building structure only, by looping and wire tieing wherever possible.
   3. Level runner channels to a tolerance of 1/8 inch in 12 feet-0 inches.

G. Installation of Metal Furring:
   1. Space furring members 16 inches on centers, except as otherwise indicated.

H. Installation of Metal Lathing:
   1. Install metal lath by wire tieing, to supports or substrate in the manner shown and in accordance with industry standards.
   2. Install with long dimension of lath accross the supports.
   3. Lap sides of wire mesh not less than 1/2 inch. Lap ends not less than 1 inch. Stagger end laps, wire ties, side laps at intervals not to exceed 9 inches, lace end laps.
   4. At external corners, cut and butt lath and provide continuous corner reinforcing.
   5. Provide corner reinforcing at all openings, at all edges of arch at all other exposed corners.

I. Installation of Plastering Accessories:
   1. Anchor each flange of accessories to plaster base 8 inches on centers.
   2. Miter or cope accessory corners, and install with tight joints accurately aligned.

3. Set accessories plumb, level and true to line, with a tolerance of 1/8 inch in 10 feet-0 inches.
4. Install casing beads at terminations of plaster work, except where plaster is shown to pass through other Work and be concealed by lapping Work, and except where special screeds, bases or frames act as casing beads including interior metal door frames. Set casing beads 1/4 inch from abutting frames and other work, for application of sealant.
5. Install prefabricated control joints of one-piece design where shown as control joint.

3.4 CUTTING AND REPAIRING

A. Cut, repair and align furring and lathing as required and as necessary to accommodate other work. Repair bent and dented surfaces. Repair or replace the Work as necessary to comply with specified tolerances.

3.5 CLEANING

A. Remove temporary covering and whatever other provisions were made to minimize debris on other work. Repair surfaces which have been stained, marred or otherwise damaged during the furring and lathing Work. When Work is completed, remove unused materials, containers, and equipment and debris.

B. Take adequate precautions for the protection of furring and lathing from deterioration and damage during remainder of construction period.

+ + END OF SECTION + +

SECTION 9A3

CEMENT PLASTER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all cement plaster Work. The Work also includes:
      a. Providing openings in cement plaster to accomodate the Work under this and other Sections and building into the cement plaster all items such as sleeves, anchor bolts, inserts and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.
   2. The extent of cement plaster is shown.
   3. The types of cement plaster Work required includes, but is not necessarily limited to, the following:
      a. Base coat.
      b. Scratch coat.
      c. Finish Coat.
      d. Miscellaneous materials.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with or prior to the cement plaster Work.
   2. Notify other contractors in advance of the construction of the cement plaster to provide the other contractors with sufficient time for the installation of items included in their contracts that must be installed with the cement plaster.

C. Related Sections:
   1. Section 7C10, Exterior Wall Insulation and Finish System.
   2. Section 9A1, Furring and Lathing.
   3. Section 9A6, Acrylic Stucco.

1.2 QUALITY ASSURANCE

A. Design Criteria: Comply with the recommendations of the Plasterer's Manual, by the Portland Cement Association and the Uniform Building Code, except where more stringent requirements are shown or specified.

B. Allowable Tolerances: For flat or curved surfaces, shall not exceed 1/8-inch in 8 feet for bow or warp of surface, and for plumb or level.

C. Do not use air entraining agents, air entrained lime, or air entrained portland cement.

D. Reference Standards: Comply with applicable provisions and the recommendations of the following, except where otherwise shown or specified.
   1. American Concrete Institute, ACI 306, Recommended Practice for Cold Weather Concreting.
   2. ANSI A42.2, Portland Cement and Portland Cement-Lime Plastering, Exterior (Stucco) and Interior.
   3. ASTM C 150, Portland Cement.

1.3 SUBMITTALS

A. Shop Drawings: Submit copies of manufacturer's product specifications and installation instructions for each product, including data showing compliance with the requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Except for stone aggregate, sand and water, deliver materials to the site in sealed containers or bags fully identified with manufacturer's name, brand, type, and grade.

B. Storage of Materials: Store materials in a dry, well ventilated space, under cover and off the ground.

1.5 JOB CONDITIONS

A. Environmental Requirements:
   1. Cold Weather Requirements: Maintain not less than 40 F temperature in areas to be plastered for a period of not less than 72 hours prior to application, during application, and thereafter.
   2. Warm Weather Requirements: Protect cement plaster Work against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial. Apply and cure cement plaster as required by climatic and job conditions to prevent dryout during cure period. Provide suitable coverings, moist curing, barriers to deflect sunlight and wind, or combinations of these, as required.
   3. Ventilation Requirements: Provide natural or mechanical means of ventilation to properly dry interior spaces after portland cement plaster has been cured.

PART 2 - PRODUCTS

2.1 PLASTERING MATERIALS

A. General: Except as otherwise specified, provide standard products recommended by the manufacturer for the application shown or specified, complying with ANSI A42.2, and provide either neat or ready mixed.

B. Base Coat Cement: Provide one of the following cements, or mixtures thereof where recommended by cement manufacturer.
   1. Portland Cement: ASTM C 150, Type I.

C. Base-Coat Lime: ASTM C 206, Type S finishing hydrated lime.

D. Base Coat Aggregate: Sand, ANSI A42.2.

E. Bonding Agent: Provide a special formulation of acrylic polymers and modifiers designed for use as an additive for portland cement mixes to improve adhesion and mechanical properties. Provide bonding agent for all cement plaster Work.

F. Job Mixed Finish Coat Materials: Products recommended by the manufacturer of job mixing to produce the finish coats specified on portland cement plaster base coats.
   1. Cement: Waterproof white Portland cement, ASTM C 150, Type I.
   2. Aggregate: Natural white sand or ground white stone, graded in accordance with ANSI A42.2 except 100 percent passing the No. 8 sieve.
   3. Lime: ASTM C 206, Type S, special finishing hydrated lime.

2.2 PORTLAND CEMENT PLASTER MIXES

A. General: Except as otherwise specified, comply with ANSI A42.2 for the proportioning of materials and manner of mixing the cement plaster for each required application.

B. Scratch Coat: One sack Portland cement, 2 sacks lime, 7-1/2 cubic feet sand, 2 pounds fiber. Include hair or fiber in mix for the scratch coat on metal lath or reinforcement.

C. Brown Coat: One sack portland cement, 2 sacks lime, 9 cubic feet sand. Include hair or fiber in mix for the brown coat on metal lath or reinforcement.

D. Job Mixed Finish Coat: One part Portland cement, one part lime, 3 parts sand.

E. Mix bonding agent with scratch coat, brown coat and finish coats in strict accordance with manufacturer's written instructions for all mixing and batching.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine surfaces to receive cement plaster Work, including grounds and other accessories which act as grounds or screeds, and shall notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the cement plaster Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Clean plaster bases, and substrates for direct application of portland cement plaster, removing loose material and substances which might impair the Work.

3.3 INSTALLATION OF PORTLAND CEMENT PLASTER AND STUCCO

A. General:
   1. Standards: Except as otherwise shown or specified, comply with ANSI A42.2 and with the recommendations of the "Plasterer's Manual" by Portland Cement Association.
   2. Do not use materials which are frozen, caked or lumpy or which are dirty or contaminated by foreign materials. Use only potable water, free from impurities which might impair the cement plaster Work; do not use water which has been used to clean tools.
   3. Do not use excessive water in the mixing and application of plaster materials.
   4. Sequence plastering applications with other Work and as follows:
      a. In general, complete interior plastering prior to installation of adjoining tile work, acoustical materials and similar finishes.
   5. Plaster flush with metal casing beads and other built-in metal items or accessories which act as a plaster ground, unless otherwise shown.
   6. Use mechanical mixing equipment, except small applications requiring less than one bag of plastering material may be hand mixed.

B. Plaster Applications:
   1. Apply 2-coat plaster over metal lath and metal reinforced substrates (scratch, brown and finish coats).
   2. Plaster Thicknesses: Apply total plaster thicknesses as shown or specified. If not shown, comply with ANSI A42.2.
      a. Apply finish coat plaster not less than 1/8-inch thick, and increase thickness as required to achieve required texture, pattern, embedment of exposed aggregate, or other finish requirements as specified.

C. Finish Coat Texture/Pattern:
   1. Sand Float Plaster Finish: Float finish coat application to a uniform sand float texture. Match sample or mock-up or, if none, provide normal sand float texture as directed by ENGINEER.

D. Curing Portland Cement Plaster: Protect each coat of portland cement plaster Work from dry out for a period of 20 to 24 hours after placement or until curing operation will not damage surface, and moisture cure not less than 48 hours after time of placement. Moisture cure by maintaining in a moist condition, by frequent fog-spraying with water and by protecting from fast dry out with covering of polyethylene film or similar enclosure. Dry each coat to a uniform moisture content before installing succeeding coat, and do not install finish coat until base coat has been dried at least 5 days.

3.4 CUTTING AND PATCHING

A. Cut, patch, repair and point-up portland cement plaster as required and as necessary to accommodate and provide acceptable substrate for other work. Repair cracks and indented surfaces. Point-up finish cement plaster surfaces around items which are built into or penetrate cement

plaster surfaces. Repair or replace the Work to eliminate blisters, buckles, check cracking, dry outs, efflorescence, excessive pinholes, and similar imperfections. Repair or replace the Work as necessary to comply with specified tolerances and required visual effects.

3.5 CLEANING AND PROTECTION

A. Remove temporary covering and whatever other provisions were made to minimize spattering of cement plaster on other work. Promptly remove cement plaster from door frames, windows and other surfaces which are not to be plastered. Repair surfaces which have been stained, marred or otherwise damaged during the cement plastering Work. When cement plastering Work is completed, remove unused materials, containers, and equipment and cement plaster Work debris.

B. Protect portland cement plaster from deterioration and damage during remainder of construction period.

+ + END OF SECTION + +

SECTION 9A6

ACRYLIC STUCCO

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all acrylic stucco as shown and specified.
   2. The extent of the acrylic stucco is shown.
   3. The types of acrylic stucco Work required includes, but is not necessarily limited to, the following:
      a. A ready-mixed acrylic-based textured interior wall coating system including all additives, components, primers and ground coats and reinforcing meshes as recommended by the manufacturer for application over properly prepared concrete unit masonry, and cement plaster.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed prior to the acrylic stucco Work.
   2. Review installation procedures under other Sections and coordinate the Work to produce substrate surfaces free from contaminants incompatible with the acrylic stucco Work, and substrates acceptable to the acrylic stucco installer for completely acceptable product performance.

C. Related Sections:
   1. Section 4C3, Concrete Unit Masonry.
   2. Section 7C10, Exterior Wall Insulation and Finish System.
   3. Section 9A3, Cement Plaster.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer regularly engaged in acrylic stucco Work, and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Engage an installer approved by the manufacturer.

B. Design Criteria:
   1. Comply with the recommendations of the Plasterer's Manual, by the Portland Cement Association and the applicable Building Code, except where more stringent requirements are shown or specified.
   2. In order to insure complete product compatibility and bondability of the completed acrylic stucco finish system Work, CONTRACTOR may, with the approval of ENGINEER, submit manufacturer sub- components of the acrylic stucco finish system Work which the manufacturer certifies in writing to ENGINEER, to be more appropriate to the

substrate or job conditions encountered. All such approved substitutions shall be at no additional cost to OWNER. Reinforcing mesh shall be provided without substitution as specified herein.

3. Final selection of products shall be made from manufacturer's complete selection of highest quality products at no additional expense to OWNER.
4. It is required that all interior concrete unit masonry mortar joints scheduled to receive acrylic stucco finish system shall be visually eliminated in the finished Work.

C. Allowable Tolerances:
1. Flat Surfaces: Do exceed 1/8-inch in 8 feet for bow or warp of surface, and for plumb or level.
2. Color Breaks: Do not exceed 1/8-inch in 8 feet out-of-alignment from color break lines shown on the Drawings.

D. Source Quality Control: Obtain all materials from the same manufacturer. Obtain materials only from manufacturers who will:
1. Provide the services of a qualified manufacturer's representative at the project site at the commencement of Work and during the time when the mock-up Work is being done to advise on materials, installation and finishing techniques.
2. Certify long term compatibility of all coatings with the substrates.
3. Do not use air entraining agents, air entrained lime, or air entrained portland cement.

E. Job Mock-Ups:
1. Prior to the installation of the acrylic stucco Work, but after ENGINEER'S approval of the samples of material, build a free-standing 4 foot by 6 foot sample panel of each type of complete acrylic stucco system over each substrate encountered in the Work, to show a representative installation of the complete interior acrylic stucco Work including final texture and colors. Obtain ENGINEER'S acceptance of visual qualities of the mock-ups before start of acrylic stucco Work. Retain and protect mock-ups during installation as a standard for judging completed acrylic stucco Work. Do not alter approved mock-ups. Build as many sample panels as required to obtain ENGINEER'S acceptance of the Work.
2. Acrylic stucco Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material, as required by ENGINEER.

F. Reference Standards: Comply with applicable provisions and recommendations, except as otherwise shown or specified.
1. ASTM E 84, Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. Complete selection of manufacturer's standard colors and textures for selections by ENGINEER.
2. 12-inch by 12-inch samples of each color and texture selected by ENGINEER on substrate simulating each actual project substrate.

3. Each component material to be used in the Work.
4. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
1. Manufacturer's specifications and installation instructions for each component of the acrylic stucco system.
2. Manufacturer's complete selection of standard and custom colors and textured finish coats.

C. Test Reports: Submit for approval certified laboratory test reports for required preformance tests.

D. Certification: Certify that all coatings are compatible with substrates as specified.

E. Maintenance Manual: Submit copies of bound maintenance manual for the acrylic stucco Work. Include instructions for cleaning, repair and general maintenance Work. Include manufacturer's data on all components of the acrylic stucco Work and name, address and telephone number of manufacturer, installer and local product distributer.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver materials in acrylic stucco manufacturer's original unopened packages.
2. Include the following information on the label:
   a. Name of material and supplier.
   b. Formula or specification number, lot number, color and date of manufacture.
   c. Mixing instructions, shelf life and curing time when applicable.
3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by ENGINEER, and his requiring its removal from the site. Supply new material conforming to the specified requirements at no additional cost to OWNER.

B. Storage of Materials:
1. Store materials so as to preclude the inclusion of foreign materials.
2. Store in accordance with manufacturer's recommendations in a clean, dry, well-ventilated area.
3. Store materials out of direct sunlight and at a temperature of not less than 40 F.

C. Handling:
1. Handle materials carefully to prevent inclusion of foreign materials.
2. Do not open containers or mix components until necessary preparatory Work has been completed and installation will start immediately.
3. Do not expose combustible or sensitive material to excessive heat or open flame.

1.5 JOB CONDITIONS

A. Environmental Conditions:
   1. Proceed with the acrylic stucco Work only when conditions will permit unrestricted use of materials and quality control of the Work being installed, complying with the Specification requirements and with the recommendations of the acrylic stucco materials manufacturer.
   2. Do not proceed with the installation of acrylic stucco until temperature and humidity conditions within the building are being, and will continue to be, maintained within final occupancy range.
   3. Proceed only when CONTRACTOR and his installer are willing to guarantee the Work as required and without additional reservations and restrictions.

B. Scheduling: Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the acrylic stucco system Work are at the site and have sufficient materials and resources to complete the Work in a manner which shall reveal no inconsistancies of texture, color or allowable tolerance in the finished Work greater than that which has been approved on the sample panels by ENGINEER.

C. Protection:
   1. Do not allow finish system Work to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining materials.
   2. Draw all color break lines accurately and to the tolerances specified.
   3. Protect materials against damage by construction traffic.

1.6 GUARANTEE

A. CONTRACTOR shall execute his own written guarantee direct to OWNER warranting all acrylic stucco system Work color fast, and non-crazing, cracking or delaminating for a period of three years after the date of conditional acceptance thereof by OWNER. Imperfections, by reason of defective materials, workmanship or arrangement of the various parts shall be made good to the satisfaction of OWNER at CONTRACTOR'S expense.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Unit Masonry:
   1. Concrete Unit Masonry Primer: Provide a solvent based acrylic polymer substrate hardener and sealer capable of consolidating and preventing saponification.
   2. Ground Coats: For primed concrete unit masonry provide a water based co-polymer emulsion containing quartz sands and other special fillers and requiring the addition of 20 percent by weight of portland cement, as recommended by the acrylic stucco manufacturer.

3. Ground Coat Primer: Provide manufacturer's recommended acrylic co-polymer emulsion primer with titanium dioxide, extenders and calcium carbonate and quartz fillers, as an adhesion and water-resistance-enhancing intermediary coat over the ground coat. Provide primer tinted to match finish coat.
4. Reinforcing Mesh: Provide the following:
   a. Alkali-resistant glass fiber symmetrically interlaced, made from twisted multi-end strands.
   b. Glass fibers coated with a minimum of 20 grams of styrene butadine per square yard.
   c. Product and Manufacturer: Provide the following:
      1) Reinforcing Mesh by STO Energy Conservation Incorporated.

B. Textured Wall Finish: Provide a ready-mixed water-based co-polymer acrylic wall coating capable of achieving a uniform smooth stucco effect, containing marble aggregate, fine pigments and fillers. Comply with the following:
1. Particle Size: 1.0 millimeter.
2. Color:
   a. Complete selection of manufacturer's standard and custom colors. ENGINEER will select a maximum of 20 different colors or tones.
   b. A maximum of two colors may be required on any walls designated in the Room Finish Schedule as receiving interior textured wall finish.
3. Texture: Smooth stucco effect. Final exact texture to be selected by ENGINEER from manufacturer's complete selection of available smooth and uniformly straited finishes. ENGINEER will select a maximum of three textures to be used in the Work.
4. Weather Resistance: Extremely resistant.
5. Hardness: Very resistant to mechanical stress. Scratch and impact resistant.
6. Flexibility: Very flexible; capable of bridging normal shrinkage cracks.
7. Surface Burning Characteristics, ASTM E 84:
   a. Flame Spread Rating: 20 maximum.
   b. Fuel contributed: 0.
   c. Smoke Development: 20 maximum.
8. Manufacturer's of "or equal" products and systems shall provide exactly the same complete selection of standard and custom colors and textures as the manufacturer specified.
9. Product and Manufacturer: Provide the following:
   a. STOLIT K-1 by STO Energy Conservation Incorporated.

C. Miscellaneous Meterials:
1. Water: Free from injurious amounts of impurities and potable.
2. Portland Cement: ASTM C 150, Type I.

2.2 MIXES

A. Stir co-polymer based adhesive, ground coat and leveler following manufacturer's written instructions, prior to the addition of Type I portland cement.

B. Anti-freeze, acclerators and rapid binders shall not be approved.

C. Primer: Mix thoroughly with 10 percent by weight of clean water.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates to receive acrylic stucco system Work, and the conditions under which the Work is to be performed, and notify ENGINEER in writing of any conditions detrimental to the proper and timely completion of the Work and performance of the acrylic stucco Work. Do not proceed with the acrylic stucco Workuntil unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Prime all concrete unit masonry with primer specified and coordinate finishing of concrete unit masonry as required by acrylic stucco system manufacturer.

B. Tint primer to match finish color of wall following manufacturer's written instructions.

3.3 INSTALLATION

A. Primed Concrete Unit Masonry:
   1. Level specified ground coat and embed standard reinforcing mesh into the wet ground coat.
   2. Overlap mesh seams a minimum of 2-1/2-inches and smooth surface with a large stainless steel trowel. Allow to dry 24 hours.
   3. Apply ground coat primer, tinted to match the finish coat, over the entire surface receiving the finish coat at the rate of approximately 0.05-0.06 pounds per square foot or more as required to visually eliminate all concrete unit masonry mortar joints. Let dry thoroughly before applying finish coat.
   4. Apply finish coat to provide colors and textures approved by ENGINEER using a clean plastic trowel following manufacturer's written instructions and as specified in 3.3.A. above.

3.4 ADJUSTMENT, CUTTING AND PATCHING

A. Cut, patch, and repair acrylic stucco finish coat Work as required and as necessary to accommodate and provide acceptable substrate for other work. Repair cracks and indented surfaces. Point-up finish surfaces around items which are built into or penetrate the gypsum wallboard system Work.

B. Repair or replace the Work to eliminate blisters, buckles, check cracking, dry outs, excessive pinholes, and similar imperfections. Repair or replace the Work as necessary to comply with specified tolerances and required visual effects.

C. Protect acrylic stucco system Work so as to be clean and undamaged at the time of Final Acceptance.

D. ENGINEER may require additional finish coats if, in the opinion of ENGINEER, the finish is inconsistent in color, texture, or has holidays, areas of unusual porosity or other imperfections.

E. Only the installer shall repair or replace deteriorated or defective Work.

F. Clean the acrylic stucco finish system Work as recommended by the manufacturer.

3.5 CLEANING AND PROTECTION

A. Remove temporary covering and whatever other provisions were made to minimize spattering of ground, primer and finish coats on other work. Promptly remove primer and finish coats from surfaces which are not to be finished as part of the Work of this Section. Repair surfaces which have been stained, marred or otherwise damaged during the acrylic stucco finish system Work. When acrylic stucco finish system Work is completed, remove unused materials, containers, and equipment and other debris caused by the Work of this Section.

B. Protect acrylic stucco system Work from deterioration and damage during remainder of construction period.

+ + END OF SECTION + +

SECTION 9C1

CERAMIC TILE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all ceramic tile Work.
   2. The extent of ceramic tile is shown.
   3. The types of ceramic tile Work required includes, but is not necessarily limited to, the following:
      a. Ceramic stone porcelain unpolished floor tile.
      b. Mortar setting bed.
      c. Grouts.
      d. Marble thresholds.
      e. Miscellaneous materials and accessories.

B. Related Sections:
   1. Section 3D, Cast-In-Place Concrete.
   2. Section 4A, Mortar.

1.2 QUALITY ASSURANCE

A. Design Criteria:
   1. Furnish tile conforming with the Standard Grade Requirements of Tile Council of America A137.1.
   2. Specified Manufacturer's written recommendations concerning layout, workmanship and installation shall be considered part of this specification.

B. Source Quality Control:
   1. Provide materials obtained from only one source for each type of ceramic tile and color to minimize variations in appearance and quality.
   2. Obtain all material from manufacturer's who are licencees of the Tile Council of America, Incorporated, or who agree to supply licensed products, where applicable.
   3. Where manufacturer's of specific products require, provide manufacturer's recommended primers, adhesive, sealants and edging strips.
   4. Manufacturer's of "or equal" material shall provide exactly the same physical properties, colors, sizes, back mounting, pregrouting and accessories as manufacturers specified.

C. Installer Qualifications:
   1. Engage a single installer regularly engaged in performing ceramic tile Work and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work.

2. Submit name and qualification to ENGINEER.
3. Engage an installer who agrees to use only the highest quality installation techniques in order to provide a minimum of 95 percent average contact areas on all ceramic tile Work.

D. Installation Tolerances:
1. Limit out-of-plane variation of all ceramic tile Work to 1/4-inch in 20 feet, but provide uniform slopes to drain as shown for floor tile.
2. Limit height offsets between individual ceramic tile to 1/32-inch.
3. Limit joint width variation to 1/16-inch plus or minus in 20 feet.
4. Provide minimum average contact area of 95 percent for all Work.

E. Job Mock-Ups:
1. Prior to the installation of ceramic tile and accessories, but after ENGINEER'S approval of samples and Shop Drawings, install 4-foot square sample of each type of ceramic tile system, in areas selected by ENGINEER to show a representative installation of the Work. Obtain ENGINEER'S acceptance of visual qualities of the mock-up before start of the ceramic tile Work. Retain and protect mock-up during construction as a standard for judging completed ceramic tile Work. Do not alter mock-up.
2. Ceramic tile Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material, as required by ENGINEER.
3. Indicate to ENGINEER back buttering techniques and "laying down" techniques to be used in the Work.

F. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. Tile Council of America, Handbook for Ceramic Tile Installation.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. Full size unit of each type and color of tile required but not less than 8-inch by 8-inch sample for tile of smaller size. Review will be for color, pattern and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.
2. Manufacturer's full selection of standard and custom color grout samples.

B. Shop Drawings: Submit for approval the following:
1. Copies of manufacturer's technical information and installation instructions for all materials required.
2. Include certifications and other data as may be required to show compliance with these Specifications.
3. Complete dimensioned plans and elevations at 1/4 scale showing all accent stripe locations, tile fields and control joint locations and details. Show location and details of all special shapes and trim. Show modular planning to minimize ceramic tile cutting.
4. Proposed installation specifications and details for each area of the Work based on TCA, Handbook details for Ceramic Tile Installation.

C. Certificate:
   1. Furnish Master Grade Certificate for each type of ceramic tile, signed by manufacturer and installer.

D. Maintenance Stock:
   1. At time of completing the installation, deliver stock of maintenance material to OWNER. Furnish full size units matching the units installed, packaged with protective covering for storage, and identified with appropriate labels.
   2. Furnish an amount equal to 5.0 percent of the amount installed.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver packaged materials and store in original containers with seals unbroken and labels intact until time of use, in accordance with manufacturer's directions.
   2. Ceramic floor tile materials shall bear the Tile Council triangular hallmark.
   3. Provide identification and formula numbers on containers of setting and grouting materials produced under TCA license.

B. Storage of Materials:
   1. Store only acceptable materials on project site.
   2. Store materials so as to preclude the possibility of contamination by foreign matter.

C. Handling of Materials:
   1. Handle materials carefully to prevent inclusion of foreign materials.
   2. Do not open containers or mix components until necessary preparatory Work has been completed and installation will start immediately.

1.5 JOB CONDITIONS

A. Environmental Conditions: Maintain a temperature of not less than 50 degrees F during ceramic tile installation and for 7 days after completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ceramic Stone Porcelain Tile: Provide the following:
   1. Unpolished fully vitrified stone porcelain ceramic tile fired at 2300 F. with flat patterned backs.
   2. Physical Properties: Provide the following:
      a. Water Absorption, ASTM C 373: 0.1 percent maximum.
      b. Abrasive Wear, ASTM C 501: 155 minimum.
      c. Breaking Strength, ASTM C 648: 420 pounds minimum.
      d. Bond Strength, ASTM C 482: 315 pounds per square inch minimum.
      e. Co-efficient of Friction (unpolished), ASTM C 21: .6-.7 minimum.

f. Facial Dimension (Range), ASTM C 499: 0.5 percent maximum.
g. Range of Thickness, ASTM C 499: ±6.25 percent maximum.
h. Diagnonal Warpage, ASTM C 485: ±0.5 percent maximum.
i. Wedging, ASTM C 502: 0.66 percent maximum.

3. Size: 7-3/4-inches by 7-3/4-inches by 5/16-inch.
4. Colors: C 533 Opal.
5. Product and Manufacturer: Provide one of the following:
   a. Genesis by Crossville Ceramic Incorporated.
   b. Or equal.

B. Mortar: Provide the following:
1. Bond Coat: Portland cement paste on a plastic bed or latex-portland cement mortar on a cured bed.
2. Latex-Portland Cement Mortar: Provide a presanded portland cement mortar with latex additives complying with ANSI A118.4.
3. Product and Manufacturer: Provide one of the following:
   a. Tile-Mate/Sanded/912/964 with Tile Mate Latex Additive by Upco Company, Division of the Emhart Chemical Group.
   b. Polycrete Latex Mortar by L&M-Surco Manufacturing Company.
   c. Or equal.

C. Grouts: Provide the following:
1. Provide a compound of portland cement and additives, factory-blended to decrease shrinkage and increase moisture resistance.
2. Color: To be selected by ENGINEER from manufacturer's standard and custom colors. ENGINEER will select a maximum of three grout colors.
3. Product and Manufacturer: Provide one of the following:
   1. Hydroment Joint Filler with Latex Additive by Upco Company, Division of the Emhart Chemical Group.
   2. Latex Modified Floor Grout by L&M-Surco Manufacturing Company.
   3. Or equal.

D. Miscellaneous Materials and Accessories: Provide the following:
1. Portland Cement: Comply with ASTM C 150, Type 1.
2. Aggregate: Provide sand complying with ASTM C 144. Provide clean, graded sand passing a 16-mesh screen.
3. Thresholds:
   a. Provide sound Group "A" marble with an abrasive hardness of not less than 10.0 when tested in accordance with ASTM C 241.
   b. Provide white marble for thresholds, where shown on the Drawings, and as scheduled.
4. Water: Potable.
5. Metal Lath: Galvanized expanded metal lath 3.4 pounds per square yard.
6. Reinforcing Wire Fabric: 2-inch by 2-inch mesh, 16/16 wire complying with ASTM A 82 and ASTM A 185.
7. Cleavage Membrane: Provide polyethylene sheeting, 4-mils thick, complying with ASTM C 171.
8. Expansion Joints: Provide expansion joint materials in accordance with TCA "Handbook for Ceramic Tile Installation" Method EJ 171, and applicable ANSI installation standards.

2.2 MORTAR MIXES

A. Follow recommendations of TCA "Handbook for Ceramic Tile Installation" specification numbers specified herein.
   1. Machine mix in approved mixer in which the quantity of water is accurately and uniformly controlled.
   2. Add only enough water to produce a workable mix allowing for maximum compaction during tamping of the mortar bed.

B. Comply with manufacturer's instructions and specified ANSI standard for the mixing of setting mortars, grouts and other materials.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the substrate and the conditions under which mortar bed and ceramic tile Work is to be installed and notify ENGINEER in writing of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Inspect substrates to assure compliance with the applicable substrate tolerances contained in specified ANSI standards.

C. Follow all recommendations for condition and inspection of surfaces including tolerances contained in the "General Conditions" of ANSI "Specifications for the Installation of Ceramic Tile'.

3.2 PREPARATION

A. Prepare all substrates in accordance with ANSI A108.1.

B. Clean substrate of all waxy or oily films and curing compounds.

C. Install cleavage membrane and reinforcing fabric over all areas receiving mortar bed.

D. Install mortar bed in accordance with ANSI A108.1. Install mortar bed continuous under all interior partitions.

E. Provide a structurally sound, dry substrate free of ridges and depressions finished in compliance with the installation method specified.

F. Neutralize and seal substrates in accordance with bond coat manufacturer's instructions, where required.

3.3 INSTALLATION

A. Comply with the Tile Council of America standard installation specifications as follows:
   1. F111 for all floor tile.

B. Prior to setting, all ceramic stone porcelain tile shall be back buttered. All notched trowel-applied adhesives shall be laid down by lightly troweling the back buttered tile to assure a minimum average contact area of ceramic stone porcelain tile with substrate of 95 percent.

C. Take extra care in setting the ceramic stone porcelain tile. User glazier suction cups to press and slide each tile into place.

D. Use of vibration to achieve maximum contact area will be permitted by ENGINEER.

E. Handle, store, mix and apply proprietary setting and grouting materials in compliance with the manufacturer's instructions.

F. Extend mortar bed and ceramic tile Work into recesses and under and behind equipment, fixtures and lockers, to form a complete covering without interruptions. Terminate Work neatly at obstructions, edges and corners without disruption of pattern or joint alignment.

G. Accurately form intersections and returns. Perform cutting and drilling of ceramic tile without marring visible surfaces.

H. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight, aligned joints. Cut and ground edges shall be uniform and straight without marring ceramic tile faces. Fit tile closely to electrical outlets, piping, and fixtures so that plates, collars, or covers overlap tile.

I. Setting Beds:
   1. Latex-Portland Cement Mortar: ANSI A108.5.
   2. Set marble thresholds in the same type mortar as ceramic floor tile.

J. Jointing Pattern:
   1. Lay ceramic tile in staggered running bond pattern with joint of tile in one row centered with body of tile in next. Layout ceramic tile Work and center tile fields both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise shown.

K. Expansion and Control Joints:
   1. Install expansion joint in locations and in the manner recommended by the Method EJ171 of Tile Council of America, Incorporated, and as shown. Whether or not shown on the Drawings the maximum distance between exterior expansion joints shall be 12 foot-0 inches.
   2. Locate openings for expansion joints directly over structural joints in horizontal surfaces, where backing materials change and where ceramic tile Work abuts restraining surfaces such as perimeter walls, curbs, columns and pipes.
   3. Width of openings for expansion joints over structural joints shall be at least as wide as the structural joint.
   4. Provide expansion joints 1/4-inch wide.

L. Grout all ceramic tile with latex-portland cement grout.

M. Cure ceramic tile Work using materials and techniques recommended by the mortar and grout manufacturer.

N. Do not use chipped, cracked or defaced ceramic tile.

O. Remove grout and mortar from ceramic tile faces before it hardens on face of ceramic tile or adjoining work.

P. Install removable divider and accent strips to the same depth as the finished ceramic floor tile system, including setting bed.

3.4 ADJUSTMENT AND CLEANING

A. Cleaning:
   1. Clean grout and setting materials from face of ceramic tile while materials are workable. Leave ceramic tile face clean and free of all foreign matter.
   2. Unglazed tile may be cleaned with acid solutions only when permitted by the ceramic tile and grout manufacturer's printed instructions, but not sooner than 14 days after installation. Protect metal surfaces, cast iron and vitreous plumbing fixtures from effects of acid cleaning. Flush the surface with clean water before and after cleaning.

B. Finished Ceramic Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, or otherwise defective ceramic tile Work. Remove cracked, broken, unbonded or damaged ceramic tile Work and replace with new at no further cost to OWNER.

C. Protection:
   1. When recommended by ceramic tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors.
   2. Protect installed ceramic tile Work with Kraft paper or other heavy covering during the construction period to prevent damage and wear. Lay board walkways on floors that are to be trucked over. Provide continuous runways of required width installed over building paper.
   3. Prohibit all foot and wheel traffic from using ceramic tiled floors for at least 7 days.
   4. Before final inspection, remove protective coverings, rinse neutral cleaner from all ceramic tile surfaces and wash all floors and walls clean.

+ + END OF SECTION + +

SECTION 9E1

ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all acoustical ceilings Work. The Work also includes:
      a. Providing openings in acoustical ceilings to accommodate the Work under this and other Sections and building into the acoustical ceilings all items such as sleeves, anchor bolts, inserts and all other items to be embedded in acoustical ceilings for which placement is not specifically provided under other Sections.
   2. The extent of acoustical ceilings are shown.
   3. The types of acoustical ceiling Work required includes, but is not necessarily limited to, the following:
      a. Acoustical panel ceilings, exposed suspension.
      b. Miscellaneous fasteners, clips, hangers, wire and other accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the acoustical ceilings.

C. Related Sections:
   1. Section 15H20, Ductwork and Accessories.
   2. Division 16, Electrical (Lighting and Devices).

1.2 QUALITY ASSURANCE

A. Erector Qualifications: The erector of the acoustical ceilings shall be an installation firm regularly engaged in the erection of ceilings for at least 5 years.

B. Design Criteria:
   1. Standards for Terminology and Performance: Applicable publications by the Acoustical and Insulating Materials Association (AIMA), including "Performance Data, Architectural Acoustical Materials".

C. Requirements of Regulatory Agencies:
   1. Light Reflectance Ratings: Except as otherwise shown or specified, provide factory-finished acoustical tile which has been tested by a recognized testing laboratory, in accordance with the procedures of ASTM C 523, to show a light reflectance rating of not less than the required rating indicated.
      a. Light Reflectance: Not less than 75 percent (AIMA value "a").

2. Noise Reduction Coefficient (NRC): The average of sound absorption coefficients (tested in accordance with ASTM C 423) reported by AIMA method for a specification range of 10 points, for middle frequencies of 250, 500, 1000, and 2000 Hertz. Provide not less than the required NRC rating specified.
   a. NRC Rating: Range of 0.60 - 0.70, except as otherwise specified.
3. Sound Transmission: Provide tile which has been sound transmission loss through the acoustical tile ceiling, determined in accordance with ASTM E 90 and ASTM E 413, and reported as a 5 Db range. Provide not less than the required STC class specified.
   a. STC Class: Range of 35-39, for mounting No. 7 except as otherwise specified.

D. Allowable Tolerances:
1. Surfaces to receive acoustical treatment: free from irregularities and level to within 1/4 inch in 12 feet.
2. Deflection:
   a. Suspension system components, hangers, and fastening devices supporting light fixtures, ceiling grilles, and acoustical units: maximum deflection 1/360 of the span.
   b. Deflection test: ASTM C 635.
3. Allowable tolerance of finished acoustical ceiling system: level within 1/8 inch in 12 feet.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. Acoustical and Insulating Materials Associations Performance Data, Architectural Acoustical Materials.
2. ASTM A 641, Zinc Coated (Galvanized) Carbon Steel Wire.
3. ASTM C 423, Methods of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.
4. ASTM C 523, Methods of Test for Light Reflectance of Acoustical Materials by the Intergrating Sphere Reflectometer.
5. ASTM C 635, Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
6. ASTM E 413, Sound Transmission Class, Classification for Determination of.

1.3 SUBMITTALS

A. Samples:
1. Submit for approval 12-inch square samples for each acoustical unit required. Samples shall show the full range of exposed color and texture to be expected in the completed Work. ENGINEER'S review will be for color and texture only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.
2. Submit for approval 12-inch long samples of each exposed runner and molding. ENGINEER'S review will be for color and texture only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings:
   1. Submit for approval copies of manufacturer's product specifications and installation instructions for each acoustical ceiling material required, and for each suspension system. Include certified laboratory test reports and other data as required to show compliance with these Specifications.
      a. Include manufacturer's recommendations for cleaning and refinishing acoustical units, including precautions against materials and methods which may be detrimental to finishes and acoustical performances.
   2. Submit for approval Shop Drawing details and reflected ceiling plans of suspension systems specified in this Section. Show location of ceiling units and other items of Work which are to be coordinated with the ceiling, and show framing and support details for Work supported by the suspension system. Certify compliance with ASTM C 635 and other specified requirements, and indicate structural classification of each type of suspension system.

C. Maintenance Stock:
   1. At time of completing the installation, deliver stock of maintenance material to OWNER. Furnish full size units matching the units installed, packaged with protective covering for storage, and identified with appropriate labels.
      a. Acoustical Units: Furnish an amount equal to 5.0 percent of the amount installed.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in original, unopened, protective packaging, with manufacturer's labels indicating brand name, pattern, size and thickness as applicable, legible and intact.

B. Storage of Materials:
   1. Store materials in original protective packaging to prevent soiling, physical damage or wetting.
   2. Store cartons open at each end to stabilize moisture content and temperature.
   3. Do not begin installation until sufficient materials to complete room are received.

1.5 JOB CONDITIONS

A. Environmental Requirements:
   1. Complete installation of dampening materials before beginning work.
   2. Maintain humidity of 65 to 75 percent in area where acoustical materials are to be installed 25 hours before, during, and 25 hours after installation.
   3. Maintain a uniform temperature in the range of 55 F prior to and during installation of materials.
   4. Do not install interior acoustical ceilings until space has been enclosed and is weather-tight, and until wet-Work in the space has been completed and is nominally dry, and until Work above ceilings has been completed, and ambient conditions of temperature and humidity are continuously maintained at values near those indicated for final occupancy.

PART 2 - PRODUCTS

2.1 CEILING UNITS

A. Acoustical Panels:
   1. General: Unless otherwise specified, provide standard lay-in panels of the type recommended by the manufacturer for the application shown or specified. Provide 24-inch by 24-inch grid-size panels.
   2. Mineral Fiber Acoustical Panels: Provide units not less than 3/4-inch thick and of density not less than 10 pounds per cubic foot, medium-coarse non-directional texture, NRC 0.50 to 0.60, STC 30-34, light reflectance over 75 percent.
   3. Provide washable plastic coating finish. Color to be selected by ENGINEER from manufacturer's complete selection of standard colors.
   4. Product and Manufacturer: Provide one of the following:
      a. Classic-Step Cirrus Travertone by Armstrong Cork Company.
      b. Or equal.

2.2 CEILING SUSPENSION MATERIALS

A. General: Comply with ASTM C 635, as applicable to the type of suspension system required for the type of ceiling units specified. Coordinate with other Work supported by or penetrating through the ceilings, including light fixtures and HVAC equipment. Refer to paragraph 1.2.B. for other requirements of coordination.
   1. Structural Class: Intermediate-duty system.

B. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung.
   1. Hanger Wires: Galvanized carbon steel, ASTM A 641, soft temper, prestretched, yield-stress load of at least 3 times design load, but not less than 12 gage.

C. Edge Moldings: Manufacturer's standard white baked enamel aluminum molding for penetrations of ceiling, with a single flange of molding exposed; "W" molding at edges.

D. Exposed Suspension System: Manufacturer's standard exposed runners, cross-runners and accessories, of the types and profiles recommended by the manufacturer to be compatible with acoustical panels specified and with exposed cross runners coped to lay flush with main runners.
   1. Finish of Exposed Members: Provide uniform factory-applied finish on exposed surfaces of ceiling suspension system including moldings, trim and accessories.
      a. Finish: Manufacturer's standard baked enamel finish. Color to be selected from the manufacturer's standard colors.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and conditions under which the acoustical ceiling Work is to be performed and notify

ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. General: Install materials in accordance with manufacturer's instructions.

B. Arrange acoustical units and orient directionally-patterned units (if any) in the manner shown by reflected ceiling plans.
   1. Install tile with pattern running in one direction.

C. Install suspension systems to comply with ASTM C 636, with hangers supported only from building structural members as shown. Locate hangers near each end and spaced 4 feet along each carrying channel or direct-hung runners, unless otherwise shown.
   1. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws or other devices approved by ENGINEER.

D. Install edge moldings of the type shown at edges of each acoustical ceiling area, and at locations where edge of units would otherwise be exposed after completion of the Work.
   1. Sealant Bed: Apply continuous ribbon of acoustical sealant, concealed on back of vertical leg before fastening to vertical surface.
   2. Secure moldings to building construction by fastening with screw-anchors into the substrate, through holes drilled in vertical leg. Space holes not more than 3 inches from each end and not more than 16 inches on centers along each molding.
   3. Level moldings with ceiling suspension system, to a level tolerance of 1/8 inch in 12 feet.
   4. Miter corners of moldings accurately to provide hair-line joints, securely connected to prevent dislocation.

E. Cope exposed flanges of intersecting suspension system members, so that flange faces will be flush; cope flange of member supported by other member.

F. Install acoustical panels in suspension system as recommended by the manufacturer.

3.3 ADJUSTMENT AND CLEANING

A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace Work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

B. The installer shall advise CONTRACTOR and ENGINEER of required protection for the acoustical ceilings, including temperature and humidity limitations and dust control, so that the Work will be without damage and deterioration at the time of acceptance by OWNER. CONTRACTOR shall provide required protection.

+ + END OF SECTION + +

SECTION 9K1

CONCRETE HARDENER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all concrete hardener Work.
   2. The extent of the concrete hardener includes all interior concrete floors not covered with ceramic tile.
   3. The types of concrete hardener Work required includes, but is not necessarily limited to, the following:
      a. Silicate penetrant.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the concrete hardener.

C. Related Sections:
   1. Section 3D, Cast-In-Place Concrete.
   2. Section 9C1, Ceramic Tile.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer regularly engaged in the installation of concrete hardeners with experience in the application of the types of materials required, and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Installer shall meet the requirements of the concrete hardener manufacturer for providing guarantee coverage. Submit name and qualifications to ENGINEER.

B. Source Quality Control: Obtain all material from only one manufacturer. Obtain material from only manufacturers who will, if required, send a qualified technical representative to the site, for the purpose of advising the installer of proper procedures and precautions for the use of the material.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval copies of manufacturer's specifications, recommendations and installation instructions. Include manufacturer's published data, indicating the material complies with the requirements and is intended for the application shown.

B. Certificates: Submit for approval a certificate of coverage signed by a duly authorized representative of the manufacturer.

C. Maintenance Data: Upon completion of the Work, furnish copies of detailed maintenance manual including the following information:
   1. Product name and number.
   2. Name, address and telephone number of manufacturer and local distributor.
   3. Detailed procedures for routine maintenance and cleaning.
   4. Detailed procedure for light repair such as scratches and staining.

D. Guarantee: Submit for approval written guarantee agreeing to replace the concrete hardener should it fail to perform as specified.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in concrete hardener manufacturer's original unopened containers.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number and date of manufacturer.
      c. Mixing instructions, shelf life and curing time when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for the rejection of the material in question, by ENGINEER, and his requiring its removal from the site. Supply new material conforming to the specified requirements at no additional cost to OWNER.

B. Storage of Materials:
   1. Store materials so as to preclude the inclusion of foreign material.
   2. Protect material from freezing.

C. Handling of Materials:
   1. Handle materials carefully to prevent inclusion of foreign materials.
   2. Do not open containers or mix components until all necessary preparatory Work has been completed.

1.5 JOB CONDITIONS

A. Environmental Conditions:
   1. Do not apply concrete hardener to uncured concrete. Comply with manufacturer's written instructions for minimum 10 days of curing time.
   2. Apply hardener only when temperature of concrete is 50 F or above.

B. Protection:
   1. Do not allow concrete hardener to overflow or spill onto adjoining surfaces.
   2. Remove concrete hardener that is splashed on surfaces not designated to receive concrete hardener immediately by flushing with water.

C. Sequencing:
   1. Coordinate the Work so that the concrete hardener is installed when best results will be obtained, as recommended by the manufacturers technical representative.

1.6 GUARANTEE

A. Provide a 2 year written guarantee, signed by CONTRACTOR and his installer, stating that should concrete floors show signs of dusting as a result of wear and abrasion it will be re-installed, in the manner specified herein, at no further cost to OWNER.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Hardener: Provide a clear, colorless, aqueous solution of chemically active silicates and fluosilicates, plus a wetting and penetrating agent, which reacts with the free lime and calcium carbonates binding soft, loose particles together to form a hard dense vitreous surface, resistant to chemical attack and the growth of mildew, fungi and other organisms.

B. Product and Manufacturer: Provide one of the following:
   1. Lapidolith by Sonneborn Division of Contech Incorporated.
   2. Armortop by Anti-Hydro Waterproofing Company.
   3. Or equal.

C. Water: Potable and free of all injurious contaminants.

2.2 MIXES

A. Follow manufacturer's written instructions for the proper mixing, dilution and coverage of each coat.

2.3 FINISH

A. The finished installation of the concrete hardener shall have a smooth, uniform even finish without discontinuities or discolorations.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the substrates and the conditions under which the concrete hardener Work is to be performed, and notify ENGINEER in writing of any conditions detrimental to the proper and timely completion of the Work and performance of the concrete hardener. Do not proceed with the concrete hardener Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 SUBSTRATE PREPARATION

A. Steel trowel concrete in strict accordance with printed directions supplied by the concrete hardener manufacturer.

B. Provide concrete free of all honeycombing and fins.

C. Do not use sealers, curing or parting compounds on the concrete unless these products have been chemically and/or mechanically removed.

D. Provide wet curing for best results.

E. Surfaces to receive concrete hardener shall be clean, dry and free of all loose dirt, oil, wax and other foreign matter.

3.3 INSTALLATION

A. Provide the services of a manufacturer's technical representative during the installation of the concrete hardener.

B. Apply concrete hardener using the coverage recommended by the manufacturer per coat.

C. Apply a minimum of three seperate coats.

D. Apply a fourth coat using undiluted material should the manufacturer's technical representative recommend this procedure based on field conditions, and as directed by ENGINEER.

E. Apply each coat by spray.

F. Mop up excess solution or puddles.

G. After each of the first and second applications allow the floor to dry until no longer visibly wet.

H. To avoid the development of crystals, when applying the third coat, flush the surface liberally with clean, hot water. At the same time brush the floor rapidly with a stiff-bristle broom. Mop up excess water.

I. Follow manufacturer's written instructions should white crystals develop after the first or second coat. Consult manufacturer's technical representative.

3.4 ADJUSTMENT AND CLEANING

A. Clean adjacent surfaces of concrete hardener resulting from the Work. Use solvent or cleaning agent recommended by the concrete hardener manufacturer. Leave all finished work in a clean neat appearance.

B. Protect the concrete hardener until fully cured.

+ + END OF SECTION + +

SECTION 9L

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all painting Work.
2. The extent of painting is specified.
3. The Work includes the painting and finishing of all items and surfaces throughout the project included in this Contract.
   a. Surface preparation, priming and coats of paint specified are in addition to shop priming and surface treatment specified under this and other sections of the Work.
4. The term "paint" as used herein means all coating systems materials, which includes pretreatments, primers, emulsions, enamels, stain, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
5. Paint all exposed surfaces whether or not colors are designated in any schedule, except where the natural finish of the material is specifically noted as a surface not to be painted. The term "exposed" as used herein means all items not covered with concrete. Ducts, conduits and other materials with corrosion resistant surfaces which are in chases, above finished ceilings, or other inaccessible areas shall not require field painting. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas.
6. Structural and miscellaneous metals covered with concrete, shall only receive a primer compatible with the covering material.
7. Pipe markers as specified.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be field painted in this Section.
2. Coordinate the painting of areas that are inaccessable once equipment has been installed.
3. Provide finish coats which are compatible with the prime paints used. Review other Sections of these Specifications in which prime paints are to be provided to ensure compatibility of the total coatings system for the various substrates. CONTRACTOR shall be responsible for the compatibility of all shop primed and field painted items. Furnish information on the characteristics of the finish materials proposed to use, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and reprime as required. Notify ENGINEER in writing of anticipated problems using the coating systems as specified with substrates primed by others.

C. Related Sections:
   1. Section 7C10, Exterior Wall Insulation and Finish System.
   2. Section 7J1, Calking and Sealants.
   3. Section 9A6, Acrylic Stucco.
   4. Section 10I, Identifying Devices.
   5. Equipment markers in appropriate equipment section.

D. Painting Not Included: The following categories of Work are not included as part of the field-applied finish Work, or are included in other Sections of these Specifications or in other contracts.
   1. Shop Priming: Unless otherwise specified, shop priming of structural metal, miscellaneous metal fabrications, other metal items and such fabricated components as shop-fabricated or factory-built heating and ventilating, instrumentation and electrical equipment or accessories shall conform to applicable requirements of Section 9L, Painting but is included under the appropriate Sections of this Specification.
   2. Pre-Finished Items:
      a. Items furnished with factory finishes such as baked-on enamel, porcelain, polyvinylfluoride or other similar finish.
      b. Touchup factory finished items with paint supplied by the item manufacturer. CONTRACTOR shall field paint damaged prefinished items as directed by ENGINEER.
   3. Concealed Surfaces:
      a. Nonmetalic wall or ceiling surfaces in concealed from view areas and generally inaccessible areas, such as furred areas, pipe spaces, duct shafts and elevator shafts, as applicable to this project.
      b. Paint all piping, equipment, and other such items within these areas, that do not have a galvanized or other corrosion resistant finish as specified.
   4. Cement plaster.
   5. Exterior above-grade non-submerged concrete.
   6. Submerged or intermittently submerged concrete unless otherwise specified.
   7. Concrete floors.
   8. Acrylic stucco.
   9. Metal surfaces of anodized aluminum, stainless steel, chromium plate, bronze, and copper will not require finish painting, unless shown or specified.
   10. Operating Parts and Labels:
      a. Moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts do not require finish painting unless otherwise specified.
      b. Do not paint over any code-required labels, such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.
      c. Remove all paint, coating or splatter inadvertently placed on these surfaces.

1.2 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Submit the name and experience record of the painting applicator. Include a list of utility or industrial installations painted, responsible officials, architects, or engineers concerned with the project and the approximate contract price.
   2. Painting applicators whose submissions indicate that they have not had the experience required to perform the Work will not be approved.

B. All paint products shall be supplied by the same manufacturer unless otherwise approved.

C. Design Criteria: The requirements of this Section shall generally conform to MAG Standard Specification Sections 530 and 790, except as modified, added to, or changed herein. Where there is a conflict between MAG Standard Specification and this Specification the provisions of this Specification shall apply.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. ANSI A13.1, Scheme for the Identification of Piping Systems.
   2. Great Lakes - Upper Mississippi River Board of State Sanitary Engineers (Ten States Standards), Recommended Standards for Waste Treatment Works - Latest Edition, Recommended Color Scheme for Piping.
   3. Great Lakes - Upper Mississippi River Board of State Sanitary Engineers (Ten States Standards), Recommended Standards for Water Works - 1968 Edition, Addendum No. 6, Painting of Water Works Piping for Public Water Supplies.
   4. OSHA 1910.144, Safety Color Code for Marking Physical Hazards.
   5. SSPC Volume 2, Systems and Specifications, Surface Preparation Guide and Paint Application Specifications.
   6. Maricopa Association of Governments, Uniform Standard Specifications for Public Works Construction.

E. Requirements of Regulatory Agencies: Coatings for surfaces in contact with potable water or water being treated for potable use shall not impart any taste or odor to the water or result in any organic or inorganic content in excess of the maximum contaminant level established by applicable laws or regulations. All such coatings shall be approved by the applicable regulatory agency. Revise painting systems specified herein to provide manufacturer's regulatory agency approved coating system where required.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Pipe Markers: Each type of marker specified.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical information, including paint label analysis and application instructions for each material proposed for use.

2. Copies of CONTRACTOR'S proposed protection procedures in each area of the Work.
3. List each material and cross-reference to the specific paint and finish system and application. Identify by manufacturer's catalog number and general classification.
4. Copies of manufacturer's complete color charts for each coating system.
5. Pipe Markers: Copies of manufacturer's technical brochure, including color chart and list of standard markers.
6. Maintenance Manual: Upon completion of the Work, furnish copies of a detailed maintenance manual including the following information:
   a. Product name and number.
   b. Name, address and telephone number of manufacturer and local distributor.
   c. Detailed procedures for routine maintenance and cleaning.
   d. Detailed procedures for light repairs such as dents, scratches and staining.

C. Test Reports: Submit for approval certified laboratory test reports for required performance tests.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Deliver all materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and the following information.
   1. Name or title of material.
   2. Manufacturer's stock number and date of manufacture.
   3. Manufacturer's name.
   4. Contents by volume, for major pigment and vehicle constituents.
   5. Thinning instructions where recommended.
   6. Application instructions.
   7. Color name and number.

B. Storage of Materials:
   1. Store only acceptable project materials on project site.
   2. Store in a suitable location approved by ENGINEER. Keep area clean and accessible.
   3. Restrict storage to paint materials and related equipment.
   4. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.

C. Handling of Materials:
   1. Handle materials carefully to prevent inclusion of foreign materials.
   2. Do not open containers or mix components until necessary preparatory Work has been completed and application Work will start immediately.

1.5 JOB CONDITIONS

A. Existing Conditions:
   1. Before painting is started in any area, it shall be broom cleaned and excessive dust shall be removed.

2. After painting operations begin in a given area, broom cleaning will not be allowed; cleaning shall then be done only with commercial vacuum cleaning equipment.

B. Environmental Requirements:
1. Comply with MAG Standard Specification Section 530.3.
2. Apply water-base paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 55 F and 90 F unless otherwise permitted by the paint manufacturer's printed instructions.
3. Apply other paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 65 F and 95 F, unless otherwise permitted by the paint manufacturer's printed instructions.
4. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or to damp or wet surfaces.
5. Painting may be continued during inclement weather only if the areas and surfaces to be painted are enclosed and heated within the temperature limits specified by the paint manufacturer during application and drying periods.
6. Adequate illumination and ventilation shall be provided in all areas where painting operations are in progress.
7. Install piping markers only after all painting and finish Work has been completed.

C. Protection: Cover or otherwise protect finished work of other trades and surfaces not being painted concurrently or not to be painted.

PART 2 - PRODUCTS

2.1 MATERIAL QUALITY

A. Manufacturer: Provide products of one of the following:
1. Koppers Company, Incorporated.
2. Tnemec Company, Incorporated.

B. Comply with MAG Standard Specification Section 790.1, 790.2, 790.3 and 790.4.

C. Provide manufacturer's best grade of the various types of coatings suitable for use in water treatment plants and pumping stations as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying the manufacturer's indentification as a standard, best-grade product will not be acceptable.

D. Provide primers produced by the same manufacturer as the finish coats. Use only thinners recommended by the paint manufacturer, and use only to recommended limits.

E. Provide paints, and pipe markers of durable and washable quality. Use materials which will withstand normal washing as required to remove grease, oil, chemicals, etc., without showing discoloration, loss of gloss, staining, or other damage.

2.2 SUBSTITUTIONS

A. No substitutions shall be considered that decrease the film thickness, the number of coats, the surface preparation or the generic type of coating specified. Approved manufacturers must furnish the same color selection as the manufacturers specified, including accent colors and custom colors in all coating systems.

2.3 COLORS AND FINISHES

A. Surface treatments, and finishes, are shown under "Painting Systems" below. All substrates scheduled under "Painting Systems" shall be painted whether or not shown, or scheduled, unless an item is specifically scheduled as not requiring the painting system scheduled below.

B. Color Selection:
   1. A maximum of 20 different colors shall be selected for the project, in addition to color coding of all piping and ducts.
   2. ENGINEER reserves the right to select non-standard colors for all paint systems specified within the ability of the manufacturer to produce such non-standard colors. Selection of non-standard colors shall not be cause for CONTRACTOR rejecting ENGINEER'S color selections and CONTRACTOR shall supply such colors at no additional expense to OWNER.

C. After approval of submittals and prior to beginning Work, ENGINEER will furnish color schedules for surfaces to be painted listed in the painting systems below.

D. Color Coding: In general, and unless otherwise specified, all color coding of piping, ducts and equipment shall comply with applicable standards of ANSI A13.1 and OSHA 1910.144.

E. Use representative colors when preparing samples for ENGINEERS' review.

F. Color Pigments: Pure, nonfading, applicable types to suit the substrates and service indicated.
   1. Lead: Lead content shall not exceed amount permitted by federal, state and local government laws and regulations.
   2. Paints specified for application in contact with potable water shall be approved by the Arizona Department of Health.

G. Submit proposed application techniques to ENGINEER. Submit proof of acceptability, of technique proposed, by the paint manufacturer selected.

2.4 PAINTING SYSTEMS

A. Cast-In-Place Concrete (except floors and walks) and Exposed Precast Concrete with "smooth form and grout cleaned finish"; Interior Non-submerged:
   1. Surface Preparation: Remove grease, oil and all foreign matter as specified in 3.2.B.

2. Product and Manufacturer: Provide one of the following:
   a. Koppers:
      1) Primer: Hi-Gard thinned 25 percent - 1 coat, 1.5-2.0 dry mils, 370-490 square feet per gallon.
      2) Finish: Hi-Gard - 2 coats, 2.0-3.0 dry mils per coat, 250-370 square feet per gallon per coat.
   b. Tnemec:
      1) Primer: 66 H.B. Epoxoline - 1 coat, 2.0-3.0 dry mils, 240-360 square feet per gallon.
      2) Finish: 66 H.B. Epoxoline - 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

B. Concrete Block Walls, and Cast-In-Place Concrete (except floors and walks) not conforming to "smooth form and grout cleaned finish";Interior Non-submerged:
1. Surface Preparation: Remove grease, oil and all foreign matter as specified in 3.2.B.
2. Product and Manufacturer: Provide one of the following:
   a. Koppers:
      1) Primer: Epoxy Block Filler - 1 coat, 10.0 dry mils, 75-100 square feet per gallon.
      2) Finish: Hi-Gard - 2 coats, 2.0-3.0 dry mils per coat, 250-370 square feet per gallon per coat.
   b. Tnemec:
      1) Primer: 54-660 Block Filler - 1 coat, 10.0 dry mils, 75-100 square feet per gallon.
      2) Finish: 66 H.B. Epoxoline - 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

C. Ferrous Metals including all Structural Steel, Miscellaneous Ferrous Metals, and all Ferrous Piping and all Ferrous Piping to be Covered with Insulation; Interior Non-submerged:
1. Surface Preparation: SSPC-SP 6 Commercial Blast Cleaning as specified in 3.2.C.
2. Product and Manufacturer: Provide one of the following:
   a. Koppers:
      1) Shop Primer: 654 Epoxy - 2 coats, 1.5-2.0 dry mils per coat, 285-385 square feet per gallon per coat.
      2) Field Primer or Field Touchup: 654 Epoxy - 1 coat, 1.5-2.0 dry mils per coat, 285-385 square feet per gallon.
      3) Finish: Hi-Gard - 2 coats, 2.0-3.0 dry mils per coat, 250-370 square feet per gallon per coat.
   b. Tnemec:
      1) Shop Primer: 66-1211 Epoxy - 2 coats, 1.5-2.5 dry mils per coat, 270-460 square feet per gallon per coat.
      2) Field Primer or Field Touchup: 66-1211 Epoxy - 1 coat, 1.5-2.5 dry mils per coat, 270-460 square feet per gallon.
      3) Finish: 66 H.B. Epoxoline - 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

D. Submerged or Intermittently Submerged Ferrous Metals; Interior and Exterior:
   1. Surface Preparation: SSPC-SP 10 Near-White Blast Cleaning as specified in 3.2.C.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Primer: 294 Epoxy - 2 coats, 1.5-2.0 dry mils per coat, 280-385 square feet per gallon per coat.
         2) Finish: Hi-Gard - 2 coats, 2.0-3.0 dry mils per coat, 250-370 square feet per gallon per coat.
      b. Tnemec:
         1) Primer: 20-1255 Epoxy - 2 coats, 1.5-2.5 dry mils per coat, 285-475 square feet per gallon per coat.
         2) Finish: 20-2000 Epoxy - 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

E. Ferrous, Non-Ferrous Metals, Fiberglass and Galvanized Metals; Exterior Non-submerged:
   1. Surface Preparation:
      a. Ferrous Metals: SSPC-SP 6 Commercial Blast Cleaning as specified in 3.2.C.
      b. Galvanized and Non-Ferrous Metal: SSPC-SP 1 Solvent Cleaning as specified in 3.2.E. and 3.2.D.
      c. Fiberglass: Sand as specified in 3.2.F.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Primer:
            a) Ferrous Metals: 654 Epoxy - 2 coats, 1.5-2.0 dry mils per coat, 285-385 square feet per gallon per coat.
            b) Non-Ferrous and Galvanized: None.
         2) Intermediate: Hi-Gard - 1 coat, 2.0-3.0 dry mils, 250-370 square feet per gallon.
         3) Finish: 1122BRS Polyurethane - 1 coat, 1.0-1.5 dry mils per coat, 360-540 square feet per gallon.
      b. Tnemec:
         1) Primer:
            a) Ferrous Metals: 66-1211 Epoxy - 2 coats, 1.5-2.5 dry mils per coat, 270-460 square feet per gallon per coat.
            b) Non-Ferrous and Galvanized: None.
         2) Intermediate: 66 H.B. Epoxoline - 1 coat, 2.0-3.0 dry mils, 240-360 square feet per gallon.
         3) Finish: 71 Endura-Shield - 1 coat, 1.5- 2.5 dry mils, 270-460 square feet per gallon.

F. Galvanized Metal and Non-Ferrous Metal; Interior, Non-submerged:
   1. Surface Preparation: SSPC-SP 1 Solvent Cleaning, as specified in Section 3.2.D., and 3.2.E.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Primer: Hi-Gard - 1 coat, 2.0-3.0 dry mils, 250-370 square feet per gallon.
         2) Finish: Hi-Gard - 1 coat, 2.0-3.0 dry mils, 250-370 square feet per gallon.

b. Tnemec:
   1) Primer: 66 H.B. Epoxoline - 1 coat, 2.0-3.0 dry mils, 240-360 square feet per gallon.
   2) Finish: 66 H.B. Epoxoline - 1 coat, 2.0-3.0 dry mils, 240-360 square feet per gallon.

G. Submerged or Intermittently Submerged Galvanized Ferrous Metal; Interior and Exterior:
   1. Surface Preparation: SSPC-SP 1 Solvent Cleaning, as specified in Section 3.2.E.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Primer: 40 Passivator - 1 coat, 0.3-0.5 dry mils, 260-435 square feet per gallon.
         2) Finish: Hi-Gard - 1 coat, 2.0-3.0 dry mils, 250-370 square feet per gallon.
      b. Tnemec:
         1) Primer: 66-1211 Epoxy - 1 coat, 1.5-2.5 dry mils, 270-460 square feet per gallon.
         2) Finish: 66 H.B. Epoxoline - 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

H. All Metal Surfaces Exposed to Temperatures Over 250 F:
   1. Surface Preparation: SSPC-SP 10 Near White blast as specified in Section 3.2.C.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Finish: Bitumastic Hi-Heat Gray - 1 coat, 2.0-3.0 dry mils, 270-403 square feet per gallon.
      b. Tnemec:
         1) Finish: 1261 Silicone Aluminum - 2 coats, 0.8 dry mils per coat, 500 square feet per gallon per coat.

I. All Aluminum in Contact with Dissimilar Materials:
   1. Surface Preparation:
      a. Remove all foreign matter.
      b. Pretreatment Wash Coat of Polyvinyl Butyral Resin: 1 coat, 0.3-0.5 dry mils.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Hi-Gard - 2 coats, 2.0-3.0 dry mils per coat, 250-370 square feet per gallon per coat.
      b. Tnemec:
         1) 66 H.B. Epoxoline - 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

J. Pipe and Duct Insulation, Cloth; Interior:
   1. Surface Preparation: Remove all foreign matter as specified in 3.2.G.

2. Products and Manufaturer: Provide one of the following:
   a. Koppers:
      1) Primer: Glamorglaze Wallboard Primer - 1 coat, 0.5 dry mils, 400 square feet per gallon.
      2) Finish: Hi-Gard - 2 coats, 2.0-3.0 dry mils per coat, 250-370 square feet per gallon per coat.
   b. Tnemec:
      1) Primer: 51-792 PVA Sealer - 1 coat, 1.0 dry mils, 400 square feet per gallon.
      2) Finish: 66 H.B. Epoxoline - 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

K. PVC Piping, Fiberglass, Fiberglass Insulation Covering; Interior:
   1. Surface Preparation: Sand as specified in 3.2.F.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Finish: Hi-Gard - 2 coats, 2.0-3.0 dry mils per coat, 250-370 square feet per gallon.
      b. Tnemec:
         1) Finish: 66 H.B. Epoxoline - 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

L. Wood Surfaces; Interior and Exterior:
   1. Surface Preparation: Sand and seal as specified in Section 3.2.H.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Primer: 625 Undercoater - 1 coat, 1.2 dry mils, 550 square feet per gallon.
         2) Finish: Rustarmor 400 - 2 coats, 1.4 dry mils per coat, 500 square feet per gallon.
      b. Tnemec:
         1) Primer: 36-603 Undercoater - 1 coat, 2.0-3.5 dry mils, 195-340 square feet per gallon.
         2) Finish: 23-Color Enduratone - 2 coats, 1.5-3.0 dry mils per coat, 230-460 square feet per gallon per coat.

M. Steel and Galvanized Steel Pipe; Buried Exterior:
   1. Surface Preparation: SSPC-SP 10, Near-White Blast, as specified in Section 3.2.C.
   2. Product and Manufacturer: Provide one of the following:
      a. Koppers:
         1) Shop Primer: 654 Epoxy - 2 coats, 1.5-2.0 dry mils per coat, 285-385 square feet per gallon per coat.
         2) Field Primer or Field Touchup: 654 Epoxy - 1 coat, 1.5-2.0 dry mils, 285-385 square feet per gallon.
         3) Finish: Bitumastic No. 300-M - 2 coats, 8.0-10.0 dry mils per coat, 90-115 square feet per gallon per coat.
      b. Tnemec:
         1) Shop Primer: 66-1211 Epoxy - 2 coats, 1.5-2.5 dry mils per coat, 270-460 square feet per gallon per coat.
         2) Field Primer or Field Touchup: Surface preparation as specified.

3) Finish: 46H-413 Tneme-Tar - 2 coats, 8.0-10.0 dry mils per coat, 90-120 square feet per gallon per coat.

2.5 PIPING MARKERS

A. Manufacturer: Provide products produced by one of the following:
   1. W. H. Brady Company.
   2. Seton Name Plate Corporation.

B. General:
   1. Piping markers shall be formed from laminated plastic. All printing shall be sealed with a formed butyrate plastic film. Markers for piping up to 6-inch diameter shall be preformed to completely wrap around the pipe requiring no adhesive. Markers for pipes over 6-inch diameter shall be preformed to the contour of the pipe and attached with stainless steel spring fastners.
   2. For pipes under 3/4-inch outside diameter: Provide brass tags, 1 1/2-inch diameter, with depressed 1/4-inch high black filled letters above 1/2-inch high black filled numbers.
   3. Each marker shall consist of at least 1 legend descriptive of the function of the pipe, and a directional arrow.
   4. The size of lettering and marker shall conform to ANSI A13.1.
   5. Location of Markers:
      a. Adjacent to each valve and "T" connection.
      b. At each branch and riser takeoff.
      c. At each pipe passage through a wall, floor and ceiling.
      d. On all horizontal and vertical pipe runs at 25-foot intervals.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his applicator shall examine the areas and conditions under which painting Work is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film.

3.2 SURFACE PREPARATION

A. General:
   1. Comply with MAG Standard Specification Section 530.8.
   2. Perform all preparation and cleaning procedures as specified herein and in strict accordance with the paint manufacturer's instructions for each particular substrate and atmospheric condition.

3. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish painted, or provide surface applied protection prior to surface preparation and painting operations. Remove, if necessary, for the complete painting of the items and adjacent surfaces. Following completion of painting of each space or area, reinstall the removed items by workmen skilled in the trades involved.
4. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.
5. All surfaces which were not shop painted or which were improperly shop painted, and all abraded or rusted shop painted surfaces, which are to be painted, as determined by ENGINEER, shall be prepared as specified below.

B. Cast-In-Place Concrete and Masonry Surfaces:
1. Prepare surfaces of cast-in-place concrete and concrete block to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, with soap and water.
2. Determine the alkalinity and moisture content of the surfaces to be painted by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish paint, correct this condition before application of paint. Provide ENGINEER with suitable testing materials in order to carry out alkalinity and moisture tests.
3. Do not paint over surfaces where the moisture content exceeds 8 percent, unless otherwise permitted in the manufacturer's printed directions.
4. Concrete and concrete block surfaces that cannot be adequately cleaned by soap and water shall be acid etched. Exceedingly dense concrete may require a second etching.

C. Ferrous Metals:
1. Clean non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop primed, of all oil, grease, dirt, mill scale and other foreign matter by commercial blast cleaning complying with SSPC-SP 6.
2. Clean submerged ferrous surfaces including structural steel and miscellaneous metal to be shop primed, of all oil, grease, dirt, mill scale and other foreign matter by near-white blasting complying with SSPC-SP 10.
3. Clean non submerged, ferrous surfaces that have not been shop-coated of all oil, grease, dirt, loose mill scale and other foreign substances by commercial blasting, complying with SSPC-SP 6.
4. Clean submerged ferrous surfaces that have not been shop-coated or that, in the opinion of ENGINEER, have been improperly shop coated, of all oil, grease, dirt, mill scale and other foreign matter by near white blasting complying with SSPC-SP 10.
5. Treat bare and blasted or pickled clean metal with metal treatment wash coat, prior to priming only if recommended by the paint manufacturer.

6. Touch-up shop-applied prime coats which have damaged or bare areas, with primer recommended by the coating manufacturer after commercial blasting complying with SSPC-SP 6.

D. Non-Ferrous Metal Surfaces: Clean non-ferrous metal surfaces in accordance with the coating system manufacturer's instructions for the type of service, metal substrate, and application required.

E. Galvanized Surfaces:
1. Clean free of oil and surface contaminants with a non-petroleum based solvent, recommended by the coating manufacturer, complying with SSPC-SP 1.
2. Remove shop applied chromic acid treatments on galvanized surfaces to be painted. Galvanized metals which have been given a humid storage stain treatment shall be prepared for painting by sanding or by other techniques as recommended by the paint manufacturer at no additional expense to OWNER.

F. PVC Piping and Fiberglass: Lightly sand and clean all surfaces to be painted.

G. Covering on Pipe:: Clean free of oil and surface contaminants as recommended by the coating manufacturer for substrate and application required. Do not cut or damage the insulation in any way.

H. Wood:
1. Clean wood surfaces to be painted of all dirt, oil, or other foreign substances with mineral spirits and sandpaper. Sandpaper smooth those finished surfaces exposed to view and dust off.
2. Seal wood required to be job painted immediately upon delivery to job. Seal edges, ends, faces, undersides and backsides of such wood including chair rails, moldings and trim.

3.3 MATERIALS PREPARATION

A. General:
1. Comply with MAG Standard Specification Section 790.5.
2. Mix and prepare painting materials in strict accordance with the manufacturer's directions.
3. Do not mix coating materials produced by different manufacturers, unless otherwise permitted by the manufacturer's instructions.
4. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in a clean condition, free of foreign materials and residue.
5. Stir all materials before application to produce a mixture of uniform density, and as required during the application of the materials. Do not stir any film which may form on the surface into the material. Remove the film and, if necessary, strain the material before using.
6. Mixing:
   a. Mix only in containers placed in suitably sized non-ferrous or oxide resistant metal pans to protect concrete floor from spashes or spills which could stain exposed concrete or react with subsequent finish floor material.

b. Mix and apply paint only in containers bearing accurate product name of material being mixed, or applied.

3.4 APPLICATION

A. General:
1. Comply with MAG Standard Specification Sections 530.4 and 530.9.
2. Apply paint by brush, roller, air spray, or airless spray in accordance with the manufacturer's directions and recommendations of Paint Application Specifications No. 1 in SSPC Vol. 2, where applicable. Use brushes best suited for the type of material being applied. Use rollers of carpet, velvet back, or high pile sheeps wool as recommended by the paint manufacturer for material and texture required. Use air spray and airless spray equipment recommended by the paint manufacturer for specific coating system specified. Submit a list of application methods proposed, listing paint systems and location.
3. The paint film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has completely dried.
4. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, until the paint film is of uniform finish, color and appearance. This is of particular importance regarding intense primary accent colors. Insure that all surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.
5. Surfaces not exposed to view do not require color coding but require the same coating system specified for exposed surfaces.
   a. "Exposed to view surfaces" is defined as those areas visible when permanent or built-in fixtures convector covers, covers, covers for finned tube radiation, grilles, etc. are in place in areas scheduled to be painted.
6. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint as specified, before final installation of equipment.
7. Paint aluminum parts in contact with with dissimilar materials as specified with appropriate primer.
8. Omit field primer on metal surfaces which have been shop primed touch-up paint shop prime coats only when approved by ENGINEER.
9. Paint the backs of access panels, and removable or hinged covers to match the exposed surfaces.

B. Heating, Ventilating, Air Conditioning and Electrical Work:
1. Heating, ventilating, and air conditioning items to be painted include, but are not limited to, the following:
   a. Piping, pipe hangers, and supports.
   b. Heat exchangers.
   c. Tanks.
   d. Ductwork and insulation.
   e. Motors, mechanical equipment, and supports.
   f. Accessory items.

2. Electrical items to be painted include, but are not limited to, the following:
   a. Conduit and fittings.
   b. Switchgear, panels, junction boxes, motor control centers, motors and accessories.

C. Minimum Coating Thickness:
   1. Apply each material at not less than the manufacturer's recommended spreading rate, and provide total dry film thickness as specified.
   2. Apply extra coat if required to obtain specified total dry film thickness.

D. Scheduling Painting:
   1. Apply the first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
   2. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

E. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects caused by insufficient sealing.

F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

G. Transparent (Clear) Finishes:
   1. On exposed to view portions, use multiple coats to produce glass-smooth surface film continuity of even matt luster. Provide a finish free of laps, cloudiness, color irregulatiry, runs, brush marks, orange peel, nail holes, or other surface imperfections.
   2. Provide satin finish for final coats, unless otherwise indicated.

H. Brush Application:
   1. Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable. Neatly draw all glass and color break lines.
   2. Brush apply all primer or first coats, unless otherwise permitted to use mechanical applicators.

I. Mechanical Applicators:
   1. Use mechanical methods for paint application when permitted by governing ordinances, paint manufacturer, and approved by ENGINEER. If permitted, limit to only those surfaces impracticable for brush applications.
   2. Limit roller applications, if approved by ENGINEER, to interior wall finishes for second and third coats. Apply each roller coat to provide the equivalent hiding as brush-applied coats.

3. Confine spray application to metal framework, siding, decking, wire mesh and similar surfaces where hand brush work would be inferior and to other surfaces specifically recommended by paint manufacturer.
4. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush-applied coats. Do not double back with spray equipment for the purpose of building up film thickness of 2 coats in one pass.

J. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by ENGINEER.

K. Piping Markers: Apply piping markers in accordance with the manufacturer's written instructions in locations herein specified.

3.5 PROTECTION

A. Comply with MAG Standard Specification Sections 530.6 and 530.7.

B. Protect work of other trades, whether to be painted or not, from the Work of this Section. Leave all such work undamaged. Correct all damages by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.

C. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove all temporary protective wrappings provided for protection of this Contract and other contracts after completion of painting operations.

3.6 CLEAN-UP

A. During the progress of the Work, remove from the site all discarded paint materials, rubbish, cans and rags at the end of each work day.

B. Upon completion of painting Work, clean all paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. At the completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces as determined by ENGINEER.

+ + END OF SECTION + +

SECTION 10A

CHALKBOARDS AND TACKBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all chalkboard and tackboard Work.
   2. The extent of chalkboards and tackboards is shown.
   3. The types of chalkboard and tackboard Work required includes, but is not necessarily limited to, the following:
      a. Chalkboard/Tackboard combination.
      b. Bulletin board case.
      c. Miscellaneous trim and mounting accessories.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
   1. Furnish all chalkboard and tackboard Work by one manufacturer for the entire project.
   2. In addition to the requirements of these Specifications, comply with manufacturer's instructions and recommendations for all phases of the Work, including preparation of substrate, installation of grounds and anchors, and application of materials.

1.3 SUBMITTALS

A. Samples: Submit for approval samples for each type and color of chalkboard and tackboard Work including trim and accessories required. Provide 4-inch square samples of sheet materials and 4-inch lengths of trim members. ENGINEER'S review of samples will be for color, pattern and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Shop Drawings for each type of chalkboard and tackboard unit. Include full-scale sections of typical trim members and dimensioned elevations. Show anchors, grounds, reinforcement, accessories and installation details.
   2. Manufacturer's technical data and installation instructions for each material and component part. Include methods of installation for each type of substrate to receive units. Transmit copy of each instruction to the installer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chalkboard/Tackboard Combinations: Provide the following:
   1. Porcelain Enamel Facing Sheet:
      a. Nickel Cobalt Primer: 0.0025-inches thick, minimum.
      b. Writing Surface: Vitreous porcelain enamel; 0.003-inch minimum thickness. Side opposite writing surface nickel cobalt ground coat 0.0025-inches minimum thickness with silica spray coat for lamination adhesion.
      c. Panel edges at butt joints porcelain coated.
      d. Total Finish Thickness: 0.0055-inches.
      e. Face Sheet Steel: 18 gage minimum; especially manufactured enameling steel with low metaloid and copper content, chemically bathed and rinsed prior to enameling.
      f. Colors: Complete selection of manufacturer's standard and custom colors. Manufacturer's of "or equal" materials shall supply exactly the same color selection as manufacturer specified. ENGINEER will select a maximum of three colors for the Work.
      g. Reflectance Factor: 20 percent maximum; 15 percent minimum.
   2. Tackboard Facing Sheet:
      a. Seamless sheet, 1/4-inch thick with washable vinyl finish, of ground natural cork compressed with resinous binder and integral color throughout entire thickness and laminated to burlap backing.
      b. Colors: Complete selection of manufacturer's standard and custom colors. Manufacturer's of "or equal" materials shall supply exactly the same color selections as manufacturer specified. ENGINEER will select a maximum of three colors for the Work.
   3. Chalkboard Core Material:
      a. Thickness: 1/2-inch minimum.
      b. Material: Fiberboard.
   4. Tackboard Core Material:
      a. Thickness: 1/4-inch minimum.
      b. Material: Hardboard.
   5. Size: 1 foot - 0 inches wide cork faced panel along entire top of assembly; 2 foot - 0 inch wide end panels on one side of assembly; 4 foot - 0 inch wide porcelain enameled chalkboard panel at center of assembly. Total height if assembly shall be 4 foot - 0 inches. Total length of assembly shall be 6 foot - 0 inches.
   6. Product and Manufacturer: Provide one of the following:
      a. AX Series Combination Chalkboard/Tackboard by Greensteel Division of Adience Company.
      b. Or equal.

B. Bulletin Board Case: Provide the following:
   1. Case: Surface-mounted extruded aluminum 6063-T5 alloy with satin anodized clear finish. Continuous piano hinged case shall be provided with 1/4-inch safety glass front with heavy aluminum channel frame reinforcement. Door frame shall not rely on glass for rigidity and shall be equipped with lock, keys and elbow catch. The near wall of the case shall be fitted with a tackboard panel as specified in 2.1.A.

2. Size: 2 foot - 0 inches wide by 3 foot - 0 inches high.
3. Product and Manufacturer: Provide one of the following:
   a. B Series Bulletin Board Case by Greensteel Division of Adience Company.
   b. Or equal.

C. Trim and Accessories: Provide the following:
1. General: Fabricate frames and trim of not less than 0.062-inch thick aluminum alloy. Provide straight, single-length units wherever possible and keep joints to a minimum. Miter corners to a neat, hairline closure. Furnish exposed aluminum trim, accessories and fasteners with clear anodized finish AA-M31A31.
   a. Provide manufacturer's deluxe wide-profile trim units, approximately 1-inch wide with cork inserts.
   b. When structural support accessories are required for chalkboards and tackboard Work in addition to normal trim, provide such additional support or modify trim as required to provide necessary support.
2. Chalktrough: Furnish continuous aluminum chalktroughs for each chalkboard, as follows:
   a. Box type, with slanted front and cast aluminum end closures.

2.2 FABRICATION

A. Assembly: Provide factory-assembled Work.
1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to the ENGINEER.
2. Provide mullion trim at joints between chalkboard and tackboard.
3. Provide manufacturer's standard vertical joint system between abutting sections of chalkboard.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine areas and conditions under which units are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install chalkboard and tackboard Work in locations specified and mounting heights as directed by ENGINEER and in accordance with the manufacturer's instructions. Provide all grounds, clips, backing materials, brackets and anchors, trim, and accessories for a complete installation.

B. Deliver factory-built chalkboard and tackboard Work completely assembled in one piece without joints, whenever possible. Where dimensions exceed panel size, provide 2 or more pieces of equal length, as acceptable to ENGINEER. When overall dimensions require delivery in separate units, prefit at the factory, disassemble for delivery, and make final joint at a site. Use splines at joints to maintain surface alignment and smooth joints.

C. Install units with concealed hangers plumb and level, in accordance with the manufacturer's printed instructions.

D. Coordinate job-assembled units with grounds, trim and accessories. Join all parts with neat, precision fit.

+ + END OF SECTION + +

SECTION 10B1

TOILET PARTITIONS AND URINAL SCREENS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all toilet partition and urinal screen Work.
2. The extent of the toilet partitions and urinal screens is shown.
3. The types of toilet partition and urinal screen Work required includes, but is not necessarily limited to, the following:
   a. Floor supported, no headrail partitions.
   b. Wall hung screens.
   c. Privacy screens.
   d. Miscellaneous fittings, fasteners, anchors and accessories.

B. Coordination:
1. Furnish inserts and anchoring devices which must be built into masonry and drywall for the installation of toilet partitions and related Work. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.
2. See concrete, masonry and gypsum wallboard sections of these Specifications for installation of inserts and anchorage devices.

C. Related Sections:
1. Section 4C1, Unit Masonry Construction.
2. Section 10P, Toilet and Bath Accessories.
2. Section 10B2, Shower and Dressing Compartments.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
1. Take field measurements prior to preparation of Shop Drawings and fabrication, where possible, to ensure proper fitting of Work. However, do not delay job progress; allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the Work.
2. Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Requirements of Regulatory Agencies:
1. Codes: Comply with applicable provisions of the Uniform Building Code and ANSI A117.1.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI A117.1, Specifications for Making Buildings and Facilities Accessible to, and Usable by, the Physically Handicapped.
   2. ASTM A 167, Stainless and Heat-Resisting Chromium Nickel Steel Plate, Sheet, and Strip.
   3. ASTM A 591, Electolytic Zinc-Coated Steel Sheets.
   4. ASTM B 633, Electrodeposited Coatings of Zinc on Iron and Steel.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Shop Drawings for the fabrication and erection of toilet partition and urinal screen assemblies. Include plans and elevations at not less than 1 inch to 1 foot-0 inches scale. Show all anchorage and accessory items, and finishes. Provide location template drawings for bolt locations in supporting members.
   2. Manufacturer's detailed technical information and installation instructions. Include catalog cuts of hardware, anchors, fastenings, complete color charts and other data as required. Indicate by transmittal form that copy of each instruction has been distributed to the installer.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver material in manufacturer's original unopened and undamaged packages.
   2. Clearly identify manufacturer, brand name, contents, color stock number, and order number on each package.
   3. Packages showing indications of damage that may affect condition of contents are not acceptable.

B. Storage of Materials: Store in original packaging under protective cover and protect from damage.

C. Handling of Materials: Handle materials in such manner as to prevent damage to products or finishes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units are not acceptable.

B. Steel Sheets for Baked Enamel Finish: ASTM A 591, galvanized-bonderized, of the following minimum thicknesses:
   1. Pilasters, Unbraced: 16 gage.
   2. Panels: 20 gage.

3. Doors: 22 gage.
4. Concealed Reinforcement for Anchorages: 12 gage.
5. Concealed Reinforcement for Tapping: 14 gage.

C. Galvanized steel concealed reinforcements: minimum thickness of 12 gage for anchorages and 14 gage for tapping.

D. Door, Panel and Pilaster Core: Manufacturer's standard sound-deadening, double-faced honeycomb, impregnated Kraft paper core.

E. Pilaster Shoes: ASTM A 167, Type 302/304 stainless steel, as follows:
1. Height: 3-inches.
2. Thickness: Not less than 20 gage.
3. Finish: To match hardware.

F. Stirrup Brackets: Manufacturer's standard design for attaching panels to walls and pilasters, as follows:
1. Type 302 formed stainless steel.

G. Hardware and Accessories: Manufacturer's standard design, heavy duty operating hardware and accessories, as follows:
1. Stainless steel, with No. 4 bright directional polish finish.

H. Anchorages and Fasteners: Provide manufacturer's standard exposed fasteners of stainless steel or brass, with finish to match hardware. Use theft-resistant, one-way, type heads and nuts for exposed anchorages.
1. For concealed anchors use hot-dip galvanized steel items.

2.2 FABRICATION

A. General: Provide standard doors, panels, screens, and pilasters fabricated for the partition system, unless otherwise as shown or specified. Pressure laminate face sheets to core material with edges sealed with a continuous locking strip or lapping and formed edges. Miter and weld corners with welds ground smooth.
1. Provide concealed reinforcement for installation of hardware, fittings, brackets, and required accessories.
   a. Internally reinforce partition panels for attachment of grab bars.

B. Panel and Door Dimensions: Not less than 1-inch thick units. Provide 32-inch wide, swing out doors in wheelchair stalls, in accordance with ANSI A117.1.

C. Floor Supported Pilasters: Not less than 1-1/4-inch thick units, with galvanized steel anchorage devices for securing to the floor. Furnish anchorage devices complete with threaded rods, lock washers, and leveling adjustment nuts. Provide shoes at each pilaster.
1. Product and Manufacturer: Provide one of the following:
   a. Normandie by Sanymetal Products Company.
   b. Series 500 by The Mills Company.
   c. Or equal.

D. Wall Hung Screens: Not less than 1-inch thick panel units, size as shown or specified, of same construction and finish as doors and panels. Provide extra heavy stirrups for securing to walls.
   1. Product and Manufacturer: Provide one of the following:
      a. Type C by Sanymetal Products Company.
      b. Model 2 by The Mills Company.
      c. Or equal.

E. Privacy Screens: Same construction as the toilet partitions.

F. Hardware and Accessories: Provide for each door in the partition system, as follows:
   1. Hinges: Cutout inset type, adjustable to hold door open at any angle up to 90 degrees. Provide spring-action cam type, to comply with manufacturer's recommendations.
   2. Latch and Keeper: Recessed latch unit, with combination rubber faced door strike and keeper. Provide latch unit which has capabilities for emergency access.
   3. Coat Hook: Manufacturer's standard unit.
   4. Door Pulls: Manufacturer's standard unit.
   5. Push Plate: Surface mounted, for entrance screen unit door only.
   6. Reinforcing: Reinforce internally partitions receiving grab bars.
   7. International handicapped symbol on handicapped stall doors.

G. Baked Enamel Finish: After fabrication and before applying enamel coating system, clean the galvanized steel surfaces to remove processing compounds, oils and other contaminants.
   1. Pretreat the metal surfaces with a phosphate coating.
   2. Prime the metal with a baked-on rust-inhibiting primer.
   3. Apply two finish coats of thermosetting acrylic enamel, applied by the electrostatic process, and baked in accordance with the paint manufacturer's instructions. Apply materials to provide a minimum total of 1.5 mils dry film thickness.
   4. Provide complete selection of manufacturer's standard and custom colors.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the areas and conditions under which toilet partitions and related items are to be installed. Notify ENGINEER in writing of conditions detrimental to the proper and timely completion on the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner to ENGINEER.

3.2 INSTALLATION

A. General: Install partitions rigid, straight, plumb and level, with the panels laid out as shown. Provide clearances of not more than 1/2 inch between pilasters and panels, and not more than 1 inch between panels and walls. Secure panels to walls with not less than two stirrup brackets attached near top and bottom of the panel.

Locate wall brackets so that holes for wall anchorages occur in masonry or joints. Secure panels to supporting walls with manufacturer's recommended anchoring devices, as shown on final Shop Drawings or in manufacturer's instructions.

B. Floor Supported Partitions: Secure pilasters to the supporting floor system with the specified anchorage device. Level, plumb and tighten the installation with the leveling device. Set tops of doors level with the tops of pilasters when the doors are in the closed position. Set pilaster units with anchorages having not less than 2 inch penetration into the supporting floor system.

C. Hardware Adjustments: Adjust and lubricate hardware for proper operation after installation.
   1. Set hinges on inswing doors to hold doors open approximately 30 degrees from closed position when unlatched.
   2. Set hinges on outswing doors and entrance swing doors, if any, to return to the fully closed position.

D. Wall Mounted Screens: Attach with heavy duty concealed anchoring devices, including wall channels, wall plates and studs as recommended by the manufacturer to suit the supporting wall construction. Set units in accordance with the manufacturer's instructions to provide support for the units and to resist lateral impact.

3.3 ADJUSTMENT AND CLEANING

A. Perform all final adjustments to pilaster leveling devices, door hardware, and other operating parts of the partition assembly just prior to final inspection. Clean exposed surfaces of partitions, hardware, fittings and accessories and touch up minor scratches and other finish imperfections using materials and methods recommended by the partition manufacturer.

B. Protect units during delivery, storage, and after erection so that there will be no indication of use or damage at the time of Final Acceptance. Replace damaged Work as directed.

+ + END OF SECTION + +

SECTION 10B2

SHOWER AND DRESSING COMPARTMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all shower compartment Work.
   2. The extent of shower and dressing compartments is shown.
   3. The types of shower and dressing compartment Work required includes, but is not necessarily limited to, the following:
      a. Pre-fabricated shower stalls.
      b. Miscellaneous fasteners, anchors and accessories.

B. Coordination:
   1. Furnish inserts and anchoring devices which must be built into masonry for the installation of shower compartments and related Work. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.
   2. See concrete and masonry sections of these Specifications for installation of inserts and anchorage devices.

C. Related Sections:
   1. Section 10P, Toilet and Bath Accessories.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of the Uniform Building Code.

B. Source Quality Control:
   1. Take field measurements prior to preparation of Shop Drawings and fabrication, where possible, to ensure proper fitting of Work. However, do not delay job progress; allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the Work.
   2. Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 167, Specification for Stainless and Heat-Resisting Chromium Nickel Steel Plate, Sheet, and Strip.
   2. ASTM A 591, Specification for Electrolytic Zinc-Coated Steel Sheets.
   3. Uniform Building Code.

1.3 SUBMITALLS

A. Samples: Submit for approval samples, 6-inch by 6-inch, of each required metal finish and color. Prepare samples on the same metal which will be used in the partition assemblies. Samples will be reviewed by ENGINEER for color, texture and surface reflectivity only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Shop Drawings for the fabrication and erection of shower compartment. Include plans and elevations at not less than 1 inch to 1 foot-0 inches scale. Show all anchorage and accessory items, and finishes. Provide location template drawings for bolt locations in supporting members.
   2. Manufacturer's detailed technical information and installation instructions. Include catalog cuts of hardware, anchors, fastenings, complete color charts and other data as required. Indicate by transmittal form that copy of each instruction has been distributed to the installer.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver material in manufacturer's original unopened and undamaged packages.
   2. Clearly identify manufacturer, brand name, contents, color stock number, and order number on each package.
   3. Packages showing indications of damage that may affect condition of contents are not acceptable.

B. Storage of Materials:
   1. Store in original packaging under protective cover and protect from damage.

C. Handling of Materials: Handle materials in such manner as to prevent damage to products or finishes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units are not acceptable.

B. Steel Sheets for Baked Enamel Finish: ASTM A 591, galvanized-bonderized, of the following minimum thicknesses:
   1. Panel: 20 gage.
   2. Concealed Reinforcwement for Anchorages: 12 gage.
   3. Concealed Reinforcement for Tapping: 14 gage.

C. Galvanized Steel Concealed Reinforcements: Minimum thickness of 12 gage for anchorages and 14 gage for tapping.

D. Panel Core: Manufacturer's standard sound-deadening, double-faced honeycomb, impregnated Kraft paper core.

E. Cap Piece: ASTM A 167, Type 302/304 stainless steel, as follows:
   1. Height: 1-1/2-inches.
   2. Thickness: Not less than 16 gage.
   3. Finish: To match hardware.

F. Receptor: Precast black and white terrazzo, 36 inches by 36 inches with integral cast 2-inch brass drain with removable stainless steel strainer.

G. Hardware and Accessories: Manufacturer's standard design, soap dish, curtain rod, rings, strainer as follows:
   1. Stainless steel, with No. 4 bright directional polish finish.
   2. Curtain: Vinyl Plastic.

H. Anchorages and Fasteners: Provide manufacturer's standard exposed fasteners of stainless steel or brass, with finish to match hardware. Use theft-resistant, one-way type heads and nuts for exposed anchorages.
   1. For concealed anchors use hot-dip galvanized steel items.

2.2 FABRICATION

A. General: Provide standard panels, fabricated for the partition system, unless otherwise as shown or specified. Pressure laminate face sheets to core material with edges sealed with a continuous locking strip or lapping and formed edges. Miter and weld corners with welds ground smooth.
   1. Provide concealed reinforcement for installation of hardware, fittings, brackets, and required accessories.
   2. Shower Panel Dimensions: Not less than 1-inch thick units. Provide 36-inch by 36-inch wide and 36-inch by 32-inch wide units.
   3. Product and Manufacturer: Provide one of the following:
      a. Showermaster by Sanymetal Products Company.
      b. Flush Wall Shower by Knickerbocker Partition Corporation.
      c. Or equal.

B. Baked Enamel Finish: After fabrication and before applying enamel coating system, clean the galvanized steel surfaces to remove processing compounds, oils and other contaminants.
   1. Pretreat the metal surfaces with a phosphate coating.
   2. Prime the metal with a baked-on-rust-inhibiting primer.
   3. Apply two finish coats of thermosetting acrylic enamel, applied by the electrostatic process, and baked in accordance with the paint manufacturer's instructions. Apply materials to provide a minimum total of 1.5 mils dry film thickness.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and conditions under which shower compartment Work is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until

unsatisfactory conditions have been corrected in an acceptable manner to ENGINEER.

3.2 INSTALLATION

A. General: Install receptor and accessories in accordance with manufacturer's written instructions and approved Shop Drawings.

3.3 ADJUSTMENT AND CLEANING

A. Perform all final adjustments to receptor and hardware, and other operating parts of the partition assembly just prior to final inspection. Clean exposed surfaces of compartment, hardware, fittings and accessories, and touch up minor scratches and other finish imperfections using materials and methods recommended by the partition manufacturer.

B. Protect units after erection so that there will be no indication of use or damage at the time of acceptance. Replace damaged Work as directed by ENGINEER.

+ + END OF SECTION + +

SECTION 10C

LOUVERS AND VENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all louver and vent Work.
   2. The extent of louvers and vents is shown.
   3. The types of louvers and vents required includes, but is not necessarily limited to, the following:
      a. 6-inch dual combination motor operable louvers.
      b. Sill extensions and other miscellaneous trim.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the louvers and vents.

C. Related Sections:
   1. Section 15H64, Automatic Temperature Controls (for actuators for operable louvers).

1.2 QUALITY ASSURANCE

A. Design Criteria: Comply with Sheet Metal and Air Conditioning Contractor's National Association, Architectural Sheet Metal Manual, recommendations for fabrication, construction details, and installation procedures, except as otherwise shown or specified.

B. Source Quality Control: Verify size, location and placement of louver and vent units prior to fabrication, wherever possible. Coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in as large sections as practicable.

1.3 SUBMITTALS

A. Sample: Submit for approval 12-inch by 12-inch corner of each louver specified with specified finish. ENGINEER'S review will be for color and for general appearance and workmanship. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Shop Drawings for the fabrication and erection of louver and vent assemblies. Include details of sections and connections. Show anchorage and accessory items.

2. Copies of manufacturer's technical data including free area, air infiltration, anchor details and installation instructions including finishing products.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Sheet: ASTM B 209, 5005 with temper as required for forming, or as otherwise recommended by the metal producer to provide the required finish.

B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T52.

C. Fastenings: Use same material as items fabricated. Provide types, gages and lengths to suit unit installation conditions. Use Phillips flat-head machine screws for exposed fasteners, unless otherwise specified.

D. Anchors and Inserts: Use stainless expansion bolt devices for drilled-in-place anchors.

E. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

F. Blank-Off Panels: Provide 16 gage aluminum sheet with polyvinylidene fluoride finish. Provide stainless steel fasteners, 12 inches on centers. Paint fasteners to match sheet color. Color of blank-off panels to match color of louver Work.

2.2 DUAL COMBINATION LOUVERS

A. Furnish 6-inch electrically operable type where shown. Furnish manufacturer's recommended bearings and operating mechanisms to suit the louver sizes and method of operation.

B. Air Leakage: Do not exceed 3.5 cubic foot per minute per square foot at a static pressure of 0.5-inch of water gage.

C. All blades shall be 0.125-inch thick pivoted with two reinforcing bosses and have 1/2-inch diameter zamac alloy pinions operating in self-lubricating nylon bearings. Mullions shall be of the sliding interlock type. All louver blades shall have vinyl gaskets on all edges and shall be operated by concealed drive arms at each jamb and assembled with aluminum shoulder rivets. Head, sill and jambs shall be one piece structural members with integral calking strips and retaining beads.

D. Provide head, sill, and jamb of one piece structural member with integral calking strips and retaining beads.

E. Provide louver supports designed to carry 30 pounds per square foot wind load.

F. Product and Manufacturer: Provide one of the following:
   1. No. 6967 by Construction Specialties, Incorporated.
   2. No. K8406 by Airolite Products Incorporated.
   3. Or equal.

2.3 FINISHES

A. Exposed Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded material. Comply with the following:
   1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
   2. Prepare a chemical conversion coating on the surface, using phosphates or chromates followed by a cold water rinse. Seal with a chromic acid rinse and dry, except where manufacturer recommends another method to achieve greater coating reliability.
   3. Apply a base prime coat of epoxy paint to the prepared surface in its coil form, by reverse roller coating. Fully cure in a gas-fired oven to a dry film thickness of 0.2 - 0.4 mils.
   4. Apply finish coating over the primer by roller coating for coil material and airless or Ransburg Elastrostatic Hand Spray for extrusions and fuse at a peak metal temperature of 440 F for a dry film thickness of 0.7 mils for coil coating and 1.2 mils for spray coating so that the total dry film is approxmately 1.0 mil thick for coil material and 1.5 mils thick for extruded material.
   5. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to ENGINEER:
      a. Weathering, ASTM D 659: Chalking, not more than No. 8, after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      b. Color Change, ASTM D 2244: No greater than 5 N.B.S units after removal of external deposits and after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      c. Humidity Resistance, ASTM D 2247; few scattered blisters no larger than ASTM No. 4, after 1000 hours.
      d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16 inch creep from areas scribed to bare metal after 500 hours.
      e. Dry Adhesion: No pick-off when tape tested over 1/16 inch cross hatch.
      f. Wet Adhesion: No pick-off when tape tested over 1/16 inch cross hatch; extruded material only.
      g. Boiling Water Adhesion: No pick-off when tape tested over cross hatch area after 1 hour immersion in distilled boiling water.
      h. Water Immersion: No pick-off when tape tested over cross hatch area after immersion in aerated distilled water 80 ±10F after 500 hours.
      i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67 minimum.
      j. Gloss, ASTM D 523: 30±5 reflectivity at 60 F.
      k. Pencil Hardness: F minimum.
      l. Dry Film Thickness: Primer, 0.2-0.4 mils, polyvinylidene fluoride based coating, 0.7-1.5 mils.

m. Solvent Resistance: 100 Double MEK rubs minimum.
n. Flexibility, ASTM D 1737: No cracking prior to metal fracture.
o. Acid Resistance, ASTM D 1308: 16 hour spot test with 5% hydrochloric acid - no effect.
p. Alkali Resistance, ASTM D 1308: 16 hour spot test with 5% sodium hydroxide - no effect.

B. Product and Manufacturer: Provide one of the following:
1. Kynar 500 Fluropon and Kynar 500 TR1-X by DeSoto Incorporated.
2. Or equal.

C. Provide a complete selection of manufacturers standard, bright and metallic colors.

2.4 LOUVER SCREENS

A. Provide removable screens for all louvers.

B. Fabricate screen frames of the same metal and finish as the louver units to which secured. Provide frames consisting of extra-heavy duty extruded 0.090-inch aluminum for permanently securing screen mesh. Frame shall be rewirable.

C. Use insect screen of 18 by 14 mesh, 0.0123-inch diameter stainless steel intercrimp wire.

D. Locate screens on inside face of louvers. Secure screens to louver frames with machine screws, spaced at each corner and at 12 inches on centers.

E. Provide minimum No. 8 stainless steel metal screws unless larger screws are required by screen size.

F. Provide crossbar screen reinforcement of same material and finish as louver which subdivides screens into maximum area of 50 square feet.

2.5 SILL EXTENSION

A. Gage and Finish: Same as louver.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the areas and conditions under which louvers, vents and associated items are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the project site.

3.3 INSTALLATION

A. Locate and place louver and vents units plumb, level and in proper alignment with adjacent work.

B. Use stainless steel expansion bolt anchors with stainless steel washers and neoprene gaskets. Use spring clips at all anchors to stop deflection of the louver frame. Provide anchors spaced 2 feet-0 inches on centers. Provide continuous aluminum angles for anchoring all operable louvers.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as shown.

D. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective Work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, as determined by ENGINEER.

E. Protect non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminuous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.

F. Provide aluminum sheet frames of same color and finish as louvers around all louver frames projecting beyond the masonry walls on the interior, and install as the Work progresses to make the installations weathertight.

3.4 ADJUSTMENT AND CLEANING

A. Set adjustable louver blades for uniform alignment in open and closed positions.

B. Adjust louvers so moving parts operate smoothly.

C. Check the motor operator installation for the operable louver.

+ + END OF SECTION + +

SECTION 10I

IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals, as shown, specified and required to furnish and install all identification device Work.
   2. The extent of identification devices is specified herein and shown.
   3. The type of identification device Work includes, but is not necessarily limited to, the following:
      a. Self-luminous exit signs.
      b. Fire extinguisher location signs.
      c. Room identification signs.
      d. Exterior building identification signs.
      e. Miscellaneous mechanical fasteners and supports.

1.2 QUALITY ASSURANCE

A. Field Measurements: Take field measurements prior to preparation of Shop Drawings and fabrication, where possible, to ensure proper fitting of the Work.

B. Inserts and Anchorages:
   1. Furnish inserts and mechanical anchoring devices for the installation of identificaton devices and related Work.
   2. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.

C. Shop Assembly: Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.3 SUBMITTALS

A. Samples: Submit for approval samples of each color and finish of exposed materials and accessories required for identification devices. ENGINEER'S review of samples will be for color and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Shop Drawings for fabrication and erection of identification devices. Include plans, elevations, and full-size graphic layout. Show anchorages and accessory items. Furnish location template drawings for items supported or anchored to permanent construction.

2. Copies of manufacturer's technical data and installation instructions for each type of device required.
3. Complete selection of specified manufacturer's standard and custom colors.
4. Plans showing location of all required exit signs with information indicating mounting position, location and substrate. Coordinate location of exit signs for non-interference with other Work as required by governing building code.

PART 2 - PRODUCTS

2.1 SELF-LUMINOUS EXIT SIGNS

A. Provide self-luminous exit signs. Sign housing shall consist of an A42 color anodized extruded aluminum frame. The size, graphics and background color of the sign legend shall conform to all relevant code requirements. The legend shall be protected by a temper-resistant acrylic shield.

B. Lumination for exit signs shall be provided by sealed phosphor-coated tubes containing tritium located directly behind each portion of each letter. The tritium light sources shall be housed in a single impact resistant module.

C. Signs shall be listed by Underwriters Laboratories as being capable of providing a 10-15 year service life.

D. Mount exit signs in locations shown. Surface mount signs above all exit doors unless otherwise shown. Provide manufacturer's standard universal mounting bracket.

E. Product and Manufacturer: Provide one of the following:
1. Everglo Signs by Self Powered Lighting Incorporated.
2. Isolite Model 2040-01 Signs by Safety Light Corporation.
3. Or equal.

2.2 FIRE EXTINGUISHER LOCATION SIGNS AND INTERIOR ROOM IDENTIFICATION SIGNS

A. Material: Subsurface silkscreened graphics on a transparent acrylic sheet, 0.08-inches thick with Helvetica Medium alphabet and matching arrows type face. Provide 2-inch high upper case letters and 1-inch high lower case letters.

B. Fire Extinguisher Identification Sign: Provide 15-inch by 15-inch with square corners, unframed. Provide one for each surface mounted fire extinguisher. Background color red with white lettering. Sign shall incorporate a directional arrow as located by ENGINEER.

C. Room Identification Signs: Provide 15-inch by 15-inch with square corners, unframed. Background color brown with white lettering. Provide one sign for each door shown. Use room names shown to determine extent of graphics.

D. Product and Manufacturer: Provide one of the following:
   1. ASI/SPE MH (Four Corners) Plaque by ASI Sign Systems, Incorporated.
   2. Or equal.

2.3 EXTERIOR BUILDING IDENTIFICATION SIGNS

A. Material: Subsurface silkscreened graphics on 1/8-inch thick flat glass-reinforced polyester sheet. Provide 4-inch high Helvetica Medium alphabet; all upper case letters and matching arrow type face.

B. Provide opague white letters on opague blue background with mechanical flush mounted stainless steel fasteners at each corner. Paint fastener heads to match panel color. Provide one sign for each exterior door each 15-inches by 15-inches with 1/8-inch radiused corners; graphics to be furnished after award of Contract.

C. Product and Manufacturer: Provide one of the following:
   1. GOF/MH Wall Mounted Signs by ASI Sign Systems, Incorporated.
   2. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the substrates and conditions under which the devices are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install identification devices and components at the locations shown or, if not shown, as directed by ENGINEER, securely mounted with concealed theft-resistant fasteners. Attach signs to substrates in accordance with the manufacturer's instructions, unless otherwise shown.

B. Use stainless steel fasteners.

C. Install level, plumb, and at the proper height. Cooperate with other trades for installation of sign units to finish surfaces. Repair or replace damaged units as directed by ENGINEER.

+ + END OF SECTION + +

SECTION 10P

TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all toilet and bath accessories Work.
2. The extent of of toilet and bath accessories is shown.
3. The types of toilet and bath accessories Work required includes, but is not necessarily limited to, the following:
   a. Recessed paper towel dispenser/disposal.
   b. Toilet tissue dispensers.
   c. Mirrors.
   e. Grab bars.
   e. Soap dispensers.
   f. Miscellaneous items.

B. Coordination:
1. Furnish inserts and anchoring devices which must be set in concrete or built into masonry and gypsum wallboard for the installation of toilet accessories. Coordinate delivery with other work to avoid delay.
2. See concrete, masonry and gypsum wallboard Sections of these Specifications for installation of inserts and anchorage devices.

C. Related Sections:
1. Section 4C1, Unit Masonry Construction.
2. Section, 10B1, Toilet Partitions and Urinal Screens.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
1. Provide products of the same manufacturer for each type of accessory unit and for units exposed in the same areas.
2. Stamped names or labels on exposed faces of units will not be permitted.
3. Provide locks with the same keying for each type of accessory units in the Project wherever possible. Furnish two keys for each lock.

B. Requirements of Regulatory Agencies:
1. Codes: Comply with applicable provisions of the Uniform Building Code and ANSI A117.1.

C. Reference Standards: Comply with applicable provisions and recommendations, except where otherwise shown or specified.
1. ASTM A 167, Corrosive Resisting Chromium-Nickel; Steel Plate, Sheet and Strip.
2. ASTM A 366 Specification for Cold Rolled Carbon Steel Commercial Quality.

3. ASTM A 386 Specification for Zinc Coating (Hot-Dip) on Assembled Steel Products.
4. ASTM B 456, Specification for Electro Deposited Coatings of Nickel Plus Chromium.
5. Federal Specification, FS DD-G-451, Glass (Laboratory).
6. Federal Specification, FS WW-P-541.
7. FS WW-P-541, Plumbing Fixtures (Land Use).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical data and installation instructions for each toilet accessory.
   2. Setting Drawings, templates, instructions and directions for installation of anchorage devices in other work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel, ASTM A 167: Type 304L with polished No. 4 finish, unless otherwise specified.

B. Brass, FS WW-P-541: Cast or forged quality alloy.

C. Sheet Steel, ASTM A 366: Cold rolled, commercial quality. Surface preparation and metal pretreatment as required for applied finish.

D. Chromium Plating, ASTM B 456: Nickel and chromium electro-deposited on metal, Type SC2.

E. Mirror Glass, FS DD-G-451: Type I, Class 1, Quality q2, 1/4-inch thick, with silver coating, copper protective coating, and non- metallic paint coating.

F. Galvanized Steel Mounting Devices, ASTM A 386: Hot-dip galvanized after fabrication.

2.2 RECESSED PAPER TOWEL DISPENSER/DISPOSAL

A. Size to dispense not less than 600 c-fold towels with interchangeable paper drop. With cabinet and door not less than 22 gage stainless steel, No. 4 satin finish all welded construction without mitered corners. Hang doors with a concealed, full-length stainless steel piano hinge and install a tumbler-lockset.

B. Product and Manufacturer: Provide one of the following:
   1. No. 0467 by American Specialties Incorporated.
   2. Or equal.

2.3 SANITARY NAPKIN DISPOSAL UNITS

A. General: Provide feminine napkin disposal units of sizes shown.

B. Surface Mounted Sanitary Napkin Disposal Units: Fabricate disposal units from not less than 0.031-inch thick (22 gage) stainless steel, with flange of one-piece seamless construction without mitered corners. Provide self-closing door equipped with a full length stainless steel piano hinge. Provide a folddown stainless steel purse shelf of 22 gage stainless steel.

C. Product and Manufacturer: Provide one of the following:
   1. No. 0852 by American Specialties Incorporated.
   2. Or equal.

2.3 TOILET TISSUE DISPENSERS

A. General: Provide toilet tissue dispensers at each water closet.

B. Multi-roll Toilet Tissue Dispenser and Ash Tray: Fabricate shelf of not less than 1/8-inch thick stainless steel, to store and dispense not less than two 4-1/2-inch by 4-1/2-inch core tissue rolls. Fabricate flange from a single piece, with seamless construction.

C. Product and Manufacturer: Provide one of the following:
   1. No. 0697GA by American Specialties Incorporated.
   2. Or equal.

2.4 MIRRORS

A. General: Provide mirrors above each lavatory.

B. Stainless Steel Mirror: Fabricate frame from 20 gage stainless steel, welded and groundsmooth, no shelf. Mirrors shall be 18- inches by 24 inches.

C. Product and Manufacturer: Provide one of the following:
   1. No. 0535A by American Specialties Incorporated.
   2. Or equal.

2.5 GRAB BARS

A. General: Provide grab bars where shown. Provide custom specials where required or specified.

B. Stainless Steel Grab Bars: Provide stainless steel knurled grab bars, 1-1/2-inch outside diameter, 16 gage.
   1. Mounting: Concealed, with manufacturer's standard flanges and anchorages for type of installation.

C. Product and Manufacturer: Provide one of the following:
   1. Type 16 with 52-inch leg and 30-inch leg by American Specialties Incorporated.
   2. Or equal.

2.6 SOAP DISPENSERS

A. General: Provide wall mounted shelf soap dispensers, one per lavatory.
   1. Cover and container finish: Stainless steel.

B. Liquid Soap Dispenser and Shelf: Fabricate units from 20 gage stainless steel to dispense lather in measured quantity by pump action with stainless steel pistons, springs, and internal parts.
   1. Capacity: 80 fluid ounces.

C. Product and Manufacturer: Provide one of the following:
   1. No. 0315 by American Specialties Incorporated.
   2. Or equal.

2.7 MISCELLANEOUS ITEMS

A. Combination shelf with utility hook and mop strip: Provide 18 gage stainless steel shelf with 3/4-inch lip, four 18 gage stainless steel hook strips and 3 mop holders. Shelf shall be 34-inches wide and 8-inches deep.
   1. Type 8 as shown.
   2. Product and Manufacturer: Provide one of the following:
      a. No. 1308A by American Specialties Incorporated.
      b. Or equal.

B. Hose Bracket: 14 gage stainless steel.
   1. Type 9 as shown.
   2. Product and Manufacturer: Provide one of the following:
      a. No. 1305A by American Specialties Incorporated.
      b. Or equal.

C. Pail Hook: 12 gage stainless steel.
   1. Type 10 as shown.
   2. Product and Manufacturer: Provide one of the following:
      a. No. 13017-A by American Specialties Incorporated.
      b. Or equal.

D. Towel and Robe Hooks: Cast brass with polished chrome finish.
   1. Type 13 as shown.
   2. General: Provide two double concealed mounting hooks.
   3. Product and Manufacturer: Provide one of the following:
      a. 0750 by American Specialties Incorporated.
      b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the areas and conditions under which toilet accessories are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory condtions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install items for the handicapped in accordance with ANSI A117.1.

B. Use concealed fastenings wherever possible.

C. Provide anchors, bolts and other necessary anchorages, and attach accessories securely to walls and partitions in locations as shown.

D. Install concealed mounting devices and fasteners fabricated of the same material as the accessories as recommended by manufacturer.

E. Install exposed mounting devices and fasteners finished to match the accessories.

F. Provide theft-resistant fasteners for all accessory mountings.

G. Secure toilet room accessories in accordance with the manufacturer's instructions for each item and each type of substrate construction.

H. Lock grab bars to concealed mounting plate installed in wall.

3.3 ADJUSTMENT AND CLEANING

A. Adjust accessories for proper operation.

B. After completion of installation, clean and polish all exposed surfaces.

C. Deliver keys and instruction sheets to OWNER.

+ + END OF SECTION + +

SECTION 11A1

CENTRIFUGAL RETURN/WASTE SLUDGE PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install dry pit centrifugal pumps complete and operational with motors and accessories.
2. Return/Waste Sludge pumps shall be two-speed, non-clog, wastewater centrifugal pumps.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 3D, Cast- In-Place Concrete.
6. Section 9L, Painting. (Surface preparation and shop painting are under this Section).
7. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The supplier or manufacturer shall have experience in producing similar equipment, and shall show evidence of installations in satisfactory operation.

B. In order to centralize responsibility, it is required that all equipment provided under this Specification be furnished by a single supplier or manufacturer who shall assume full responsibility for the completeness of the system. The supplier or manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Standards of the Hydraulic Institute.
2. National Electric Code.
3. Standards of National Electrical Manufacturers Association.
4. Institute of Electrical and Electronic Engineers.
5. American National Standards Institute.
6. Standards of American Water Works Association.

D. Shop Tests:
1. Pump Tests:
   a. The pump casings shall be hydrostatically tested to twice the discharge head or 1-1/2 times the shutoff head, whichever is greater.

b. All test measurements shall be taken with properly calibrated instruments and all procedures shall conform to the test code of the Hydraulics Institute unless modified herein.

c. Running Test: Each pump assembly shall be operated from zero to maximum capacity as shown on the performance curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency, NPSH and current. Readings shall be taken at a minimum of five evenly spaced capacity points including shutoff, design point and minimum head for which the pump is designed to operate. Performance tests shall be run within a five percent of design maximum speed and capacity utilizing either the job motor, a calibrated test motor, or dynamometer. No minus tolerances will be allowed with respect to capacity, total head, or the maximum allowable efficiency at the design point.

d. Each test shall be witnessed by a Registered Professional Engineer, who may be an employee of the manufacturer. He shall sign and seal all copies of the curves and shall certify that the hydrostatic tests were performed. Tests shall be conducted in conformance with applicable methods described in Section A6 of AWWA E101.

e. Pumps shall not be shipped until the ENGINEER has approved the test reports.

2. Motor Tests:

a. Each motor shall be given a routine test at the manufacturer's factory. The test shall consist of: Running Light Current; Locked Rotor Current; Winding Resistance; High Potential; and Bearing Inspection.

b. In addition to the inspection report required for the above, a certified motor data sheet shall be furnished for approval prior to shipment. The data sheets shall show winding resistances; torques; guaranteed minimum efficiencies at full, 3/4 and 1/2 load; power factors; slip; full load, locked rotor and running light amperes; temperature rises and results of dielectric tests. All values shall be from tests of previously manufactured electrically duplicate motors. Data sheets shall be marked to indicate motor application, manufacturer, type, frame size, bearing type, lubrication medium, insulation type, and enclosure type.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. Descriptive literature including a cross-sectional view of the pump indicating the materials of construction and dimension prints of pump and motor.
2. Performance curves for the complete pump assembly showing the relationship between head and capacity, efficiency, horsepower, and NPSH from shut-off head to the minimum operating head specified.
3. Impeller type.
4. Maximum size sphere passed.
5. Weight of pumps and motors (including all components).
6. Motor manufacturer, type, rated horsepower, temperature rating, and expected minimum life under design conditions, minimum efficiency at 3/4 and full load, and descriptive literature including description of motor insulation, for each type of motor to be furnished.
7. Description of test facilities available.

8. Deviations from Drawings and Specifications.

B. Operation and Maintenance Manuals: Submit six complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

C. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA - PUMPING EQUIPMENT

A. The following centrifugal pumping units are required:
   1. The pumps shall be designed to meet the following conditions and shall be furnished with two speed motors.

	Return/Waste Sludge Pumps
Liquid Pumped	Clarifier sludge with up to 2.5% solids
No. of Pumps	2
Pump Configuration	Vertical, suction elbow
Maximum Solids to be Passed	4-inch sphere
Suction Condition	Flooded
Design Speeds (rpm)	1200/900
Design Capacity @ 1350 rpm (gpm)	520
Design Head @ 1350 rpm (tdh)	25
Min. Pump Efficiency at Design Point @ 1350 rpm (%)	71%
Approx. 2nd Design Capacity @ 1200 rpm (gpm)	400

Approx. 2nd Design Head @ 1200 rpm (tdh)	28
Shut Off Head - 1350 rpm (Ft)	34
Second Speed (rpm)	900
Design Point Capacity (gpm)	260
Design Head (tdh)	18
Motor Horsepower	5
Drive	2 speed

2.2 FABRICATION - PUMPING EQUIPMENT

A. Pump Construction:

1. The casing and suction cover shall be of close grained cast iron of sufficient strength, weight and metal thickness to insure long life, accurate alignment, and reliable operation. The volute shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the impeller and provide smooth unobstructed flow. Clean-out openings, with removable covers, shall be provided. One opening and cover having its interior surface matching the volute contour, shall be located on the casing to allow access to the interior of the impeller. The casing shall be split perpendicular to the shaft, with removable suction cover and stuffing box cover. The casing shall be so arranged that the impeller may be removed without disturbing either suction or discharge piping. Suction and discharge connections shall have standard ANSI flanges. Each suction and discharge flange shall be drilled and tapped for gage connections. The casing shall be provided with lifting lugs or eye bolts and the necessary vents and drain connections.
2. A replaceable 11-13 percent chrome stainless steel casing wear ring, providing 1/4-inch minimum wear, shall be installed with the wear surface parallel to the end of the impeller.
3. Impellers shall be of close grained cast iron or ductile iron and shall be of the enclosed radial non-clog or mixed flow type having a minimum number of vanes. The impeller shall be particularly designed with smooth water passages to prevent clogging by stringy or fibrous materials, and shall be capable of passing solids having a maximum sphere size as listed. Impellers shall be statically and hydraulically balanced, and shall be keyed and positively secured to the shaft. A replaceable stainless steel wear ring shall be provided. The ring shall be mounted on the impeller to provide a renewable surface opposite the suction cover wear plate.
4. The stuffing box cover shall be made of close-grained cast iron with integral stuffing box. The stuffing box shall be fitted with a mechanical seal instead of packing. The mechanical seal shall be a double inside mounted end face seal of the rubber

bellows type as manufactured by John Crane, Type 8-1, Type 21, or equal. The seal shall be suitable for the specified pump pressures. Flushing water will be provided from a separate water supply.

5. The pump shaft shall be high-strength steel, accurately machined and of sufficient size to transmit full driver output. It shall be protected from the pumped liquid by a shaft sleeve in the stuffing box area.
6. A renewable 11-13 percent chrome stainless steel hardened shaft sleeve, which extends through the stuffing box and under the gland, shall be provided.
7. The pump bearing frame shall be of one-piece rigid cast iron construction. The frame shall be provided with a cast iron bearing housing at the outboard end, and a cast iron end cover at the inboard end. The housing shall have filling and draining plugs. Both ends of the frame shall be provided with lip type grease seals and labyrinth type deflectors to prevent entrance of contaminants. The bearing frame shall be designed so that the complete rotating element including rotor can be removed from the casing without disconnecting piping or coupling.
8. Bearings shall be designed for 100,000 hours minimum life as defined by the Anti-Friction Bearing Manufacturers Association, at conditions of operation. Bearings shall be grease lubricated with provisions for the addition and relief of grease.
9. Each vertical pump shall be supplied with a suction elbow with clean-out hand hole.
10. Each vertical pump shall be mounted on a suitable pedestal base of heavy cast iron or fabricated steel. The pedestal base shall have openings large enough to permit access to the suction elbow and clean out hand hole. The base shall safely withstand all stresses imposed thereon by vibration, shock, and all possible direct and eccentric loads. The base shall have adequate horizonal dimensions, foundation contact area, and anchorage facilities.
11. Each pump shall be directly connected to its driver by means of a flexible coupling. An approved coupling guard shall be provided. The motor support adapter for vertical pumps shall bolt directly to the pump frame, and shall be designed to permit access to the frame and flexible coupling.
12. All data plates shall be of stainless steel suitably attached to the pump. Data plates shall contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, frame and bearing numbers and other pertinent data.

B. Motor Drives:

1. Motors for two speed pumps shall be of the vertical squirrel cage induction type, grease lubricated, low starting current. Each motor shall have an open drip-proof enclosure. All motors shall be suitable for operation on 460 volt, 3 phase, 60 Hz power. The motors shall be of proper size to drive the pumps continuously at any point on the pump curve without exceeding the nameplate horsepower. Each motor shall have a 1.15 service factor, 50°C ambient rise. The full load speed of the motor shall be the same as required by the pump. Motors shall have two speed-one winding.

2. Motors shall be high efficiency design, Westinghouse Electric Corporation TEEII, Reliance Electric XE, General Electric Energy Saver, or equal. Efficiencies shall be determined in accordance with NEMA STandard MG1-12.53a and IEEE STandard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MG1-12.53b.
3. Each motor shall have stators moisture protected by means of epoxy encapsulation.
4. Unless otherwise specified, the motors shall comply with the latest ANSI, NEMA, and IEEE Standards as minimum.
5. Each motor shall be provided with a ductile cast iron non-reverse coupling.
6. Each motor shall be supplied with a lifting hook and a suitable base. Approved coupling guards shall be provided.
7. Each motor shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, Hp, full load current, RPM, centigrade degree rise, manufacturers name and serial no., model, voltages, locked rotor KVA code (constant speed), bearing numbers and a connection diagram.
8. Each motor terminal box shall be of cast iron or fabricated steel, neoprene gasketed and bolted, and oversized to provide adequate space for connections. The motor leads shall be permanently marked in agreement with connection diagram.

C. Surface Preparation and Shop Painting:
1. Surface preparation and shop painting is required for all ferrous metals, equipment and accessories. Stainless steel shall not be painted.
2. All ferrous metal surfaces shall be cleaned and provided with two coats of priming paint. All paint materials shall be products of the Koppers Company Inc., or the Tnemec Company Inc. All ferrous surfaces of the equipment shall be cleaned with a Commercial Sandblast (SSPC-SP6) and shall receive two coats of Koppers Epoxy Primer 654, with a minimum dry thickness of 1.5 to 2.0 mils per coat, or two coats of Tnemec 66-1211 Epoxy Primer, with a minimum dry thickness of 1.5 to 2.5 mils per coat. Ferrous metal surfaces may be given two coats of the manufacturer's standard paint system in lieu of the priming paint, provided that the total mil thickness of paint is equal to that specified above.
   Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6) except that motors and like items that may be damaged by sandblasting may be prepared by other means.
3. Gears, bearing surfaces, and other unpainted surfaces shall receive a heavy application of a rust-resistant coating which shall be maintained during storage and until the equipment is placed into operation.

D. Gages: An indicating gage shall be furnished and installed on the suction and discharge flanges of each pump. Gages shall have a 4-1/2-inch diameter aluminum alloy case, and shall be furnished with diaphragm seals (with flush connection) and gage cocks. Ranges shall be as follows:
1. Suction: 30 inches Hg to 15 psi.
2. Discharge: 0 to 60 psi.

E. Manufacturer: Provide return/waste sludge pumps as manufactured by one of the following:
   1. Aurora Pump Company.
   2. Worthington Corporation.
   3. Or equal.

2.3 SPARE PARTS

A. The following spare parts shall be provided for the Return/Waste Sludge Pumps:
   1. Two mechanical seals.
   2. One complete set of any special tools required for maintenance.

B. In addition to the spare parts to be furnished by the CONTRACTOR, the CONTRACTOR shall furnish a list of additional recommended spare parts for an operating period of one year. This list shall describe each part, the quantity recommended, and the unit price of the part. The OWNER will purchase all, some, or none of the recommended spare parts at his option.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in complete accordance with manufacturer's instruction and recommendations.

B. All pumping units shall be installed on concrete bases and secured with anchor bolts in accordance with the manufacturer's recommendations and as shown. The concrete bases shall be poured up to a inch below the metal bases or soleplates. Concrete work and grout are in Division 3. The base with the equipment mounted thereon, or the soleplate, shall then be accurately shimmed to grade and the spaces between filled with an approved nonshrink grout. Where channel baseplates are used, the void inside the channel shall be filled with nonshrink mortar and the open ends plastered with 1 to 2 cement mortar.

C. Neatly placed 1 inch hard copper pipe shall be provided on each pump to convey leakage to the nearest drainage inlet.

D. Installation shall include furnishing and applying an initial supply of grease and oil.

E. Support piping independent of the pump.

F. Check and align all pumps, motors and shafting.

3.2 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall furnish the services of a qualified factory-trained serviceman from pump manufacturer who shall assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct the plant operators in the care, operation and maintenance of the equipment.

B. Serviceman will be required to make not less than two visits to the site. The first visit shall be for a period of not less than one 8-hour day to assist in the installation of the equipment. The second visit shall be for a period of not less than two 8-hour days to check the completed installation, to start-up the units, and to instruct the plant operators in the proper operation and maintenance of the equipment.

C. All costs, including travel, lodging, meals and incidentals shall be considered to have been included in the CONTRACTOR's lump sum bid price.

3.3 START-UP AND TEST

A. The CONTRACTOR shall be responsible for over-all coordination of the pumps and motors installation and start-up.

B. Start-up shall include but not be limited to: demonstrating pumps and motors operability, calibration of all necessary instruments, obtaining any and all manufacturers' assistance during and after installation, demonstrating safety features and obtaining manufacturers' certifications that components are installed properly.

+ + END OF SECTION + +

SECTION 11A2

VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install vertical turbine centrifugal pumps complete and operational with motors, and accessories.

B. In order to centralize responsibility, it is required that all equipment and services provided under this Section be furnished by a single supplier or manufacturer who shall assume full responsibility for the completeness of the system.

C. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 9L, Painting.
6. Division 15, Mechanical.
7. Division 16, Electrical unless specified in 11A2.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The Manufacturer shall have experience in producing similar equipment, and shall show evidence of installations in satisfactory operation.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Standards of the Hydraulic Institute.
2. National Electric Code.
3. Standards of National Electrical Manufacturers Association.
4. Institute of Electrical and Electronic Engineers.
5. American National Standards Institute.
6. Standards of American Water Works Association.

1.4 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Descriptive literature including a cross-sectional view of the pump indicating the materials of construction and preliminary dimension prints of pumps and motors.
2. Performance curves for the complete pump assemblies showing the relationship between head and capacity, efficiency, horsepower, and NPSH from shut-off head to the minimum operating head specified. Curves shall be corrected for pump losses and shaft friction Hp losses. Pump losses shall include column and discharge head losses.
3. Impeller type.

4. Bowl and shaft WR square.
5. Maximum down thrust at design points and shutoff, and maximum up thrust.
6. Weight of pumps and motors (including all components).
7. Motor manufacturer, type, enclosure, phase, voltage rated horsepower, full load and locked rotor amperage temperature rating, and expected minimum life under design conditions, minimum efficiency at 1/8, 3/4 and full load, and descriptive literature including description of motor insulation, for each type of motor to be furnished.
8. Shop Drawings Showing: Fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall comply with JIC Standards.

B. Operation and Maintenance Manuals: Submit six complete manuals including:
1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 1I3.

C. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA - PUMPING EQUIPMENT

A. General:
1. Elevation of the bottom of the pump suction bell below the minimum water level shall be as recommended by the manufacturer for optimum operating and submergence requirements. The suction barrel shall extend below the suction bell a distance recommended by the manufacturer.
2. Pump characteristic curve shall rise from minimum head condition to shut-off head, with no intermediate valley.
3. Pump TDH as described above, includes only the bowl assembly head. The column loss and discharge head loss must be added by the manufacturer for complete pump design.
4. The first critical speed of the pump rotating assembly shall always be above the operating speed by at least 20 percent.
5. Peak efficiency should be at a flow less than design capacity. Pump efficiency shall be for the complete pump assembly, from inlet bowl to discharge flange.
6. Pumps will pump wastewater reclamation facility effluent.
7. Pumps shall be capable of continuous operation without exceeding the vibration limits established by the Hydraulic Institute. They shall be suitable for start up against an initially closed hydraulically operated discharge valve.

B. The following vertical turbine pumping units shall be furnished:

No. of Pumps	-	3
Design Capacity	-	600 gpm
Design Head	-	185 feet (tdh)
Minimum Operating Head	-	____ feet
Shutoff Head	-	____ feet

Maximum Operating Speed	-	1800 rpm
Discharge Size	-	____ inch
Discharge Head Construction	-	Above base discharge
Minimum Pump Efficiency	-	____% (at design conditions)
Motor Horsepower	-	40
Drive	-	Constant Speed
Elevation of Pump Discharge Centerline	-	
Elevation of Top of Suction Barrel Flange	-	As req'd by discharge head furnished
Elevation of Suction Inlet on Pump Suction Barrel	-	
Diameter of Suction Inlet	-	____ inches
Maximum Hydrostatic Water Surface Elevation	-	____
Minimum Water Surface Elevation	-	____
Diameter of Suction Barrel	-	____ inches

2.2 FABRICATION - PUMPING EQUIPMENT

A. Pump Construction:

1. General: All pumps shall conform to AWWA Standard E101, latest revision, except where modified herein.
2. Bowl Assembly: The pump bowl shall be of close-grained cast iron free from blowholes, sand holes, and all other defects, and shall be accurately machined and finished to close dimensions, capable of withstanding hydrostatic pressure equal to 1 and 1/2 times the shut-off head or 2 times the rated head, whichever is greater. All water passages shall be finished in such a manner as to deliver with a minimum loss in hydraulic efficiency. The inlet to the bowl shall be flared with supports for the bottom bearing and streamlined to act as guide vanes and present minimum resistance to flow.
   The impeller shall be enclosed or semi-open constructed of bronze, accurately machined and finished and dynamically balanced. It shall be securely fastened and locked to the impeller shaft. The bowl and impeller shall be designed with open and smooth passages to secure efficient operation and to prevent air or sand locking. Pump impeller wearing rings and case wearing rings shall be provided and shall be of bronze of dissimilar hardness. Rings shall be fitted in such a manner that they can be easily removed.
   The impeller shaft shall be of Type 416 stainless steel containing not less than 12 percent chromium with bearing surfaces properly hardened, ground and polished to final size. Pump bearings shall be of bronze, of ample size and designed to give long service with positive means of lubrication utilizing the water pumped. The suction case bearing shall be permanently grease lubricated in an approved manner.
3. Discharge Column Assembly: The discharge column assembly shall be of open line shaft construction, with columns of flanged steel pipe conforming to ASTM A 53, latest revision. They shall be furnished in interchangeable sections having a nominal length of not more then 10 feet and shall be connected with Type 303 or 304 stainless steel nuts and bolts. Each section of column pipe shall be provided with two heavy duty lifting lugs 12 to 18 inches below the top end. The

line shafting shall be of Type 416 stainless steel of adequate diameter to operate the pump without distortion or vibration. Minimum size of shaft shall be determined in accordance with the requirements of AWWA Standard E101, Paragraph 4.3.3 latest revision. The shaft shall be furnished in interchangeable sections having a nominal length of not more than 10 feet. The top line shaft section shall be a two piece unit provided with one piece connecting to the line shaft and the other extending through the hollow shaft motor. A suitable coupling shall be provided between the two pieces to permit removal of the motor without requiring it to be lifted up over the shaft. A water slinger and a bronze quill bushing shall be provided at the hollow motor shaft. Shaft sections shall be connected by screwed couplings. Couplings shall have locking feature to prevent unscrewing of shaft. Each line shaft shall be provided with a hard chrome plating or approved equal system at each line shaft bearing and a removable separate hard chrome plated stainless steel or monel shaft sleeve through the stuffing box. Line shaft bearings shall be of cutless rubber or equal and shall be held in place in bronze bearing retainers which shall be supported in the column couplings by means of the flanged ends of the column pipes. Bearings shall be lubricated utilizing the water pumped, and shall be spaced at intervals not exceeding 10 feet.

4. Pump Head: The pump head shall be of fabricated steel or high grade cast iron free from any defects or roughness, of ample and proper design for all loads it is to carry, and shall have a base flange drilled to match the suction barrel flange. The top surface for mounting the drive motor and the bottom surface for mounting to the suction barrel shall be machined. An accessible deep packing box shall be provided. The stuffing box shall be of cast iron and shall contain not less than 6 rows of woven teflon packing. The packing gland shall be bronze split type, and held in place by Type 316 stainless steel hardware. The lantern ring and bearing shall be of bronze construction. The length of the bearing shall be at least 1-3/4 times the shaft diameter. Sufficient access shall be provided to permit complete replacement of the packing without disturbing the shafting. The pump head shall have an above-the-floor flanged discharge with flange conforming to ANSI B16.1, Class 125.
5. A fabricated steel suction barrel shall be provided for each pump. A suction barrel shall be provided complete with gasketed blind flange, bolts and nuts for future pump in accordance with the requirements described hereinbefore. Flanged inlets shall be provided in each barrel at the elevations given in the design criteria. The distance from the centerline of the barrel to the face of the suction flange shall be not less than 21 inches, and shall be the same for all sizes of suction barrels. Each barrel shall have a minimum wall thickness of 0.375 inches. A suitable gasket shall be provided to prevent leakage at the mounting flange.
6. Each pump head flange and each suction barrel flange shall be drilled at a matched location on one side of the pump discharge head. The set of drilled holes is for the installation of an air valve to purge air that may accumulate in the barrel with varying water levels. The hole shall be 1 inch diameter. The pump head flange hole shall be tapped and provided with a plug in the top side of the flange. The suction barrel flange shall be tapped and provided with a 1 inch diameter stainless steel or copper tube extending not less than 8 inches down into the barrel.

7. Data Plates: All data plates shall be of stainless steel suitably attached to the pump. Data plates shall contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, frame and bearing numbers and other pertinent data.

B. Motor Drives:

1. Motors for all pumps shall be of the vertical hollow shaft squirrel cage induction type with Class B insulation. Each motor shall have a WT-1 enclosure. All motors shall be suitable for operation on 460 volt, 3 phase, 60 Hz power. Pumps and drives shall be selected so that the required horsepower at any point on the operating curve from shut off to run-out does not exceed the nameplate horsepower. Each motor shall have a 1.15 service factor, 50° C ambient rise. Motors shall be arranged for mounting on the pump heads.
2. Each motor shall have stators moisture protected by means of epoxy encapsulation. In addition, space heaters, 120 volt, single phase, shall be placed in each motor frame.
3. Motors shall be high efficiency design, Westinghouse Electric Corporation TEEII, Reliance Electric XE, General Electric Energy Saver, or equal. Efficiencies shall be determined in accordance with NEMA Standard MG1-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standards as minimum.
4. Unless otherwise specified, the motors shall comply with the latest ANSI, NEMA and IEEE Standards as minimum.
5. Bearings shall be selected to have AFBMA rated (minimum) life of 10 years when operated continuously at rated speed of motor and at total load consisting of the weight of the motor rotor plus combined dead weight and hydraulic thrust load imposed on the motor by the pump, when pumping at design point. Thrust bearings shall be of the angular contact ball or spherical roller type. Bearings shall be adequate to carry continuous thrust loads existing under all conditions of pump operation from zero to shutoff.
6. Each bearing shall be oil lubricated. There shall be a visual level indicator, accessible drain plug and accessible filling plug for all oil bearings. The lubrication system shall be so designed as to provide the correct quantity of lubricant with minimum foaming or aeration. Each motor shall have a stainless steel plate indicating all essential lubricating information such as type, viscosity, frequency of changes, etc.
7. Each motor shall be provided with a ductile cast iron non-reverse coupling.
8. Each motor shall be supplied with a lifting hook and a suitable base.
9. Each motor shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, Hp, full load current, RPM, centigrade degree rise, manufacturers name and serial no., model, voltages, locked rotor KVA code (constant speed), bearing numbers and a connection diagram.
10. Each motor shall be furnished with a power factor improving capacitor sized to correct the power factor to 95 percent at full load. The capacitor shall be furnished with mounting brackets for mounting at the motor and all necessary cable and liquid-tight flexible conduit for connection to the motor terminal box.
11. Each motor terminal box shall be of cast iron or fabricated steel, neoprene gasketed and bolted, and oversized to provide adequate

space for connections, including capacitor. The motor leads shall be permanently marked in agreement with connection diagram.

C. Surface Preparation and Shop Painting:
   1. Surface preparation and shop painting is required for all ferrous metals, equipment and accessories. Stainless steel shall not be painted.
      a. All paint materials shall be products of the Koppers Company Inc., or the Tnemec Company Inc. The exterior surfaces of the pump head and the suction barrel shall be cleaned with a Commercial Sandblast (SSPC-SP6) and shall receive two coats of Koppers Epoxy Primer 654, with a minimum dry thickness of 1.5 to 2.0 mils per coat, or two coats of Tnemec 66-1211 Epoxy Primer, with a minimum dry thickness of 1.5 to 2.5 mils per coat. The exterior surfaces of the pump head and the suction barrel may be given two coats of the manufacturer's standard paint system in lieu of the priming paint.
      b. Motors shall be given two coats of the manufacturer's standard paint system.
      c. Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6) except that motors and like items that may be damaged by sandblasting may be prepared by other approved means.
      d. The interior surfaces of the pump, suction bell and discharge column pipes, and the interior surfaces of the pump head and suction barrel shall be cleaned with a Near White Metal Sandblast (SSP-SP10), shall receive two coats of Koppers Epoxy Primer 294, with a minimum dry thickness of 1.5 to 2.0 mils per coat, and two coats of Koppers Hi-Gard with a minimum dry thickness of 2.0 to 3.0 mils per coat <u>or</u> shall receive two coats of Tnemec 20-1255 Epoxy Primer with a minimum dry mil thickness of 1.5 to 2.5 mils per coat and two coats of Tnemec 20-2000 with a minimum dry mil thickness of 2.0 to 3.0 mils per coat.
   2. Bearing surfaces, and other unpainted surfaces shall receive a heavy application of a rust-resistant coating which shall be maintained during storage and until the equipment is placed into operation.

D. Manufacturers:
   1. Aurora Pump Company.
   2. Worthington Corporation.
   3. Or equal.

E. Mounting Bolts:
   1. All mounting bolts and nuts and other fasteners furnished for connection of the pumps to the suction barrels shall be of Type 304 stainless steel, furnished by the CONTRACTOR, and shall be of ample size and strength for the purpose intended.

2.3 SPARE PARTS

A. The following spare parts shall be furnished:
   1. Two complete sets of packing.
   2. One complete set of any special tools required for maintenance.

   The spare parts shall be delivered carefully boxed or packaged and plainly marked for reordering.

B. In addition to the spare parts to be furnished the Manufacturer under this section shall furnish a list of additional recommended spare parts with for an operating period of one year. This list shall describe each part, the quantity recommended, and the unit price of the part. The OWNER will purchase all, some, or none of the recommended spare parts at his option.

PART 3 - SPECIAL SERVICES

3.1 INSTALLATION

A. The pumping equipment shall be installed in accordance with the details shown on the Drawings, in accordance with approved shop drawings and manufacturer's instructions.

3.2 CONTRACTOR'S SERVICES

A. The CONTRACTOR shall furnish the services of a qualified factory-trained serviceman who shall assist as necessary in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct the OWNER'S personnel in the care, operation and maintenance of the equipment.

B. The serviceman will be required to make as many visits as are necessary to provide for proper installation and continuous satisfactory operation of the equipment.

+ + END OF SECTION + +

SECTION 11A4

SUMP PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: SUBCONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install submersible, end suction centrifugal pumps complete and operational with motors, control equipment and accessories.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 9L, Painting.
6. Section 13A, Instrumentation and Control-Plant.
7. Sections 15A and 15B, Piping.
8. Section 15D, Valves, Specials and Appurtenances.
9. Division 16, Electrical unless specified in 11A3.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The manufacturer or supplier shall have experience in producing similar equipment, and shall show evidence of installations in satisfactory operation.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Standards of the Hydraulic Institute.
2. National Electric Code.
3. Standards of National Electrical Manufacturers Association.
4. Institute of Electrical and Electronic Engineers.
5. American National Standards Institute.
6. Standards of American Water Works Association.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, specifications and engineering data including: dimensions, materials, size, weight, performance data and curves showing overall pump efficiencies, flow rate, head, brake horsepower, motor horsepower, speed and shut-off head.
2. Fabrication, assembly, installation and wiring diagrams.
3. Deviations from Drawings and Specifications.

B. Operation and Maintenance Manuals: Submit complete manuals including:
1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. Pumps shall be submersible end suction centrifugal. They shall be specially designed, constructed, and installed for the service intended and shall comply with the following minimum conditions:
Design Conditions

Location	Return Sludge P.S. & Blower Bldg.
No. Required	2
Design Flow, gpm	75
Design TDH, Ft.	25
Shutoff TDH, Ft.	32
Maximum Motor Hp	1-1/2
Discharge Size, in.	3
Maximum Speed	1,750

B. One pump at each location shall be normally operated with the second pump as a standby.

2.2 FABRICATION

A. Pumps:
1. The pumps, with appurtenances and cable, shall be designed for continuous operation under submergence, without leakage, in water to a depth of 20 feet.
2. The impeller shall be enclosed bronze single or double vane nonclog, dynamically balanced and shall pass spheres 2-1/2 inches in diameter or larger.
3. All bolts, nuts and cap screws shall have hexagon heads and be of stainless steel.
4. The shaft shall be of stainless steel.
5. All surfaces in contact with the waste shall be protected with an epoxy or rubber asphalt coating resistant to sewage.
6. Bearings shall be anti-friction, grease or oil lubricated with a minimum B-10 life of 40,000 hours.
7. Brass or stainless steel nameplates giving the manufacturer's model and serial number, rated capacity, head, speed and other pertinent data shall be attached to the pump.
8. A mechanical shaft seal of high quality carbon, stainless steel and Buna-N seal shall be provided.
9. The motor shall be sealed against entry of moisture and oil-filled to dissipate motor heat for more efficient operation.
10. The pump and motor shall be designed for continuous operation in a non-submerged condition without damage.
11. The motor shall be non-overloading for the entire pump operating curve, and shall operate on 460 volt, 60 Hz, 3-phase power.
12. The pump motor cable shall be UL approved, designed for submersible duty and shall be indicated by code or legend permanently applied to the cable. The cable length shall be as required for direct connection to the terminal box.
13. Motors shall be provided with a service factor of 1.15.

14. Motor thrust bearings shall be designed for continuous thrust loads under all conditions of pump operation from zero head to shut-off. The anti-friction bearings shall be rated for a B-10 life of 40,000 hours.
15. The motor shall have built-in thermal overload protection.
16. The control panel shall be a wall mounted NEMA 4X enclosure factory wired for use with mercury float switches with the following components:
    a. Contact relay.
    b. Running light showing through cabinet door - green.
    c. Hand-Off-Auto switch.
    d. High water condition light - red.
    e. 6-inch alarm bell for high water mounted on panel door.
    f. Alarm silence button.
    g. Dry contacts for remote high water alarm annunciation.
    h. Combination type magnetic starter with overload reset and low voltage protection.
    i. Fusible disconnect switch with handle through the cover.
    j. Overload reset button.
    k. Suitably sized control power transformer.
17. Mercury float switches and accessories shall be furnished as follows:
    a. Support Pole: 1-inch diameter galvanized pipe threaded one end.
    b. Support Bracket: Galvanized steel.
    c. Flow Switch: Normally open mercury switches encapsulated in epoxy resin. Float casing shall be polypropylene.
    d. Switch Cable: Cable within sump Type SO neoprene jacket, 4 #18 conductor, 41 strand, 300 volt insulation. Cable between control panel and sump shall conform to the requirements of Division 16, Electrical.
    e. Cable Supports: Polypropylene composition clamp with Type 304 stainless steel bolts.
    f. High Water Alarm: 2 conductor cable with color coded cover.
    g. Sequence of Operation: Simplex system.
        1) Number 2 float switch starts pump on liquid rise.
        2) Number 3 float switch actuates high water alarm on liquid level rise, deenergizes alarm on liquid level drop.
        3) Number 1 float switch deenergizes pump on liquid level drop and closes control holding circuit on liquid level rise.
18. Manufacturer: Provide submersible end suction pumps as manufactured by one of the following:
    a. Hydr-O-Matic Pump Company.
    b. Or equal.

2.3 SURFACE PREPARATION AND SHOP PAINTING

A. Surface preparation and shop painting is required for all ferrous metals, equipment and accessories, except that stainless steel shall not be painted.

B. All ferrous metal surfaces shall be cleaned and provided with two coats of priming paint in accordance with the applicable requirements of Section 9L, Painting. All prime coat materials shall be compatible with the finish coat materials to be furnished under Section 9L. All ferrous metal surfaces may be given two coats of the manufacturer's standard paint system in lieu of the priming paint, provided that the total mil thickness of paint is equal to that specified for the priming paint.

Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6) except that motors and like items that may be damaged by sandblasting may be prepared by other approved means.

C. Gears, bearing surfaces, and other unpainted surfaces shall receive a heavy application of a rust-resistant coating which shall be maintained during storage and until the equipment is placed into operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in complete accordance with manufacturer's instructions and recommendations.

B. A check valve, and shut-off valve in discharge piping are required for each pump. Coordinate with Division 15.

C. Support piping independent of pump.

D. Securely fasten control panels to wall or other mounting surfaces. Where local wall is not available, provide galvanized steel supports to rigidly support equipment reasonably close to motor.

3.2 START-UP AND TEST

A. The SUBCONTRACTOR shall verify that structures, pipes and equipment are compatible.

B. Make adjustments required to place system in proper operating condition.

C. A manufacturer's representative shall check and approve the installation before operation. He shall test operate the system in the presence of the Construction Manager and verify that the pumps conform to requirements.

+ + END OF SECTION + +

SECTION 11A11

CENTRIFUGAL INFLUENT PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide two (2) raw sewage pumps complete and operational with motors and accessories as shown and specified. Anchor bolts are included in this Section.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 3D, Concrete bases for pumps and drives are under Cast-In-Place Concrete.
6. Section 13A, Instrumentation and Control Equipment.
7. Section 15D, Valves and Appurtenances.
8. Division 15, Sections on Piping.
9. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Standards of the Hydraulic Institute.
2. National Electric Code.
3. Standards of National Electrical Manufacturers Association.
4. Institute of Electrical and Electronic Engineers.
5. American National Standards Institute.
6. Standards of American Water Works Association.

B. Shop Tests:
1. Pump casings shall be hydrostatically tested to twice the discharge head or 1-1/2 times the shutoff head, whichever is greater.
2. Running Test: Pump assembly shall be operated from zero to maximum capacity as shown on the approved curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency, and current. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design point and minimum head for which pump is designed to operate.
3. Each test shall be witnessed by a Registered Professional Engineer, who may be an employee of the manufacturer. He shall sign and seal all copies of curves and shall certify that hydrostatic tests were performed. Tests shall be conducted in conformance with applicable methods described in Section A6 of AWWA E101.
4. Pumps shall not be shipped until the ENGINEER has approved the test reports.

C. Motor Tests:
   1. Each motor shall be given a routine test at the manufacturer's factory. The test shall consist of: Running Light Current; Locked Rotor Current; Winding Resistance; High Potential; and Bearing Inspection.
   2. In addition to the inspection report required for the above, a certified motor data sheet shall be furnished for approval prior to shipment. The data sheets shall show winding resistances; torques; guaranteed minimum efficiencies at full, 3/4 and 1/2 load; power factors; slip; full load, locked rotor and running light amperes; temperature rises and results of dielectric tests. All values shall be from tests of previously manufactured electrically duplicate motors. Data sheets shall be marked to indicate motor application, manufacturer, type, frame size, bearing type, lubrication medium, insulation type, and enclosure type.

1.3 SUBMITTALS

A. Shop drawings: Submit for approval the following:
   1. Descriptive literature including a cross-sectional view of the pump indicating the materials of construction and dimension prints of pump and motor.
   2. Performance curves for the complete pump assembly showing the relationship between head and capacity, efficiency, horsepower, and NPSH from shut-off head to the minimum operating head specified.
   3. Impeller type.
   4. Maximum size sphere passed.
   5. Weight of pumps and motors (including all components).
   6. Motor manufacturer, type, rated horsepower, temperature rating, and expected minimum life under design conditions, minimum efficiency at 3/4 and full load, and descriptive literature including description of motor insulation, for each type of motor to be furnished.
   7. Description of test facilities available.
   8. Deviations from Drawings and Specifications.
   9. Shop Drawings Showing: Fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall comply with JIC Standards.

B. Operation and Maintenance manuals: Submit six complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 1I3.

C. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Pumps shall be vertical, non-clog centrifugal type. They shall be specially designed, constructed, and installed for the service intended and shall comply with the following minimum conditions:

Design Conditions	Pumps
Location	Influent Pump Station Dry Pit
Use	Raw Sewage
No. Required	2
Design Flow: gpm	350
Design TH: ft	50
Min. Shut-Off Head, ft	58
Efficiency at Design: %	55
Motor hp	10
Pump Speed: rpm	1760
Max. Sphere Dia.: in.	3
Suction Size: in.	4
NPSH Required at Design: ft.	10
Flow at 2nd Design Point: gpm	520
TH at 2nd Design Point: ft.	46

2.2 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:
1. Casing: Cast iron with handhole and cover.
2. Impeller Type: Non-clog, dynamically balanced.
3. Impeller Material: Cast iron.
4. Impeller Wear Ring: Chrome steel, hardened.
5. Suction Head Wear Ring: Chrome steel, hardened.
6. Shaft Sleeve: Chrome steel, hardened.
7. Shaft: Carbon steel.
8. Seals: Packing with split-glands and seal water.
9. Bearings: Anti-friction, grease or oil lubricated with a minimum B-10 life of 20,000 hours.
10. Baseplate: Structural steel or cast iron provided with means for collecting and draining oil and water.
11. Furnish with 125 pound ANSI connection flanges and handhole.
12. Coupling: Shall have a minimum 1.5 service factor based on the drive rated horsepower and protected with an OSHA approved guard.
13. Anchor bolts and inserts shall be furnished under this Section and shall be sized and installed in accordance with the manufacturer's recommendations.
14. All bolts, nuts and cap screws shall have hexagon heads.
15. Brass or stainless steel nameplates giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.
16. A seal water connection shall be made to each pump stuffing box. The pump manufacturer shall provide and install the following as shown on the Drawings:
    a. Pressure switch.
    b. Rotameter.
    c. Solenoid valves.

B. Motors:
1. High efficiency, TEFC, 480 volt, 3 phase, 60 Hz, solid shaft, ball bearing type.

2. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, NEC, and ANSI.
3. Motors shall be normal starting torque, normal slip, squirrel cage induction type.
4. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 50° C.
5. Motors shall be provided with a service factor of 1.15.
6. The motor shall be NEMA B design. Motor frame size and insulation shall conform to the following requirements:
   a. All motors for applications where the specified type, speed and horsepower rating is such as to fall within the scope of NEMA Standard No. MG-13 shall employ the frame size assigned for the rating by that standard but shall be wound with Class F insulation to provide a temperature rise equal to or less than the rise permitted by NEMA Standard No. MG-1 for a motor of similar design and rating with Class B insulation.
   b. All motors for applications where the specified type, speed, rating or special characteristics do not fall within the scope of NEMA Standard No. MG-13 shall be wound with Class F insulation on frame sizes selected to provide a Class B temperature rise by resistance, at 50 C ambient at the service factor load.
7. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of pump operation from zero head to shut-off.
8. Locked rotor currents shall be as specified in NEMA standards.
9. Lubrication may be grease or oil type.
10. Motor Tests and Data:
    a. For each motor furnish a certified motor data sheet for the actual motor or for a previously manufactured electrically duplicate motor which was tested. Provide the following minimum data:
       1) Starting torque.
       2) Efficiency at 1/2, 3/4 and full load.
       3) Power factor at 1/2, 3/4 and full load.
       4) Percent slip.
       5) Running light, full load and locked rotor current.
       6) Current balance check.
       7) Vibration check.
       8) Temperature rises and results of dielectric tests.
       9) Motor type and frame size.
       10) Bearing type and lubrication medium.
       11) Insulation and enclosure type.

C. Product and Manufacturer: Provide pumps as manufactured by one of the following:
   1. Aurora Pump Company.
   2. Worthington Corporation.
   3. Or equal.

2.3 ACCESSORIES

A. Provide the following accessories for each pump:
   1. Gages:
      a. Provide suction and discharge gages for each pump.
      b. Gage shall be 4-1/2-inch diameter aluminum alloy case with diaphragm seal (with flush connection) and gage cocks.

c. Range shall be:
   1) Suction: 30 inches Hg - 15 psi.
   2) Discharge: 0-60 psi.

2.4 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. Each pump shall be furnished with the following:
   1. One packing for each gland.
   2. One set of gaskets.
   3. One set of wear rings.
   4. One shaft sleeve.
   5. Special tools required for maintenance or operation.

B. In addition to the spare parts to be furnished by the CONTRACTOR, the CONTRACTOR shall furnish a list of additional recommended spare parts for an operating period of one year. This list shall describe each part, the quantity recommended, and the unit price of the part. The OWNER will purchase all, some, or none of the recommended spare parts at his option.

2.5 PAINTING

A. Surface Preparation and Shop Painting:
   1. Surface preparation and shop painting is required for all ferrous metals, equipment and accessories. Stainless steel shall not be painted.
   2. All ferrous metal surfaces shall be cleaned and provided with two coats of priming paint. All paint materials shall be products of the Koppers Company Inc., or the Tnemec Company Inc. All ferrous surfaces of the equipment shall be cleaned with a Commercial Sandblast (SSPC-SP6) and shall receive two coats of Koppers Epoxy Primer 654, with a minimum dry thickness of 1.5 to 2.0 mils per coat, or two coats of Tnemec 66-1211 Epoxy Primer, with a minimum dry thickness of 1.5 to 2.5 mils per coat. Ferrous metal surfaces may be given two coats of the manufacturer's standard paint system in lieu of the priming paint, provided that the total mil thickness of paint is equal to that specified above.
      Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6) except that motors and like items that may be damaged by sandblasting may be prepared by other means.
   3. Gears, bearing surfaces, and other unpainted surfaces shall receive a heavy application of a rust-resistant coating which shall be maintained during storage and until the equipment is placed into operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in complete accordance with manufacturer's instructions.

B. All pumping units shall be installed on concrete bases and secured with anchor bolts in accordance with the manufacturer's recommendations and

as shown. The concrete bases shall be poured up to 1 inch below the metal bases or soleplates. Concrete work and grout are in Division 3. The base with the equipment mounted thereon, or the soleplate, shall then be accurately shimmed to grade and the spaces between filled with an approved nonshrink grout. After the grout has reached its initial set, exposed edges shall be cut back 1/2 inch and the edges neatly finished with 1 to 2 cement mortar. Where channel baseplates are used, the void inside the channel shall be filled with nonshrink mortar and the open ends plastered with 1 to 2 cement mortar.

C. Neatly placed 1-inch hard copper pipe shall be provided for each pump to convey leakage to nearest drainage inlet.

D. Installation shall include furnishing and applying an initial supply of grease and oil, recommended by the manufacturer.

E. Support piping independent of pump.

F. Check and align all pump, motor and flexible shafting.

G. The CONTRACTOR shall connect each pump stuffing box to the seal water system, and shall furnish and install all required piping, valves and rotameters, as shown on the Drawings.

3.2 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall furnish the services of a qualified factory-trained serviceman from pump manufacturer who shall assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct the plant operators in the care, operation and maintenance of the equipment.

B. Serviceman will be required to make not less than two visits to the site. The first visit shall be for a period of not less than one 8-hour day to assist in the installation of the equipment. The second visit shall be for a period of not less than two 8-hour days to check the completed installation, to start-up the units, and to instruct the plant operators in the proper operation and maintenance of the equipment.

C. All costs, including travel, lodging, meals and incidentals shall be considered to have been included in the CONTRACTOR's lump sum bid price.

3.3 START-UP AND TEST

A. The CONTRACTOR shall be responsible for over-all coordination of the pumps and motors installation and start-up.

B. Start-up shall include but not be limited to: demonstrating pumps and motors operability, calibration of all necessary instruments, obtaining any and all manufacturers' assistance during and after installation, demonstrating safety features and obtaining manufacturers' certifications that components are installed properly.

+ + END OF SECTION + +

SECTION 11A19

HYDRO-PNEUMATIC NON-POTABLE WATER SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to furnish, install, test and place into satisfactory operation, a complete, skid mounted, hydro-pneumatic water system as shown on the Contract Drawings and specified herein. Hydro-pneumatic system shall consist of two (2) supply pumps, two (2) air compressors, one (1) hydro-pneumatic pressure tank, control panel, controls, control wiring, conduits and interconnections, valves, piping, pressure gages, and all required appurtenances required for a complete installation. System shall be suitable for operation with non-potable water (wastewater treatment plant effluent).

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I4, Operation and Maintenance Data.
5. Section 3D, Cast-in-Place Concrete.
6. Section 3I, Grout.
7. Section 5G, Anchor Bolts, Expansion Anchors and Concrete Inserts.
8. Section 9L, Painting.
9. Division 15, Mechanical, if not specified otherwise.
10. Division 16, Electrical, if not specified otherwise.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM A 36, Structural Steel.
2. AWS D1.1, Structural Welding Code.
3. AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.
4. AGMA Standards.
5. ASTM A 48, Gray Iron Castings.
6. SSPC, Steel Structures Painting Council.
7. ASME Unfired Pressure Vessel Code.
8. NEC, National Electric Code.
9. Standards of Hydraulic Institute
10. Standards of American Water Works Association

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, specifications and engineering data which indicate: performance, dimensions, materials, size and weight.

2. Fabrication, assembly and installation drawings, and wiring diagrams. Wiring diagrams shall comply with JIC Standards.
3. Provide setting drawings, templates, and directions for the installation of anchor bolts and other anchorage devices.

B. Operation and Maintenance Manuals: Submit complete manuals including:
1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

C. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

1.4 PRODUCT INSPECTION, DELIVERY AND STORAGE

A. Deliver materials to the site to ensure uninterrupted progress of the work.
1. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to not delay that work.

B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Store all mechanical equipment in covered storage off the ground to prevent condensation.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Description:
1. The hydro-pneumatic water system shall have service conditions and characteristics as follows:

System Operating Pressure		
Min (psig):	80	
Max (psig):	100	
System Operating Flows		
Min (gpm):	20	
Max (gpm):	110	
Hydro-pneumatic Tank		
Size (gal):	2,100	
Design press (psi)	300	
Operating Points (gallons)		
Low level alarm	200	
Pump ON	300	
Pump OFF	500	
Minimum (Supply Pump)		
Capacity:	100	gpm @ 230 ft
Shut Off Head (ft.)	540	
HP: (MAX):	15	
Speed (RPM):	1750	

Air Compressors
Min. Capacity (SCFM): 5.5 (min)
Discharge Press (psig): 100
HP: 1

2.2 MATERIALS AND DETAILS OF CONSTRUCTION

A. Supply Pump:
1. The hydro-pneumatic system shall be furnished with two water pumps with capacity and characteristics as specified herein.
2. The supply pumps shall be of the horizontal, direct coupled, turbine type. Pumps shall be bronze fitted, with vertically split cast iron casing; bronze, double suction turbine type impeller and stainless steel shaft, and shall be fitted with mechanically sealed stuffing boxes. Bearings shall be of the grease lubricated ball type.
3. Each electric motor shall be suitable for continuous 24 hour operation and shall be of sufficient horsepower to operate the pump over its full range without overloading. Motors shall be of the horizontal, totally enclosed, fan cooled, squirrel cage induction type with a 1.15 service factor suitable for 460 volt, 3-phase, 60 Hz alternating current. Each motor shall be NEMA B design for normal starting torque equipped with, winding over temperature protector, non-hygroscopic grease lubricated ball bearings (extended duty type) and non-hygroscopic insulation suitable for 50°C ambient rise. Each motor shall be equipped with at least one normally closed automatic resetting winding over temperature switch.
4. Accessories for each pump:
   a. Valved bypass piping
   b. Pressure relief valve
   c. Discharge flow monitor to deactivate the pump under a no flow condition. Monitor shall include a 0-60 second field adjustable time delay.
   d. 4-1/2 inch pressure gage on discharge.
   e. Isolating gate valve.
   f. Non-slam type check valve.
   g. Vibration isolation hose connections on suction and discharge pipe.
   h. Strainer on suction pipe.
   i. Pressure switch.
5. Product and Manufacturer:
   a. Provide supply pumps and accessories as manufactured or supplied by one of the following:
      1. "APCO" Type W turbine pump as manufactured by Aurora Pump Company.
      2. Chicago Pump.
      3. FMC Corporation.
      4. Or equal.

B. Air Compressors:
1. The hydro-pneumatic system shall be furnished with two air compressors with the capacity and characteristics as specified herein.
2. Air compressors shall be of the single acting, two stage, air cooled, reciprocating type. The compressor shall have a V-belt drive with a service factor of not less than 1.5.
3. Each electric motor shall be suitable for continuous 24 hour a day operation and shall be of sufficient power to operate the compressor

without overloading. The motors shall be TEFC squirrel cage induction type with a 1.2 service factor suitable for 460 volt, 3-phase, 60 Hertz, alternating current. Each motor shall be NEMA B design for normal starting torque equipped with winding over temperature protector, non-hygroscopic grease lubricated ball bearing (extended duty type) and non-hygroscopic insulation suitable for 50°C ambient rise. Each motor shall be equipped with at least one normally closed automatic resetting winding overtemperature switch.

4. The compressor assembly shall be mounted on a structural steel base on the skid mounted unit. The compressors shall be equipped with filter-silencers, unloading relief valves, gate valves and piping as required for connection to the hydro-pneumatic tank.
5. Product and Manufacturer:
   a. Provide air compressors and accessories as manufactured or supplied by one of the following:
      1. Ingersoll-Rand.
      2. Gardner-Denver Company.
      3. Or equal.

C. Hydro-pneumatic Tank:
1. The hydro-pneumatic system shall be furnished and installed with a welded steel hydro-pneumatic tank. The size and design pressure shall be as specified herein. Tank shall be designed, constructed, tested and stamped in accordance with the ASME Unfired Pressure Vessel Code. ASME data sheets for pressure vessels shall be submitted to the ENGINEER for approval upon fabrication of the vessel.
2. Tank shall be furnished with a 20" manway and shall be mounted on concrete cradles based on dimensions as required by manufacturer.
3. Tank shall be furnished with inlet/outlet and drain connections, pressure relief valve; sight glass with scale board mounted behind glass; liquid level probes, pressure switches, anti-swirl baffle, and other appurtenances as required for a complete installation. Provide water gage with rods to protect against damage.

2.3 CONTROL SYSTEM

A. Control System
1. CONTRACTOR shall provide a combination pressure tank control system for operating the water pumps with automatic alternation and the compressors to accurately and automatically maintain the correct air/water ratio in tank at all times. Pump shall be stopped at the desired high water level by liquid level probe and stopped at low water level by another liquid level probe. Air pressure shall be automatically rebalanced by adding air with a compressor.
2. Control shall include an independent and adjustable pressure sensor for each pump start point and another for air control. Each pressure sensor shall be easily adjustable and consist of independent bellows which operate a dust proof glass hermetically sealed mercury switch. Bellows shall be restricted to allow movement at the measured pressure point only to prevent fatigue failure and errors due to hystersis effect. Pressure elements shall be adjustable over entire range of control and errors shall not exceed ±0.5 percent of the full range.
3. A two-circuit alternator shall be furnished for automatic alternation of the pumps suitable for operation with a 460 volt, 60 Hz,

three-phase alternating current. It shall provide completely automatic alternation of the starting sequence of the pumps. The alternator shall permit operation of both units singly as called for by the pilot devices. The alternator shall provide for operation of standby unit through the second pilot device in event of failure of the lead unit or first pilot device or alternator coil.

4. Each level probe shall be an induction sensing type device which detects a predetermined liquid level upon contact with the probe. One device shall be included for each operating point except where dual probes with one probe housing provides operating sequence specified. Each probe shall be complete with all required housing and fittings. Each probe shall be stainless steel encapsulated in a polyethylene shield. Probe housing shall be of bronze construction with NPT threads for connection to the tank. Each probe shall be complete with all required housing and fittings. Each probe shall be stainless steel encapsulated in a polyethylene shield. Probe housing shall be of bronze construction with NPT threads for connection to the tank.
5. Product and Manufacturer:
   a. Provide control system as manufactured by one of the following:
      1. Autocon Industries Inc.
      2. Consolidated Electric Co.
      3. Or Equal.

B. Electrical Controls:
1. A circuit breaker combination starter for each motor with overload protection single phase protection relays, power disconnect, including on/off switch, lock-out stop push button indicating light, dry contact for motor run indication as well as normally closed dry contact for overload malfunction for signal transmission to remote location. Minimum 100 volt ampere, control power transformer shall be provided. Necessary relays, timers, momentary switches is and selector switches shall be furnished.
2. Each starter shall be furnished with three melting alloy type contacts. Normally open auxiliary contacts for local and remote alarm purposes, manually reset locally by means of pushbutton.

C. Control Panel:
1. The control panel shall be mounted on the pumps/compressors assembly by the manufacturer. Provide all interconnecting wiring between panel and equipment. The control devices specified herein shall be designed to operate on 120 volt, single phase, 60 Hz alternating current.
2. Each water supply pump and compressor shall be furnished with the following controls mounted on the face of the control panel:
   a. Run indicating lights (Red)
   b. HOA switch
   c. Selector switch - 3 position (compressors)

3. The panel annunciator shall include the following alarms:
   a. Water pump failure (2).
   b. Compressor failure (2).
   c. Hydro-pneumatic tank high and low level alarm (2).

   A repeat alarm contact shall be provided for remote annunciation. Twenty percent spare points shall be provided.

2.4 SPARE PARTS AND MAINTENANCE MATERIALS

A. The CONTRACTOR shall furnish a list of manufacturers recommended spare parts with his proposal for an operating period of one year. This list shall describe each part, the quantity recommended, and the unit price of the part. The OWNER will purchase all, some, or none of the recommended spare parts at his option.

B. Furnish spare parts and maintenance materials in conformance with the requirements of Section 1J1.

2.5 PAINTING

A. All ferrous metal surfaces of the structural base, pumps, compressors and tank, except motors, shall be blast cleaned in accordance with SSPC-SP10, and shop primed and field painted in accordance with the requirements of Section 9L. Motor and other components of equipment which could be damaged by blast cleaning may be prepared by other approved methods.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hydro-pneumatic water system equipment shall be installed in a manner recommended by the manufacturer and approved by the ENGINEER.

B. Each piece of equipment shall be set in accordance with manufacturer's instructions and as shown on the Contract Drawings. In placing the foundation, allowance of at least 1 inch shall be made for grout. The equipment shall be mounted on the base, shimmed to proper elevation and grouted into position using non-shrink grout. Prior to final set of the grout, it shall be cut back at the edge and plastered with 1:2 cement mortar.

C. All anchor bolts and nuts and other fasteners furnished for connection of the equipment to the concrete structure or concrete base pads shall be of Type 304 stainless steel, and shall be of ample size and strength for the purpose intended.

3.2 MANUFACTURER'S SERVICES

A. A qualified, factory representative of the manufacturer shall be provided to check and approve the installation before it is placed in service, supervise initial operation and testing in the presence of the ENGINEER and instruct the OWNER'S personnel in the operation and maintenance of the equipment. A minimum of two 8-hour days shall be provided for these services. In the event of trouble with the equipment, the manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. CONTRACTOR shall provide instruction for operating personnel in conformance with the requirements of Section 1H5.

+ + END OF SECTION + +

SECTION 11A20

WATER SOFTENER EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals to provide an ion-exchange water softening unit complete and operational with all necessary interconnecting piping, electrical wiring, valves, appurtenances and controls for automatic operation.

B. Related Work Specified Elsewhere:
1. Section 09900, Painting.
2. Section 13620, Instrumentation and Control Equipment.
3. Series 150 - Sections on Piping and Valves.
4. Division 16, Electrical, unless specified in Section 11233.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
1. ASME Boiler and Pressure Vessel Code.

B. Manufacturer's Qualifications: Manufacturer shall have experience in producing similar equipment, and shall show evidence of similar installations in satisfactory condition and operation.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, specifications and engineering data including dimensions, materials, size and weight.
2. Shop Drawings showing fabrication, assembly, installation and wiring diagrams.
3. Operation and Maintenance Manuals including complete installation, operation and maintenance instructions including copies of all approved Shop Drawings.
4. Guarantee.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. Each ion-exchange softener unit shall be designed, constructed and installed for the following design conditions:

Service Water	Potable City
Use	Caustic Scrubber Solution Water
Estimated Influent Hardness	150 mg/l (15.2 grains/gallon)

Estimated Dissolved Solids	425 mg/l
Flow Rate	10 gpm
Minimum Daily Usage	15,000 gal
Minimum Hours in Service Between Regeneration	20
Influent Water Pressure	50 psig

B. The ion-exchange softener shall consist of two exchange tanks and a single brine tank. All three tanks shall be mounted on a common skid. Each exchanger tank shall be capable of meeting the requirements detailed under the service conditions and given in the design parameters.

C. Design Parameters:

Maximum Loading Rate	10 gpm/sf
Minimum Effective Volume of Resin	8 cu. ft.
Maximum Brine Tank Volume	100 cu. ft.
Maximum Pressure Drop	10 psig
Average Effluent Hardness	2 mg/l

2.2 EQUIPMENT

A. Ion Exchange Tanks:
1. The ion-exchange tanks shall be 1 feet-8 inches in diameter by 5-feet straight side exclusive of heads.
2. Each tank shall be of welded steel construction conforming to ASME Code for Pressure Vessels. The steel tanks shall be designed for a working pressure of 100 psig and hydrostatically tested at 150 psig pressure.
3. Each tank shall be provided with all necessary inlet and outlet connections.
4. A distribution system shall be provided that effectively distributes the influent water, regenerant and rinse over the complete media surface.
5. An underdrain system shall be provided that adequately collects the treated water and distributes the wash water.
6. An access opening shall be provided on the upper head of each tank.

B. Brine Tank:
1. The brine tank shall be 2 feet in diameter by 4 feet straight side with a flat bottom and open top. The brine tank shall be of reinforced fiberglass construction.
2. The brine tank shall be provided with a float operated make-up water valve, brine suction piping and an eductor to transport brine to the ion-exchange tanks for regeneration.

C. Media:
1. Exchange media shall be a high capacity polystyrene cation resin with a minimum exchange capacity of 26,000 grains per cubic foot.

D. Piping and Valves:
1. The ion-exchange softener unit shall be supplied with all piping and valves necessary for completely automatic operation. Exterior piping shall be screwed or flanged Schedule 40 black steel. The

distribution and collection system within each tank shall be PVC Schedule 80.

2. Provide valves and appurtenances including, but not limited to, the following:
   a. Hydraulically operated diaphragm valves for operation and regeneration control.
   b. Service inlet, rinse, backwash and outlet valves with rate set screws.
   c. Rotameter for adjusting rinse and backwash rates.
   d. Brine eductor.
   e. Brine control valve.
   f. Vent pipe and valve.
   g. Water meters for controlling each water softening cycle. Meters shall indicate flow and total volume.
   h. Pressure gages for service backwash inlet and outlet lines.
   i. Manual isolation valves at inlet and outlet of each softner tank.

E. Salt:
   1. Provide 250 cubic feet of bagged salt for regeneration.

F. Manufacturer: Provide water softener equipment as manufactured by:
   1. Crane/Cochrane Environmental Systems.
   2. Or equal.

2.3 OPERATION AND CONTROL

A. Operation:
   1. The operation of the ion-exchange softener shall be completely automatic. The unit shall be capable of operating in a manual mode also.
   2. The backwash/regeneration/rinse cycles shall be initiated based on the volume of water treated. A controller shall be provided to initiate the various regeneration steps, open and close all necessary valves and place the unit back into service. Only one tank shall be regenerated at a time.

B. Controls:
   1. The controller and other necessary control equipment shall be provided in a fully assembled and tested panel in accordance with Section 13620. Panel shall be provided with a 120 volt, 60 Hz circuit under Division 16, Electrical Work.

2.4 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide the following:
   1. One diaphragm valve.
   2. One solenoid valve of each type provided.
   3. Media for one tank.
   4. Special tools required for operation or maintenance.
   5. Hardness test kit.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the project.

2.5 PAINTING

A. All ferrous metal surfaces including, but not necessarily be limited to, interior and exterior of softner tanks, pipes and supports shall be painted in accordance with Section 09900.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in complete accordance with manufacturer's instructions.

+ + END OF SECTION + +

SECTION 11C4

ROTARY SCREENING EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment, and incidentals required to provide rotary screening equipment and appurtenances as shown and specified. Anchor bolts are included.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 3D, Cast-In-Place Concrete.
6. Section 3I, Grout.
7. Section 9L, Painting.
8. Section 13A, Instrumentation and Control.
9. Division 16, Electrical, unless specified in this Section.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM A 36, Structural Steel.
2. AWS D1.1, Structural Welding Code.
3. AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.
4. AGMA Standards.
5. ASTM A 48, Gray Iron Castings.
6. SSPC, Steel Structures Painting Council.

B. Obtain the rotary screen, cylinder drive, control panel, and other accessories from not more than one manufacturer.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, specifications, and engineering data which indicate: performance, dimensions, materials, size and weight.
2. Fabrication, assembly and installation drawings, and wiring diagrams.
3. Provide setting drawings, templates, and directions for the installation of anchor bolts and other anchorage devices.
4. Shop Drawings Showing: Fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall comply with JIC Standards.

B. Operation and Maintenance Manuals: Submit six complete manuals including:

1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

C. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Screen shall be shipped as a complete unit or as otherwise specified.

B. Deliver materials to the site to ensure uninterrupted progress of the work.
   1. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to not delay that work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from condensation and corrosion.

D. Store all mechanical equipment in covered storage off the ground and prevent condensation.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. The rotary screen shall meet the following service conditions:

Type of Influent	-	Raw wastewater containing grit
Max Operating Flow, gpm	-	2250 gpm
Min. Screen Length, in.	-	72
Min. Screen Width, in.	-	25
Max Size of Media Opening, in.	-	0.040
Motor Horsepower	-	3/4

B. The screen shall be suitable for continuous duty service.

C. The screen shall capture not less than 90 percent of all solids equal to or larger than the screen opening.

2.2 MATERIALS AND DETAILS OF CONSTRUCTION

A. General:
   1. The screen shall be of the rotating wire wound screen cylinder type and shall positively remove coarse solids from the influent flow.
   2. All parts shall be Type 316 stainless steel construction except motor, gears, and bearings.
   3. All of the influent flow shall enter the headbox and flow over an integral weir perpendicular to the slot openings of the screen.

4. The rotating action of the screen shall cause the captured solids to be retained on the cylinder surface until removed by the doctor blade. The rotation of the screen shall be in the same direction of the flow of the liquid from the headbox. All the flow from the headbox shall be fed so that all the flow passes through the cylinder and results in a self-cleaning backwash of the cylinder as it rotates.
5. Each screen unit shall be furnished as a complete self-contained unit with field assembly not being required.

B. Chassis:
1. The cylinder chassis, including integral headbox, shall be ruggedly constructed of minimum 14 gauge, 316 stainless steel with open-bottom discharge.
2. The chassis shall be equipped with an 12-inch flange suitable for connection to an 12-inch flanged ductile iron pipe.
3. The influent shall enter the headbox and flow over an integral weir or wiper blade that makes direct contact with the rotating cylinder.
4. The chassis shall be fitted with a 5" diameter cleanout port, having a removable UHMW 1900 polyethylene plastic cover secured with a hand-tightened band clamp.
5. The screen cylinder shall be constructed of Type 316 stainless steel and consists of a continually helical wound spiral peripheral wedge shaped wire with a face width of .060 inches and a height of 0.100 inches with a 26 degree included taper angle, and shall be resistance welded to each of the longitudinal supporting members placed on 1" centers within the inside diameter of the cylinder. The longitudinal support members shall be proportioned for the anticipated loads as recommended by the manufacturer.
6. The opening between the wedge shaped wire shall be 0.06 inches.
7. The cylindrical screen shall be supported on both ends by an end ring hub assembly bolted to rings which are welded to the interior ends of the cylinder. Each hub assembly has a welded axle which is supported by self-aligning, greaseable pillow block bearings. The bearings shall be outside of the fluid flow.
8. Radial end seals shall not make contact with cylindrical screen surfaces.

C. Solids Discharge Doctor Assembly:
1. The solids discharge doctor assembly shall be constructed of Type 316 stainless steel with the exception of a "K" series Monel doctor blade. The doctor blade shall be designed to effectively remove solids from the cylindrical screen surface and shall be easily removable, and shall have sufficient travel so as to clear the cylinder and flanges for changing or inspection. Pressure of the doctor blade against the cylindrical screen surface shall be adjustable through a locking compression assembly. The pressure shall be preset prior to shipment from factory.

D. Cylinder Drive System:
1. The cylinder drive system shall consist of a single speed, dual voltage motor direct coupled to a gear reducer. The electric motor shall be 3/4 HP (1800 RPM) with 230/460v, TEFC, NEMA design B, Class F insulation, 50°C ambient rise, 1.15 service factor, 3 phase, 60 Hz, power supply. Gear reducer shall be shaft mounted directly on the cylinder drive shaft and have an output speed of 11 RPM.

E. Hydraulic Testing:
   1. Equipment shall be hydraulically test run in the factory and thoroughly inspected by the manufacturer prior to shipment to insure leak-free operation, proper interface and adjustment of all parts. Manufacturer shall provide ENGINEER with certified statement of hydraulic performance, which shall include maximum headloss characteristics and hydraulic capacity. Certified tests shall be signed by a Registered Professional Engineer. ENGINEER and/or OWNER may, at their option and expense, witness the factory test.

F. Automatic Doctor Blade Cleaner:
   1. An automatic doctor blade cleaner (ADBC) assembly shall be furnished and mounted above the solids discharge doctor blade. The ADBC blade shall be of "K" series Monel, and the blade holder and pivot end bearing shall be of Type 316 stainless steel. Tension springs shall hold the ADBC against the discharge doctor blade. The ADBC shall wipe the discharge doctor blade once per screen cylinder revolution by means of screen cylinder mounted camrol bearings. The ADBC shall be hinged to allow for cleaning or replacement without interrupting the operation of the solids discharge doctor blade.

G. Discharge Chute:
   1. A Type 316 stainless steel screening discharge chute shall be provided and attached to the baseplate and headbox support as shown on the Drawings.

H. Anchorages and Fasteners:
   1. Provide all required anchor bolts and fasteners for the screen and accessories. All anchor bolts and fasteners for structural framework shall be Type 304 stainless steel.

I. Internal Spray System:
   1. An internal spray system shall be provided within the cylinder of the screen to assist in cleaning. A minimum of 23 spray nozzles shall be installed to deliver a total of 16 gpm of water at 40 psig. An external 2-inch NPT coupling with factory assembled normally closed solenoid valve, shall be manufacturer furnished for connection with the spray water source. The internal spray system shall be field seviceable.

2.3 PRODUCT AND MANUFACTURER

A. Provide rotary screening equipment and accessories as manufactured or supplied by one of the following:
   1. Hycor Corporation, Model RSA-2572.
   2. Or Equal.

2.4 CONTROL PANEL [MANUFACTURER'S FURNISHED PANEL (MFP)]

A. Provide a manufacturer's furnished panel (MFP) with control devices in accordance with Section 13A50 and Section 16H2.
1. Electrical Controls:
   a. A circuit breaker combination starter with overload protection, single phase protection relay, H-O-A switch, on, off, indicating light, dry contact for motor run indication as well as normally

open dry contact for overload malfunction for signal transmission to remote location. Minimum 100 volt ampere, (influent lift station) control power transformer shall be provided. Necessary relays, timers, H-O-A and selector switches and interconnections to MFP 101 and 102 shall be furnished in pump control panel. See partial control schematic.

b. Provide NEMA 4X stainless steel enclosure.

c. Each starter shall be furnished with three melting allow type contacts. Normally open auxiliary contact for local and remote alarm purposes, manually reset locally by means of pushbutton.

d. Interconnection to the automatic washwater bar.

2.5 SPARE PARTS AND MAINTENANCE MATERIALS

A. The CONTRACTOR shall furnish a list of recommended spare parts with his proposal for an operating period of one year. This list shall describe each part, the quantity recommended, and the unit price of the part. The OWNER will purchase all, some, or none of the recommended spare parts at his option.

B. Furnish spare parts and maintenance materials in conformance with the requirements of Section 1J1.

2.6 PAINTING

A. All ferrous metal surfaces of the screen, except the motor, shall be blast cleaned in accordance with SSPC-SP10, and shop primed and field painted in accordance with the requirements of Section 9L. Motor and other components of equipment which could be damaged by blast cleaning may be prepared by other approved methods.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation of all equipment shall be in complete accordance with manufacturer's instructions and recommendations, and the approved Shop Drawings.

B. The screen shall be installed and grouted in place with non-shrink grout.

C. Installation shall include furnishing and applying an initial supply of lubricants recommended by the manufacturer.

D. CONTRACTOR shall verify that structures and equipment are compatible.

E. Make all adjustments required to place all systems in proper operating condition.

3.2 MANUFACTURER'S SERVICES

A. A qualified, factory representative of the manufacturer shall be provided to check and approve the installation before it is placed in service, supervise initial operation and testing in the presence of the ENGINEER

and instruct the OWNER'S personnel in the operation and maintenance of the equipment. A minimum of two, 8-hour days shall be provided for these services. In the event of trouble with the equipment, the manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

+ + END OF SECTION + +

SECTION 11C6

SEWAGE GRINDERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install two sewage grinder systems, including prefabricated channels with emergency overflows, all controls, and ancillary equipment complete and operational.
2. The grinder shall handle sewage and all solid material normally found in sewage collection systems.

B. Related Work Specified Elsewhere:
1. Section 3D, Concrete.
2. Section 5E3, Miscellaneous Metal Fabrications.
3. Division 16, Electrical, unless specified in this Section.

C. Coordination: The CONTRACTOR shall be responsible for coordinating the work among the manufacturers whose equipment interfaces with the sewage grinders specified herein. This coordination shall include design, fabrication and installation of all interfacing equipment.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The manufacturer shall have experience in providing similar type equipment, and shall show evidence of similar installations in satisfactory operation.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM A36, Structural Steel.
2. AWS D1.1, Structural Welding Code.
3. AISC Manual of Steel Construction.
4. AGMA, American Gear Manufacturers Association.
5. ASME, American Society of Mechanical Engineers.
6. NEC, National Electrical Code.
7. NEMA, National Electrical Manufacturers Association.
8. OSHA, Occupational Safety Health Act.
9. IEEE, Institute of Electrical and Electronic Engineers.
10. ANSI, B20.1-1976, American National Standards Institute.

C. Codes: The Work shall comply with local, state, and federal codes, standards and regulations having jurisdiction in the area where the equipment will be installed. Where conflict exists between the above standards, and the codes, it shall be brought to the attention of the ENGINEER. The manufacturer shall make all necessary tests and inspections to ensure that the equipment meets all codes and regulations.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Dimensions.
   2. Materials of construction.
   3. Fabrication, assembly, and installation Drawings.
   4. Performance data.
   5. Manufacturer's literature, illustrations, specifications and engineering data.
   6. Anchor and support points loading diagram.
   7. Deviations from Drawings and Specifications.
   8. Shop Drawings Showing: Fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall comply with JIC Standards. All electronic and electrical equipment shall be furnished with complete and accurate manufacturer's schematic, wiring and electronic diagrams.

B. Operations and Maintenance Manual: Submit six complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

C. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. Description: The following sewage grinder units are required:

Material Grinded	-	Raw Sewage
No. of Grinders	-	2, Channel Configuration
Prefabricated Channel Configuration	-	Flat Wall Mounted type for, Two Grinders with Overflow Screen
Nominal Cutter Chamber Ht, inches	-	60
Flow Capacity, gpm	-	1,880
Max. Hydraulic Drop, inches	-	9
Approx. Net Weight, lbs.	-	785

B. The sewage grinder system shall be suitable for continuous operation, 24 hours per day.

C. The sewage grinder system shall be suitable for installation and operation in a Class I, Division I, Group D hazardous location.

2.2 FABRICATION - GRINDER EQUIPMENT

A. Grinder Construction:

1. The sewage grinders shall be of the two shaft design, with a minimum output torque of 2100 in/lbs. The speed of the driven shaft shall be 61% of the speed of the drive shaft. Shafts shall be fabricated from 2 inch hexagonal, 4140 steel, hardened to 42-45 Rockwell "C". The two shafts shall counter rotate and be equipped with spacers and intermeshing cutters. Cutters shall be cast from 4130 steel, surface ground for uniformity and through hardened to 43-48 Rockwell "C".
2. Cutters shall be of the 5 tooth with two leading cutting edges on each tooth so as to cut in each direction without removing the cutters from the grinder.
3. The grinder shall be so designed that when one cutting edge on the tooth of the cutter becomes worn, the entire grinder can be rotated 180 degrees in line, or in channel; and by changing two power leads to the motor, the opposite cutting edge on the cutter tooth can be utilized. Cutters shall be placed on the shafts in a 1:1 ratio to the spacers and shall be in a helical formation. The inside diameter of the cutters and spacers shall be hexagon shaped.
4. The sewage grinder shall be constructed of corrosion resistant material and must be compatible so as to resist corrosion due to cavitation or galvanic action. Housing of the sewage grinder shall be cast of class 30 Grey Iron. Side rails shall be of the open end design and bolt laterally to the end housings.
5. The sewage grinder shall be capable of operating continuously, processing wet or dry.
6. Seals shall be comprised of a replaceable wear sleeve cartridge mounted to the housing bore which carries internally the fixed race of an anti-friction bearing and a tungsten carbide static seal race. The wear sleeve cartridge defines with labyrinth preseal bushing hexagonally fixed to the shaft, the basic elements of a labyrinth preseal and additionally, resiliently couples through a seal wedge, a tungsten carbide rotating seal race whose end face of the annular static seal race. Seals shall require no external water source.
7. Bearings shall be the sealed oversized conrad type ball bearing.
8. The speed reducer shall be of the planetary type, grease filled, have a service factor of 1.9 and have a load classification of "heavy shock".
9. The high speed shaft of the grinder and the shafts of the reducer and the motor shall be in a direct line with each other and have 2 and 3 piece couplings.
10. Standard sewage grinder motor shall be of the energy efficient type, 5 H.P., 1725 RPM, 60HZ., 3 Phase, 460V, NEMA 145 TC, Explosion Proof (EXP), 1.15 service factor, 50° C ambient rise. Cast iron NEMA "C" end plates and locked shaft end bearings for longer life and positive end play control. Heavy duty, non-sparking external aluminum fan featured - no passageways to clog up and cause burnouts. Heavy duty steel stator band protected with corrosion resisting baked resin coating. No exposed windings. Gasketed cast conduit and condenser boxes. Condensate drains shall be included.
11. The prefabricated channel shall be able to accommodate a slide gate downstream of the grinder before the grinder is removed for maintenance. The slide gate shall be able to stop all flow.

B. Motor Controller Construction:
   1. The motor controller shall utilize a solid state logic design. Line transient protected to 1,000 volts. A transformer will supply all low and intermediate control voltages. All transformer legs shall be fuse protected. It shall have reversing contactors, operating voltage of 460V, 50-60HZ., motor overload protection, single phase protection, voltage unbalance protection and designed for operation with or without a grounded system. Forward and reverse contactors shall be both electrically and mechanically locked. Operational environment: Temperature range - 40 degrees C to + 50 degrees C.
   2. Enclosure: 4X Fiberglass.
   3. The controller shall provide the following functions:
      a. Operate in a normal "On" "Off" condition.
      b. Sense an overload (jam) condition, momentarily reverse the shaft direction to clear the condition and return to a forward direction. If the overload has cleared, return to normal operation.
      c. If a second overload (jam) occurs, the same schedule shall apply as for one overload condition.
      d. Dry contacts in the motor controller for overload (jam) signal to the telemetry panel shall be provided.
   4. If a third overload (jam) occurs within 30 seconds, sewage grinder will reverse the shaft directions, shut down, and a light and alarm circuit will be energized.
   5. Provide automatic restart after power failure.
   6. Product and Manufacturer: Provide one of the following:
      a. Model 30000-60 Muffin Monster, Disposable Waste Systems, Inc.
      b. Or equal.

2.3 SPARE PARTS

A. The following spare parts shall be provided for the sewage grinders:
   1. Cutters.
   2. Spacers.
   3. Seals and Gaskets.
   4. Bearings.
   5. 5 HP Explosion Proof Motor.

   The spare parts shall be delivered carefully boxed or packaged and plainly marked for reordering.

B. In addition to the spare parts to be furnished, the manufacturer shall furnish a list of additional recommended spare parts with his proposal, for an operating period of one year. This list shall describe each part, the quantity recommended, and the unit price of the part. The OWNER will purchase all, some, or none of the recommended spare parts at his option.

2.4 SURFACE PREPARATION AND SHOP PAINTING

A. Surface preparation and shop painting is required for all ferrous metals, equipment and accessories, except that stainless steel shall not be painted.

B. All ferrous metal surfaces, except moving parts, shall be cleaned and provided with minimum 30 mils of Koppers 300 M Coal Tar Epoxy. All epoxy shall be compatible with the prime coat materials to be furnished.

Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6) except that motors and like items that may be damaged by sandblasting may be prepared by other approved means.

C. Gears, bearing surfaces, and other unpainted surfaces shall receive a heavy application of a rust-resistant coating which shall be maintained during storage and until the equipment is placed into operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in complete accordance with manufacturer's instructions and recommendations.

B. Grinding units shall be installed in premanufactured channels and secured with anchor bolts in accordance with the manufacturer's recommendations and as shown. A rubber gasket shall be placed between the wall and the channel.

C. Installation shall include furnishing and applying an initial supply of grease and oil.

D. Check and align all grinder, motor and shafting.

3.2 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall furnish the services of a qualified factory-trained serviceman from grinder manufacturer who shall assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct the operators in the care, operation and maintenance of the equipment.

B. Servicemen will be required to make not less than two visits to the site. The first visit shall be for a period of not less than one 8-hour day to assist in the installation of the equipment. The second visit shall be for a period of not less than one 8-hour day to check the completed installation, to start-up the units, and to instruct the operators in the proper operation and maintenance of the equipment.

C. All costs, including travel, lodging, meals and incidentals shall be considered to have been included in the CONTRACTOR'S bid price.

3.3 START-UP AND TEST

A. The CONTRACTOR shall be responsible for over-all coordination of the grinder system installation and start-up.

B. Start-up shall include but not be limited to: demonstrating grinder and motor operability, calibration of all necessary instruments, obtaining any and all manufacturers' assistance during and after installation, demonstrating safety features and obtaining manufacturers' certifications that components are installed properly.

+ + END OF SECTION + +

SECTION 11E6

FLOCCULATOR-CLARIFIER MECHANISM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install the following:
   a. One circular, suction-type center feed flocculator-clarifier mechanism.
2. Mechanism includes, but is not limited to, the following features:
   a. Center drive mechanism complete with reducer, motor and overload device.
   b. Stationary influent column.
   c. Access bridge, including handrailing and toe plate.
   d. All associated attachment bolts and anchor bolts for above.
   e. Sludge collection arms with draw-off pipes.
   f. Flocculation well.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 3D, Cast-In-Place Concrete.
6. Section 3I, Grout.
7. Section 5E3, Miscellaneous Metal Fabrications.
8. Section 5E5, Aluminum Grating and Checkered Plate.
9. Section 5E10, Aluminum Handrails and Railings.
10. Section 5G, Anchor Bolts, Expansion Anchors and Concrete Inserts.
11. Section 9L, Painting.
12. Section 13A, Instrumentation.
13. Division 16, Electrical.

C. Coordination:
1. Review installation procedures under other Sections and coordinate them with the work specified herein.

1.2 QUALITY ASSURANCE

A. Manufacturers Qualifications: Manufacturer shall have experience in fabricating similar type equipment and shall show evidence of at least five installations where sludge collectors of the type specified herein have been in satisfactory operation for at least five years.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM A 36, Structural Steel.
2. ASTM A 48, Iron Castings.
3. ASTM A 536, Specifications for Ductile Iron Castings.
4. ASTM B 241, Aluminum Alloy Seamless Pipe and Seamless Extruded Tube.

5. ASTM B 429, Aluminum Alloy Extruded Structural Pipe and Tube.
6. AISC, Code of Standard Practice for Steel Bridges and Buildings.
7. AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.
8. AISC, Manual of Steel Construction.
9. AGMA Standards 218 and 440.
10. AWS D1.1, Structural Welding Code.
11. AFBMA, Anti-Friction Bearing Manufacturers' Association.
12. ANSI A12.1 Safety Requirements for Floor and Wall Openings, Railings and Toeboards.
13. NAAM, National Association of Architectural Metal Manufacturers.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval Shop Drawings showing the following:
1. Dimensions.
2. Materials of construction.
3. Assembly, installation, wiring and control diagrams and drawings.
4. Manufacturer's literature, illustrations, specifications and engineering data including total weight of unit, structural loads at supports, details of the center drive mechanism, connection details and performance data.
5. Provide setting drawings, templates and directions for the installation of anchor bolts and other anchorages.
6. Documentation of the AGMA rating of the drive assembly.
7. Complete description, control diagrams, and schematics of the torque overload device and control relay.
8. Description of surface preparation and shop prime paint.
9. Shop Drawings Showing: Fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall comply with JIC Standards.

B. Design calculations and data for the center drive mechanism including:
1. Calculations covering the B-10 life expectancy of the anti-friction bearing system for the turntable assembly.
2. Gear motor information to verify compliance of the drive assembly with the requirements of these Specifications.
3. Structural calculations which indicate that the equipment will meet all the torque requirements specified herein.
4. Calculations to verify compliance with the standards specified for the turntable assembly gearing.

C. Operation and Maintenance Manuals: Submit six copies of complete manuals including:

1. Copies of all Shop Drawings, test reports, maintenance data and schedule, description of operation, and spare parts information.
2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

D. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

1.4 PRODUCT INSPECTION, DELIVERY AND STORAGE

A. Prior to shipping, the equipment shall be completely inspected to assure that all equipment is complete and in compliance with all requirements.

It shall then be boxed or crated as required by the manufacturer to prevent damage during shipment. All machined surfaces or matching connections shall be suitably protected to prevent damage.

B. All boxes, crates, or packages shall clearly identify their contents by name or tag number using a packing slip affixed to the outside of the container.

C. All boxes, crates and packages shall be inspected by the CONTRACTOR upon delivery to the site. CONTRACTOR shall notify the ENGINEER if damage exists to any equipment or components. CONTRACTOR shall make all necessary arrangements to replace loss or repair such damage, to new condition, with manufacturer's instructions.

D. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

E. All fabricated assemblies shall be shipped in the largest sections permitted by carriers. All assemblies shall conform with the manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall furnish and erect in-place one circular, suction type, center feed flocculator-clarifier mechanism as shown on the Drawings. Collector shall remove sludge from a circular area of 36 feet in diameter. The concrete tank at the location of each sludge collector shall have a conical bottom with a slope of 1-inch per foot.

B. Mechanism shall be of the center column suction type. Unit shall have a center driving mechanism which shall support and rotate a center cage with sludge collection arms attached thereto. Draw-off pipes attached to the sludge collection arms shall be arranged to remove sludge.

C. Sludge collector shall include an overload protection and alarm device, and an access walkway to the center driving mechanism.

D. The sludge collector mechanism shall be so designed that there will be no chains, sprockets or operating mechanism below the liquid surface or in contact with the liquid. All submerged structural steel shall have a minimum thickness of 1/4 inch.

E. The allowable stress values used in the design of structural steel components of the mechanism shall be in accordance with the American Institute of Steel Construction "Specifications for the Design, Fabrication and Erection of Structural Steel Buildings". Structural steel shall conform to the requirements of ASTM A 36. All shop welding shall conform to the latest standards of the American Welding Society.

2.2 TORQUE DEFINITIONS

A. The following torque definitions shall apply:

1. Operating Torque Rating: Normal operating torque of the entire mechanism. The entire mechanism shall be designed for operation at this torque rating without excessive resultant wear.
2. Alarm Torque Rating: The torque rating at which the overload alarm is activated.
3. Cutout Torque Rating: Torque rating at which the overload protection device is activated to de-energize the drive motor.
4. Continuous Torque Rating: The maximum torque at which the drive can be subjected to without pitting of the gear teeth. This rating is based on 24 hours per day, 365 days per year, 20 years continuous operation using the AGMA Standards 218 and 440 specified for the strength and durability of gearing employed in the turntable assembly. The continuous torque rating shall be equal to or greater than the operating torque.
5. Momentary Torque Rating: Torque rating which can be momentarily developed due to starting, stalling, impact or any other sudden buildup of torque. The entire mechanism, including the drive, center cage and all structural elements shall be designed to withstand this torque without damage to or permanent deformation or failure of any component.

2.3 SERVICE CONDITIONS

	Clarifiers
A. Basin Dimensions and Hydraulics:	
1. Diameter	36'-0"
2. Average Side Water Depth:	12'-0"
3. Freeboard:	1'-6"
4. Max Flow To Basin:	500,000 gpd
5. Surface Overflow Rate at Design Flow:	491 gpd/sq. ft.
B. Center Drive Mechanism Design Requirements:	
1. Approximate Rotating Speed:	
2. Torque Ratings (foot pounds):	
a. Operating Torque Rating (minimum):	14,700 ft. lbs.
b. Alarm Torque Rating:	12,500 ft. lbs.
c. Cutout Torque Rating (minimum):	15,000 ft. lbs.
d. Continuous torque rating (minimum):	14,700 ft. lbs.
e. Momentary Torque Rating (minimum):	61,000 ft. lbs.

2.4 DETAILS OF CONSTRUCTION

A. General:
1. Mechanism shall include an access walkway with handrails, stationary influent column and sludge discharge pipe, center drive mechanism with center drive cage, flocculation well, sludge collection arms with draw-off pipes, sludge sight well, sludge regulation devices, effluent trough, effluent weirs, surface skimmer, baffles, and scum boxes, overload device, and all anchorage items.
2. The mechanism shall be so designed that no gears, bearings or similar operating components shall be below the liquid surface or in

contact with liquid. All steel below liquid level shall be not less than 1/4-inch thick except the flocculation well, which shall not be less than 3/16-inch thick with stiffening angle supports as required. All structural steel used in the fabrication of the mechanism shall conform to the requirements of ASTM A 36. Truss arms shall be capable of sustaining maximum operating torque without damage or permanent deformation. All shop welding shall conform to the latest standards of the American Welding Society.

3. Fabricated assemblies shall be shipped in as large sections as truck or rail shipment permits, properly marked for field assembly.

B. Access Walkway:

1. An access walkway constructed of beams complete with cross bracing, grating deck, and handrails shall be furnished from the tank wall to a point beyond and around the drive mechanism. The support trusses shall be designed to support, in addition to the structure dead loads (including flocculation well and flocculators), a minimum walkway live load of 175 pounds per linear foot with a deflection not to exceed 1/360 of the span. The main members shall be braced to assure rigidity. Structural parts shall be welded where possible. The walkway shall be 3 foot-6 inches minimum width. Adequate clearance is required for control panel. The walkway shall be constructed of aluminum grating and steel structural members, and shall be adequate for complete accessibility to the drive mechanism, flocculators, and to the sludge regulation devices in the sludge sight well. Platform shall be a minimum of 5 feet by 12 feet.
2. Gratings shall be designed to support a uniform load of not less than 150 pounds per square foot with a maximum deflection of 1/160 of the span or 1/4 inch, whichever is smaller, and a maximum fiber stress of 12,000 psi.

   Gratings shall be of aluminum material, and of I-bar design. Bars shall have a nonslip exposed surface. Spaces between main bars shall not exceed 1-1/4 inch. Frames shall be banded with straight bar size material.

   Gratings shall be set with a full and uniform end bearing on the supports to preclude rocking movement.

   Wedges or similar shimming devices shall not be used. Aluminum clamps or clips shall be installed to anchor the grating to the supports.

   No field welding of members will be permitted.

   All aluminum gratings, and any aluminum support members, shall have a mill finish.
3. The railing system shall conform to OSHA, Part 1910.23, including the 200 pound loading requirement. In addition, the system shall conform to the following requirements of ANSI A12.1:
   a. Completed railing shall withstand a load of 25 pounds per linear foot applied in any direction at the top of the railing.
   b. The intermediate rails shall withstand a horizontal load of 20 pounds per linear foot and control panel weight.
   c. The above loads are not additive.

   All material supplied for posts and railings shall be 1-1/2 inch diameter extruded aluminum pipe or tubing conforming to ASTM B 429 or B 241, Alloy 6063-T6, Schedule 40.

   All materials supplied for toeboards shall be of aluminum structural shapes.

   All aluminum railings, posts, flanges, and structural shapes shall have a mill finish.

The railing system may be of either welded or non-welded construction.

All railings shall be fabricated to shape in the shop. Fabricated lengths shall be as long as possible commensurate with shipment requirements. A top and two middle rails shall be provided.

For a welded railing system, all joints except field joints shall be welded. All field joints shall be approved slip type with counter-sunk stainless steel fasteners. Field welding of pipe and railing will not be permitted. All joints shall be smoothed by grinding to present a workmanlike appearance when completed. For a non-welded railing system, the components shall be fabricated in accordance with the manufacturer's design requirements. Posts shall be provided at the beginning and end of a run, at or adjacent to all corners and equally spaced over the length of the run at not greater than 6 feet on centers. Railings shall be 42 inches nominal from upper surfaces of top rail to the floor. The intermediate rails shall be spaced at 13-1/2 inches center to center starting from the top rail. All railings shall have a smooth surface.

A toe board shall be provided for all railings. The toe board shall be 4 inches nominal in vertical height from its top edge to the level of the floor, and securely fastened in place with not more than 1/4 inch clearance above floor level. The toe board shall be a plate or channel suitably supported on the railing posts.

C. Stationary Influent Column and Sludge Discharge Pipe:

1. The stationary influent column shall be not less than 24 inches in diameter, fabricated of not less than 3/8-inch steel plate. One end shall have a support flange for bolting to the foundation, with a similar flange at the top for supporting the center drive mechanism. Suitable openings shall be provided in the middle portion of the column to allow unrestricted passage of flow into the flocculation well. The influent column shall be designed to take the full torque developed by the drive mechanism with no torque transmitted to the walkway.

   Inside this column there shall be a 8-inch diameter sludge discharge pipe. It shall extend from the bottom of the visual sludge well to a point below the bottom of the stationary influent column, where it shall connect to a 6-inch diameter sludge discharge elbow. The vertical discharge pipe and elbow shall be provided by the CONTRACTOR. The elbow shall be of cast iron, cement lined, with integral base support, conforming to ASA 21.10. A seal shall be provided between the visual sludge well and the stationary influent column.

D. Center Drive Mechanism:

1. The center drive mechanism shall consist of a turntable base with ball race, spur gear, and worm gear assembly and speed reduction units driven by a totally enclosed fan cooled motor, with a maximum speed of 1,800 rpm through a chain and sprocket arrangement. The motor shall be of adequate size so that there is no overload on the motor above rated nameplate horsepower under normal conditions of service, but not less than 1/2 horsepower. The motor shall be suitable for operation on 460 volt, 60 Hz, 3 phase power. Space heaters, 120 volt, single phase shall be provided. The motor shall have a 1.15 service factor, 50° C ambient rise and shall comply with the latest ANSI, NEMA, and IEEE Standards as minimum. The motor

shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, Hp, full load current, RPM, centigrade degree rise, manufacturer's name and serial no., model, voltage, locked rotor KVA code, bearing numbers, and a connection diagram. The motor terminal box shall be of cast iron or fabricated steel, neoprene gasketed and bolted, and oversized to provide adequate space for connections. The motor leads shall be permanently marked in agreement with the connection diagram. The turntable base shall be high tensile, 40,000 psi cast iron, cast steel, or welded steel with annular raceway for a ball race near the outer periphery. The ball race shall have 1-¼-inch minimum diameter balls of AISI 52100 steel, with minimum Rockwell C60 hardness. Bearing surfaces shall have a minimum Rockwell C40 hardness. Balls shall run in an oil bath protected by both a felt seal and a dust tight shield. An oil dipstick shall be provided.

Gears shall have minimum Brinell 300 hardness. The spur gear shall be rotated by a separately mounted spur pinion keyed to the gear reduction unit. Pinions shall have a minimum Rockwell hardness of C55 with minimum tooth hardness of Brinell 300.

The gear head shall have an AGMA Class II rating and an AGMA rating plate shall be fastened to the unit.

The main gear and worm assembly shall be enclosed in a housing provided with adequate seals to protect the interior of the housing. The housing shall be designed so that all gears and bearings are oil bath lubricated. The housing shall be provided with oil level sight gauge, oil fill and drain connections and condensate drain connections from the low points of the oil reservoir.

The exposed chain drives shall be provided with a guard of sheet steel or fiberglass construction.

The center drive assembly gearing shall be designed and rated using the criteria established by the following American Gear Manufacturers Association (AGMA) Standards, and shall be based on:

a. Surface Durability (Pitting) of Spur Gear Teeth: AGMA 218.
b. Rating the Strength of Spur Gear Teeth: AGMA 218.

The output torque rating of the drive shall be based on the smaller of the two values determined from the above AGMA Standards.

E. Drive Cage:

1. The drive cage shall be of steel truss construction. It shall be provided with connections for the sludge collection arm(s) and shall be bolted to the center drive mechanism which shall rotate the cage with the attached rake arms, flocculation well and sludge sight well.

F. Flocculation Well:

1. The flocculation well shall be constructed of not less than 3/16-inch thick steel plate with stiffeners and supports as required. The well shall be provided with a sufficient number of baffled scum ports to permit the escape of floating material while preventing short circuiting. The well shall be not less than 16 feet in diameter and shall extend from a minimum of 4 inches above the water surface to at least 5 feet-8 inches below the water surface.

G. Sludge Collection Arms and Sludge Sight Well:

1. Two structural steel arms, of truss construction, min. 2'-10" x 2'-10", conforming to the slope of the tank floor, shall be rigidly connected to the center cage without the use of supporting tie rods. The arms shall be provided with steel V-plow blades and adjustable spring brass or stainless steel squeegees to scrape the settled sludge along the tank bottom to the sludge draw-off pipes and to a drain sump. The blades shall be properly spaced to insure a complete raking of the bottom, twice each revolution. Trussing of the rake arms shall be with structural steel members, capable of sustaining 1.1 times the maximum continuous operating torque without damage or permanent deformation. Tie rods and single member arms are not acceptable. Attached to each arm there shall be sludge draw-off pipes designed to provide controlled sludge flow. The number and size shall be adequate to provide for the return sludge flows specified but there shall be not less than 2 draw-off pipes per rake arm, and each draw-off pipe shall be not less than 4 inches in diameter. The innermost draw-off pipe shall be placed at a radius from the center column such that it will draw sludge at a distance just beyond the drain sump. Each draw-off pipe shall be made of poly-vinyl chloride or other approved material with bends to provide free flow and minimum friction. Each draw-off pipe outlet shall terminate in a manually adjustable sludge regulation device with positioning stem and position indicator, arranged to delivery settled sludge to a sludge sight well to allow for visual observation and sampling from each individual pipe. The sight well shall be attached to the upper portion of the torque cage and rotated by the cage. An effective seal shall be provided between the sludge sight well and the center column to prevent clarified water from mixing with the sludge. The seal shall be easily accessible and shall be replaceable. The sludge sight well shall be provided with provisions for draining and shall be of adequate dimensions to handle the required return sludge flow from the tank. Valves shall be fabricated using approved hot weld procedures. Solvent welded joints are not allowed.

H. Effluent Trough:

1. The effluent trough shall be of the annular type, fabricated of not less than 1/4-inch steel plate. The trough shall be fabricated in accordance with the details shown on the Drawings. The trough shall be drilled to receive fiberglass weir plates, and shall be provided with support brackets on which to mount a fiberglass scum baffle.

I. Weir Plates And Scum Baffle:

1. The weir plates and scum baffle shall be circular of the dimensions shown on the Drawings and fabricated from fiberglass reinforced polyester laminate. The weir plates shall have "V" notches, and shall use butt plates at the joints. The weir plates shall be accurately adjustable to be perfectly level around the tank. The scum baffle shall extend completely around the periphery of the inboard side of the effluent trough and shall project 3 inches above the liquid surface. The scum baffle shall be adjusted to form a true circle within the clarifier tank. Fiberglass weir plates and baffle shall have all machined edges resin sealed. All fiberglass weir plates and baffle shall consist of resins formulated to resist ultraviolet degradation.

All bolts, nuts and washers for attachment of the baffles and weir plates shall be of Type 304 stainless steel. Rubber gaskets shall be provided where shown or required.

J. Skimming Devices:

1. Skimming devices shall be furnished to collect the floating scum to the periphery of the tank where it shall be automatically deposited into the scum box. A hinged skimming blade with cantilevered extension section shall be supported from one rake arm. A scum box with shelf shall be provided. The hinged blade shall be made of steel and shall be the width of the scum box with a steel wearing plate on its outer edge and neoprene strips on the bottom and inner edges to seal the entrapped scum and water when discharging into the box. The hinged blade wiper strip shall be constantly forced against the scum baffle to keep the scum box scraped clean. The hinged blade shall be designed so that it is carried across the opening of the scum box without resting on the bottom neoprene strip. The hinged blade shall be adjustable so that the quantity of liquid discharged with the scum can be varied and shall be so designed that the blade can move in a vertical plane, so that the bottom edge of the blade is always in contact with the scum box, even if the arm is not horizontal. The hinged blade shall be so designed that it can be raised and held inactive above the water level when skimming is not required. The scum box shall be located on the interior side of the annular effluent weir and scum baffle as shown on the Drawings. The scum box and shelf shall be not less than 3 feet wide and 3 feet long and shall have a 6-inch, flexible connection for the scum discharge pipe.

K. Overload System:

1. An electrical or mechanical overload control system shall be furnished for the center drive mechanism. The system shall include torque switches, field adjustable over the full torque range of the unit, relays to activate an alarm in case of an impending overload, and normally closed contacts to cut off the motor if the overload becomes excessive. This device shall be operated by the back pressure of the worm to worm gear. The loads at which the alarm and motor cut out occur shall be independently adjustable, with initial setting to be made by manufacturer. The overload system shall be housed in a gasketed cast iron or aluminum NEMA 4X enclosure including an indicating device suitable for indication mechanism loading at all times during operation. All necessary current transformers, relays and other appurtenances for a complete system shall be provided by the CONTRACTOR.

L. Surface Preparation And Shop Painting:

1. Surface preparation and shop painting is required for all ferrous metals, equipment and accessories. Stainless steel shall not be painted.
2. All ferrous metal surfaces shall be cleaned and provided with two coats of priming paint. All paint materials shall be products of the Koppers Company, Inc., or the Tnemec Company, Inc.
   All ferrous surfaces of the equipment above normal water surface shall be cleaned with a Commercial Sandblast (SSPC-SP6) and shall receive two coats of Koppers Epoxy Primer 654, with a minimum dry thickness of 1.5 to 2.0 mils per coat, or two coats of Tnemec

66-1211 Epoxy Primer, with a minimum dry thickness of 1.5 to 2.5 mils per coat.

The center drive mechanism, including motor, gearbox, and like items may be given two coats of the manufacturer's standard paint system in lieu of the priming paint, provided that the total mil thickness of paint is equal to that specified above.

Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6) except that motors and like items that may be damaged by sandblasting may be prepared by other approved means.

All castings and carbon steel parts below the normal water surface shall be cleaned with a Near White Metal Sandblast (SSPC-SP10) and shall receive two coats of Koppers Epoxy Primer 294, with a minimum dry thickness of 1.5 to 2.0 mils per coat, or two coats of Tnemec 20-1255 Epoxy Primer with a minimum dry thickness of 1.5 to 2.5 mils per coat. The exterior of the stationary influent column, exterior of the 16-inch diameter steel pipe outlet section from each effluent trough,and the flexible couplings shall be cleaned, sandblasted and receive a prime coat as specified above.

In addition, the interior of the ____ inch diameter steel outlet pipe section from each effluent trough, the interior of the stationary influent column, and the interior and exterior of the sludge discharge pipe shall receive the same preparation and prime coat, and shall also receive two coats of Koppers Hi-Gard with a minimum dry thickness of 2.0 to 3.0 mils per coat <u>or</u> two coats of Tnemec 20-2000 with a minimum dry mil thickness of 2.0 to 3.0 mils per coat.

3. Gears, bearing surfaces, and other unpainted surfaces shall receive a heavy application of a rust-resistant coating which shall be maintained during storage and until the equipment is placed into operation.

M. Bolts, Nuts, and Anchors:
1. All anchor bolts and nuts and other fasteners furnished for connection of the equipment and other miscellaneous items to the concrete structure or concrete base pads shall be of Type 304 stainless steel furnished by the CONTRACTOR, and shall be of ample size and strength for the purpose intended.

N. Control Panel [Manufacturer's Furnished Panel (MFP)]:
1. Provide control panels in accordance with Section 13A50 and 16H2.
2. Electrical Controls:
   a. A circuit breaker combination starter for drive motor with overload protection single phase protection relays, power disconnect, including switch, on/off, indicating light, dry contact for motor run indiction as well as normally open dry contact for overload malfunction and clarifier shut down for signal transmission to remote location. Minimum 100 volt ampere, control power transformer shall be provided. Necessary relays, timers, momentary switches and selector switches shall be furnished. All equipment shall be housed in NEMA 4X enclosure.
   b. Factory sealed to insure torque trip settings are tamper proof; 120 volt control panel pilot circuitry.
   c. Each starter shall be furnished with three melting alloy type contacts. A minimum of four normally open auxiliary contacts

for local and remote alarm purposes, manually reset locally by means of pushbutton.

d. Local visual beacon shall be included.

O. Product and Manufacturer:

1. Provide clarifier mechanisms as designed and manufactured by one of the following:
   1. EIMCO PEC.
   2. Rexnord.
   3. Walker Process - CB&I.
   4. FMC - Link-Belt.
   5. Or equal.

2.5 SPARE PARTS

A. The following spare parts shall be supplied by the CONTRACTOR:

1. 1 set squeegees
2. 1 set of neoprene gaskets for skimmers
3. 1 set motor bearings
4. 1 set oil seals
5. 1 chain sprocket
6. 1 steel drive chain
7. 12 shear pins
8. 6 sets of shear pin thimbles
9. 1 set each of oil seals for the worm shaft and pinion shaft
10. Scum deflector wiper including necessary bolts, nuts and washers
11. 1 skimmer backup plate including bolts and nuts
12. 2 skimmer wiper clamps including bolts and nuts
13. 1 skimmer bottom wiper blade and 1 slide wiper blade
14. One complete set of any special tools required for maintenance

The spare parts shall be delivered carefully boxed or packaged and plainly marked for reordering.

B. In addition to the spare parts to be furnished, the CONTRACTOR shall furnish a list of additional recommended spare parts for an operating period of one year. This list shall describe each part, the quantity recommend, and the unit price of the part. The OWNER will purchase all, some, or none of the recommended spare parts at his option.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The CONTRACTOR shall install the flocculator-clarifier mechanism in accordance with the details shown on the Drawings, the approved Shop Drawings and the manufacturer's instructions and recommendations.

B. Installation shall include furnishing and applying of all required oil lubricants for initial operation. Grades and types shall be as recommended by the equipment manufacturer.

3.2 START-UP AND FIELD TEST

A. CONTRACTOR shall verify that structures and equipment are compatible.

B. Make adjustments required to place equipment in proper operating condition.

C. Conduct functional field test of flocculator-clarifier mechanism in the presence of the ENGINEER to demonstrate that each part and all components together function correctly as intended and conform to the requirements of the Specifications. All testing equipment required shall be provided by the CONTRACTOR.

D. Torque tests shall be performed on flocculator-clarifier mechanism to verify accurate torque indication, the adequacy of the mechanism to safely withstand the specified torque and to verify the structural integrity of the mechanism and drive. The tests shall accurately depict actual operation of the mechanism and shall not apply impact loading, jerky loading or abnormal conditions which may reduce the life of the equipment. The testing shall be carried out in the presence of the ENGINEER before the mechanisms are approved and placed into operation.

1. The torque test shall consist of securing the rake arms by cables to anchor bolts installed by the CONTRACTOR in the basin floor at locations recommended by the manufacturer and approved by the ENGINEER.
2. A torque load shall be applied to the truss arms by means of a ratchet lever and cable assembly. The magnitude of the applied load shall be measured by a calibrated pressure reading and the distance of the line of action of each cylinder from the centerline of the mechanism.
3. Readings shall be taken at 50 percent, 75 percent, 100 percent, of cut-out torque specified.
4. The test load shall be applied such that the torque overload device can be used to indicate and signal the alarm and motor cutout torque values of the drives.
5. Loads shall not be applied by energizing the motor.
6. The mechanism shall exhibit no permanent deformation of any components. If deformation does occur the defective parts shall be replaced by the CONTRACTOR and then retested at no additional cost to OWNER until satisfactory results are achieved.
7. In the event the mechanisms fail to meet the above torque test, the necessary changes shall be made and the mechanisms retested. If the mechanisms remain unable to meet the test requirements to the satisfaction of the ENGINEER, they shall be removed and replaced with satisfactory mechanisms at the Contractor's expense.
8. After the necessary adjustments and settings to the overload device have been made, the drive motor shall be switched on and the mechanism loaded to overload condition to insure that the sludge collector mechanism will stop, switch off the drive motor and sound an alarm when a predetermined overload condition occurs in the tank.
9. Six copies of certified test results shall be furnished upon completion of satisfactory testing of the equipment.

E. Field acceptance tests and testing procedures shall be mutually arranged and coordinated with the ENGINEER and the OWNER.

F. Complete test procedures shall be submitted to the ENGINEER for approval prior to testing. All labor, materials and test apparatus necessary for conducting the above tests shall be furnished by the CONTRACTOR at no additional cost to the OWNER.

3.3 GROUT TOPPING

A. A 2-inch grout topping shall be installed in the bottom of the basins as shown on the Drawings. Grout topping shall conform to the requirements of Section 3I.

B. The CONTRACTOR shall follow the instructions of the equipment manufacturer with regard to the installation of the grout topping.

C. Grout placement shall be continuous, once started, until all grout is placed. Development of "cold" joints due to delay in concrete delivery, placement, weather or any other cause may result in rejection and removal of the entire grout work as directed by the Engineer. All surfaces shall be given a steel trowel finish.

D. The finished surface of the grout topping shall be within 1/4 inch of the required true surface.

3.4 MANUFACTURER'S SERVICE

A. The CONTRACTOR shall provide the services of a qualified, factory-trained representative of the manufacturer to check and approve the installation before and after it is placed in service, supervise initial operation and testing in the presence of the ENGINEER and instruct the OWNER'S personnel in operation and maintenance of the equipment. A minimum of 12, 8-hour days, which may not necessarily be consecutive, shall be provided for these services. In the event of trouble with the equipment, the manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

+ + END OF SECTION + +

SECTION 11F7

PROCESS AIR DIFFUSION EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Aeration Tanks:
   1. Scope: The CONTRACTOR shall provide all labor, materials, tools and equipment necessary for furnishing, installing, testing, and placing into satisfactory operation a fine bubble air diffusion system in the Aeration Tanks in accordance with this Specification and the Drawings. Spare parts shall be furnished as described hereinafter.
   2. The aeration system shall consist of porous ceramic bonded fused alumina diffusers, an air distribution system including piping, mounting brackets, diffuser and pipe supports, diffuser blanks and appurtenances as described hereinafter and within the limits shown on the Drawings.
   3. In order to centralize responsibility, it is required that all equipment provided under this Specification Section be furnished by a single air diffusion system supplier or manufacturer who shall be responsible through the CONTRACTOR for the completeness, performance, adequacy and proper operation of the system in accordance with the requirements herein. The CONTRACTOR shall guarantee and be the source of information for the complete system as well as each piece of equipment furnished under this Section regardless of the manufacturing source of that equipment.
   4. The attention of the CONTRACTOR also is directed to the fact that the subsequent selection of a named or unnamed manufacturer's equipment by the ENGINEER in no way relieves the CONTRACTOR from the responsibility of conforming with the requirements of the Contract Documents.
   5. All piping, valves and appurtenances included herein shall also conform with the applicable Sections of Division 15.

B. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. Section 1H4, Field Tests of Equipment.
   3. Section 1H5, Instruction of Operating Personnel.
   4. Section 1I3, Operation and Maintenance Data.
   5. Section 3D, Cast-In-Place Concrete.
   6. Division 13, Instrumentation and Control Equipment.
   7. Division 15, Sections on Piping, Valves, and Appurtenances.

1.2 QUALITY ASSURANCE

A. Supplier's Qualifications: The supplier shall have experience in the design and fabrication of fine bubble diffuser aeration system as described herein, and shall show evidence of installations in satisfactory operation.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASCE Standard for Measurement of Oxygen Transfer in Clean Water.

C. Quality Control Testing:
   1. Prior to initiation of production, the CONTRACTOR shall submit for the ENGINEER'S approval, a testing plan designed to ensure consistently good quality and uniformity of the diffuser assemblies. A sampling plan shall be included. After testing, all diffusers tested shall be marked with their test results. All costs incurred for performing the tests shall be included in the bid price.
   2. All work of testing and inspecting shall be done by the supplier at a facility approved by the ENGINEER. Imperfect or defective diffusers and those not meeting the requirements specified herein, shall be rejected. If any diffuser fails to meet the requirements of the individual tests stated below, additional tests shall be made on 10 percent of all the assembled diffusers and the additional costs shall be borne by the CONTRACTOR. If these additional tests indicate that 10 percent or more of these additional tested assembled diffusers do not meet the requirements, the entire batch of assembled diffusers shall be tested and the additional cost shall be borne by the CONTRACTOR. Assembled diffusers which fail to meet the requirements shall be discarded. Diffusers which do not meet the requirements shall be replaced with new diffusers which pass these tests at the CONTRACTOR'S expense. The tests shall be witnessed by a Registered Professional Engineer, who may be an employee of the supplier.
      a. Permeability Testing:
         1) Ceramic diffuser elements shall have a design mean permeability rating in the range of 12 to 15 SCFM when used without a flow control device, and shall be permeable over their active surface. The permeability rating is defined as the number of cubic feet of air per minute at 70 F plus or minus 2 F and 10 to 25 percent relative humidity which will pass through one diffuser element under a differential pressure equivalent to 2-inches of water column.
         2) Diffusers shall be tested in a room maintained at 70 F plus or minus 5 F and 10 to 25 percent relative humidity.
         3) Each lot of the diffuser elements shall be acceptance tested at Level II, 1.0 AQL, Normal Multiple Sampling, per Military Standard 105D.
         4) The tested rating of each sample shall be stenciled on the diffused elements.
         5) The results shall conform to the following requirements:
            a) The 95 percent limits of individual lot range shall be 11 to 17 SCFM.
            b) The 95 percent of mean variability for the total order average shall be 12 to 15 SCFM.
         6) Records shall be maintained by lot number.
         7) A test plan designed to meet the above requirements shall be submitted by the CONTRACTOR for the ENGINEER'S approval.
      b. Uniformity Testing:
         1) All lots accepted for permeability shall be randomly sampled for uniformity testing.
         2) Uniformity is defined as substantially even distribution of air bubbles when the diffuser is submerged and operating at 0.5 to 1.0 SCFM.
         3) A minimum of five diffusers shall be tested.

4) Tested diffusers shall be thoroughly dried before being returned to the lot.

c. Strength Testing:
1) All lots accepted for permeability and uniformity shall be randomly sampled for strength testing.
2) A minimum of two diffusers from each 500 shall be tested.
3) Adequate strength shall be defined as the ability of the sample diffusers to withstand a vertical load of 750 pounds applied to the center 1-inch diameter of the diffuser when the diffuser is supported properly in a fixture similar to the diffuser element holder.
4) Records shall be maintained by lot number.
5) Diffusers sampled for strength testing shall be stenciled with their inspection lot number. Diffusers accepted for strength shall be packed separately.

d. Visual Examination:
1) All diffusers shall be visually examined during packaging.
2) All diffusers shall be free of cracks, soft spots, chipping, spalling or other structural defects.

D. Oxygen Transfer Efficiency Testing:
1. Prior to shipment of any equipment to the job site, the manufacturer shall conduct performance tests on the proposed aeration tank air diffusion system to demonstrate conformance with the oxygen transfer efficiency requirement.
2. The tests shall be performed in a test tank having a minimum plan area of 150 square feet. The shorter plan dimension shall be at least fifteen percent of the longer plan dimension.
3. The tests shall be performed at a test location suitable to the ENGINEER and each test shall be witnessed by a Registered Professional Engineer, who may be an employee of the supplier. The ENGINEER and/or the OWNER may, at their option, witness the tests. The expenses for the ENGINEER and OWNER shall not be included in the bid price.
4. All test measurements shall be taken with instruments calibrated properly and in accordance with the instrument manufacturer's recommendations.
5. The CONTRACTOR shall notify the OWNER and ENGINEER at least one month in advance of the scheduled test dates.
6. Details of the test procedure including all analytical water testing procedures shall be submitted to the ENGINEER for approval at least two months prior to the test. All costs incurred for performing the tests shall be considered as included in the bid price.

a. Oxygen Transfer Testing Procedure:
1) The test tank shall be thoroughly cleaned and inspected prior to testing. Test grid shall be installed as specified hereinafter. Only those diffusers shall be installed in the test tank which have undergone quality control testing. Quality control test results of the test diffusers shall be submitted prior to actual oxygen transfer testing.
2) The tank shall be filled to the design depth from potable public water supply. The test water temperature shall be maintained between 15 C and 25 C. Before the first test and after the last test on each batch of test water, samples of tank water shall be withdrawn and analyzed for total dissolved solids. Total dissolved solids in the last test shall not exceed 1,500 mg/l.

3) Oxygen Transfer Efficiencies shall be determined for the aeration tank for the following aeration tank air flow conditions:

   Design: 740 scfm
   Peak: 1200 scfm

   Three replicate test runs shall be performed for each air flow rate indicated above. Diffuser arrangement and submergence shall be identical to the proposed full scale installation. Submergence of the diffusers shall be based on side water depth of 20 feet. Air flow per diffuser into the test tank shall correspond to the respective aeration tank pass under investigation. The clean water Oxygen Transfer Efficiencies for design and peak air flow rates, respectively, shall not be less than the following: 34, 28, percent

4) The amount of air in scfm being introduced into the test tank for each run shall be measured and recorded a minimum of three times per test run including readings at the outset and conclusion of each run. The air flow in cfm shall be determined by two flow measuring devices with calibration curves factory certified to be within ±2 percent at the air rate specified. Proof of calibration shall be submitted to the ENGINEER along with the test procedure.

5) In line air temperature and pressure shall be measured upstream of the flow measuring device.

6) The air delivered during any test shall be within 10 percent of the specified volume, and shall not vary by more than 2.5 percent from the mean during any single test run.

7) At least four submersible sampling ports shall be used. The sampling ports shall be located in an attempt to have each sense an equal portion of the tank volume and shall be distributed vertically and horizontally (or radially) to best represent the tank contents. The locations are subject to the approval of the ENGINEER.

8) Cobalt chloride ($CoCl \quad 6H_2O$) shall be used as a catalyst at a maximum concentration of 0.1 mg/l (Cobalt ion concentration). Each batch of test water shall be conditioned by the addition of one dose of cobalt prior to the first test.

9) A cobalt interference test shall be performed by running a blank on the Winkler method by not using magnous sulfate in the blank test bottle.

10) Technical grade anhydrous - sodium sulfite (Na_2SO_3) shall be used to de-oxygenate the test water. A sample of each batch of the sulfite chemical used shall be tested for rate hindering contaminants. The procedure for determination of rate hindering contaminants shall be approved by the ENGINEER.

11) Sodium sulfite shall be added to the test tank one hour after the addition of cobalt. Sulfite shall be discharged into the test tank at two or more locations within five minutes. The amount of sodium sulfite used for each test shall be 1.5 times the stoichiometric requirement. Sufficient sodium sulfite shall be added to depress the dissolved oxygen concentration to below 0.5 mg/l at all points in the test water. Prior to sulfite addition, the air rate shall be set at the specified flow rates.

12) All chemicals shall be added to the test tank in solution form.
13) The Azide Modification of the Winkler method shall be used to determine dissolved oxygen in each sample.
As an alternate, use of in-tank dissolved oxygen probes shall be acceptable. The dissolved oxygen probes shall be fast response probes with a probe time constant of less than 0.02/KLa and recorder with a precision of ±0.05 mg/l. All dissolved oxygen probes shall be calibrated with Winkler method, using test water before the addition of cobalt. Dissolved oxygen probes shall be rechecked for drift at the start of each new run by the Winkler Method, and shall be adjusted if the oxygen value shown by the Winkler Method is lower than those indicated by the D.O. probes.
14) All equipment shall be operated for minimum one hour prior to the start of oxygen transfer testing.
15) An initial oxygen transfer test run of each new batch of test water shall be performed to check out all the equipment and testing procedure. The results of the initial test run shall not be used as a valid test run.
16) A minimum of 21 points shall be taken during each test run. 14 or more points shall be selected up to 86 percent saturation, and about 7 discrete points shall be selected in the range of 86.5 to 98 percent saturation. The last reading of the test run shall be equal to or greater than 98 percent of the saturation value. The saturation value is defined as equilibrium dissolved oxygen concentration attained as time approaches infinity.
17) Out of three replicate test runs for each determination point, $K_L a_{20}$ value for each run shall not vary more than ±5 percent of the average of the three replicate test runs.
For each determination point $K_L a_{20}$ shall be within ±10 percent of the mean value for the tank.
18) The dissolved oxygen versus time data for each test run shall be plotted. Low dissolved oxygen values shall be examined for lingering effects of the deoxygenation chemicals. The low DO values shall be truncated up to a maximum of 30 percent of the saturation value as per criteria given in the ASCE Standard.
19) The adjusted data for each determination point shall be analyzed by the non-linear regression of the following equation to obtain $K_L a$ and C^*sat.

$$C = C^*sat - (C^*sat - Co) \exp(-K_L a)$$

where:

C = Dissolved oxygen concentration, mg/l

C^*sat = Saturation dissolved oxygen concentration as time approaches infinity, mg/l

Co = Dissolved oxygen concentration at time zero, mg/l

$K_L a$ = Apparent volumetric mass transfer coefficient, hr^{-1}

20) The values of K_La and C^*sat shall be corrected to the standard conditions as follows:

$$K_La_{20} = K_La \times 1.024^{(20-T)}$$

$$C^*sat\ 20 = \frac{C^*sat \times C^*s20 \times Ps}{C^*st \times P_b}$$

where:

K_La_{20} = K_La corrected to 20 C , hr^{-1}

C^*sat20 = C^*sat corrected to 20 C and standard barometric pressure of 1.00 atmosphere

C^*_{s20} = Tabular value of dissolved oxygen surface saturation concentration at 20 C, standard pressure of 1.00 atm., and 100 percent relative humidity, 9.09 mg/l

C^*_{st} = Tabular value of dissolved oxygen surface saturation concentration, mg/l, at the test temperature, standard pressure of 1.00 atm., and 100 percent relative humidity

P_s = Standard barometric pressure, 14.73 psia

P_b = Barometric pressure during test, psia

T = Water temperature during test, C

21) The average value of Standard Oxygen Transfer Rate (SOTR) shall be calculated as follows:

$$SOTR\ (lbs/hr) = \frac{W \times \Sigma(K_La_{20} \times C^*_{sat20})}{4}$$

where:

W = Weight of water tested, millions of pounds

22) Standard Oxygen Transfer Efficiency (SOTE) shall be calculated as follows:

$$SOTE\ (\%) = \frac{SOTR \times 100}{Q_s \times 60 \times 0.075 \times 0.232}$$

where:

Q_s = Standard air flow rate supplied to the test tank, scfm

0.075 = Standard weight of air, lbs/ft^3

0.232 = Weight fraction of oxygen in air

E. Preliminary Operating Pressure Test: As part of the shop test for oxygen transfer efficiency described above, the operating pressure shall be measured and recorded for each test run. Headloss through the diffusers shall be calculated from this data.

F. Shop Test Results: Six prints and one reproducible copy of the curves and computations and data sheets for the quality control, oxygen transfer efficiency, and preliminary operating pressure tests shall be furnished to the ENGINEER for approval. Each page of these test results shall be signed and sealed by the witnessing Registered Professional Engineer. The state of the Engineer's registration, the registration number and the Engineer's name on the seal shall be legible. Under no circumstances shall any equipment be shipped until the ENGINEER has approved the test reports as well as the Shop Drawings. Shop Drawings and other submittals are discussed in Article 1.3.

1.3 SUBMITTALS

A. Comply with the general requirements of Section 1E4 and the specific requirements below.

B. Submittals After Award of Contract:

1. Calculations:
   a. The CONTRACTOR shall submit design calculations as described hereinafter for the support system and piping expansion and contraction to the ENGINEER for review. Supports shall be designed as specified in Paragraph 2.2.E.
   b. Headloss calculations for air distribution system, including piping and diffusers, starting from the point of equipment supplier's responsibility, as shown on the Drawings.
   c. Calculation of maldistribution of air in the nearest and farthest diffusers of each grid both at maximum and minimum air flow rates as specified under Paragraph 2.1.D. Maldistribution at minimum air flow to each grid shall not exceed one percent.
2. Submit for approval Shop Drawings and other submittals including the following:
   a. Fabrication, assembly and installation drawings including views of all air feed piping and diffuser assemblies, and indicating location and spacing of diffusers and blanks and all pipe sizes, separately for initial and future design conditions.
   b. Supplier's literature, illustrations, specifications and engineering data.
   c. Provide setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
   d. Detailed description of recommended field test procedures for supports, air piping leakage, system operating pressure, uniform air distribution, and uniform mixing.
   e. Quality control and oxygen efficiency test reports as described in Article 1.2.
   f. Results of all field tests including certified friction headloss curves based on the actual field test data for the aeration diffuser system from the point of supplier responsibility as defined hereinafter.
   g. Summary of air flow rates per diffuser and predicted transfer efficiency based on shop test data in each tank third.

   No equipment shall be shipped until the Shop Drawings and shop test results are approved by the ENGINEER.

C. Operation and Maintenance Manuals: Submit six complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 1I3.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. General: The air diffusion equipment shall provide fine bubble aeration. The main operational requirements of the air diffusion system shall be the required oxygen transfer and solids suspension in the tank configurations shown on the Drawings and under the design conditions provided below.

B. Diffuser Blanks for the Aeration Tanks: A minimum number of blanks, equal to ten percent of the total number of diffusers required per design criteria below shall be provided and equally distributed within each grid to allow "fine tuning" of the air taper to actual operating requirements.

   Orifice plugs for blanks shall be of Type 316 stainless steel, with neoprene gaskets or O rings suitable for a temperature range of 30 to 150 F.

C. Design Criteria:
   1. General: The system shall provide activated sludge treatment to screened influent sewage.

Design Criteria - Aeration System

Nominal Aeration Tank Dimensions*	
No. of passes per tank	1
Width of each pass (ft)	30
Length of each pass (ft)	56
Side Water Depth (ft)	
at Average Influent Wastewater Flowrate	20.11
at Peak Influent Wastewater Flowrate	20.13
Total Number of Aeration Tanks	2
Nominal Volume/Tank (million gallons)	0.250
Nominal Total Volume (million gallons)	0.50
Design Liquid Temperature (°C)	30

	Design	Peak
Facility Flow Rate (mgd)	0.50	0.50
Total Air Flow Rate (scfm)	740	1,200
Mixed Liquid Suspended Solids (mg/l)	2,400	3,100
Minimum D.O. Concentration (mg/l)	3.0	2.0

*See Drawings for exact dimensions.

	Design	Peak
Influent BOD5 Loading (lb/d)	1,140	1,710
Influent NH3-N Loading (lb/d)	130	190
Oxygen Requirements (lb/d)	1,720	2,580
Average Wastewater Correction Factor	0.42	0.42
Salinity-Surface Tension Correction Factor	0.95	0.95
Mean Cell Residence Time (days)	11	11

D. The maximum diffuser spacing (center line of diffuser to center line of diffuser) shall be __ inches. The number of diffusers and respective spacings shall be uniform and shall provide the required quantities of air under all operating conditions as specified. The system shall provide complete mixing and solids suspension with uniform air distribution within each pass within the range of tapered air distribution as above.

E. Air flow rate per diffuser shall be at least 0.6 scfm per diffuser and shall not exceed 1.50 scfm per diffuser under any operating condition.

F. Design criteria of process air compressors is such that the maximum operating pressure, when operating at maximum air supply and submergence of diffusers at peak plant flow shall not exceed 9.0 psig at the point of supplier's responsibility. The point of supplier responsibility shall be as shown on the Drawings. Failure of the system to meet this condition will be a cause for rejection of the air diffusion equipment.

2.2 FABRICATION

A. Product and Supplier: The fine bubble aeration system shall be as supplied by:
   1. Sanitaire.
   2. Or equal.

B. Air Diffusers:
   1. The air diffusion equipment shall be manufactured according to the best engineering practice and shall be designed for the maximum stresses to which it might be subjected, without failure, distortion, or damage.
   2. All diffusers furnished shall provide fine bubble aeration. The main operational requirements of the air diffusion system shall be oxygen transfer and solids suspension.
   3. Each air diffuser assembly shall consist of a porous ceramic diffuser element, an air flow control device, provisions for connection to the diffuser holder installed on the air distribution header piping, and a gasket.
   4. Each air diffuser assembly blank shall consist of a diffuser holder, provisions for connection to the diffuser holder installed on the distribution header piping and a plug/bolt.
   5. The air release of the orifice shall be designed such that the air entering the diffuser assembly shall be distributed evenly under the horizontal surface of the diffuser element.
   6. The diffuser element shall be composed of crystalline fused alumina (aluminum oxide) with a suitable ceramic bonding material. The individual alumina grains shall be thoroughly joined together with the bonding material to form a strong, uniformly porous and otherwise homogenous structure.

7. Diffusers shall be substantially free from any material soluble in sewage containing household or industrial wastes of any character and from any loose, unbonded material which may affect their normal and proper operation. All diffusers shall be free of cracks, soft spots, chipping, spalling, or other structural defects. All diffusers shall be uniform throughout their entire structure and free from holes and impervious material which may cause unequal air distribution. The diffuser elements shall provide a constant and uniform distribution of the emergent diffused air bubbles across their entire active section.
8. Each diffuser assembly shall incorporate a retaining device to securely hold and seal the ceramic diffuser to the assembly. Diffuser assembly and retaining device shall be designed to prevent air escape at the diffuser element-sealing gasket interface.
   a. Design using hold-down bolts shall require Type 316 stainless steel bolts.
   b. Designs utilizing screw on retainer rings shall have a positive "O" ring seat and have a minimum of 2-1/2 complete threads for engagement. Threads shall have a minimum cross section of 1/8 inch.
9. Diffuser element gaskets shall be medium density closed cell molded neoprene and shall meet the requirements of ASTM D 1056 - RE-42-43. Water absorption shall be 5 percent maximum. Compression deflection shall be 5 to 13 psi. The gasket shall be suitable for temperature range of 30 to 150 degrees Fahrenheit.

C. Purge System:
1. A purge system shall be provided to drain the entire submerged aeration piping system. All components of the purge system piping shall be of minimum Schedule 80 UPVC. Minimum two moisture purge systems shall be provided per grid.

D. Air Distribution System:
1. Air Feed Droplegs (Droplegs) and In-Tank Mains: The droplegs and in-tank mains shall be of Type 304L stainless steel, fabricated in accordance with ASTM A 778 and A 774. All stainless steel shall conform to ASTM A 240 with a 2D finish. The droplegs and in-tank mains shall be rolled from previously annealed and pickled sheet and automatically welded by the Inert Gas Shielded Arc Method. In-tank mains shall be minimum Schedule 5. The size of in-tank mains and the droplegs shall be as shown on the Drawings. The dimensional tolerances of this equipment shall conform to ASTM A 554 and ASTM A 530. Dropleg wall thickness shall be as shown on Sheet M-21.
   a. Length of Pipe: Pipe length shall not exceed 30 foot nominal.
   b. Eccentric Reducers: Eccentric reducers shall be shop welded to adjacent pipe lengths, to conform to 30 foot nominal lengths so far as practical. Eccentric reducers shall be used wherever size reduction is required.
   c. Measurement Tap: Provide one measurement tap on each dropleg downstream of the point of supplier responsibility, as defined previously and on the Drawings, located to provide easy access.
   d. Expansion joints shall be of Type 304L stainless steel.
2. Air Diffuser Distribution Headers (Distribution Headers): The distribution headers shall include the header piping, factory installed diffuser element holders, joints, expansion joints, and drainage system. Distribution headers, expansion joints, diffuser

holders and retainer rings shall be manufactured of unplasticized polyvinyl chloride (UPVC) with minimum of 2 percent TiO_2 added for ultraviolet protection.

The invert elevation of each distribution header shall be the same throughout the tank. Each end of the distribution header shall have a removable UPVC end cap.

The distribution header spacing shall be as provided by the supplier, and as per maximum diffuser spacing requirements defined hereinbefore. Standard pipe lengths not to exceed 18 feet. Distribution headers shall be a minimum nominal 4-inch diameter and shall conform with ASTM D 3034 or ASTM D 2241.

Distribution headers, expansion joints and diffuser holders shall have a minimum wall thickness of 0.173 inches.

3. All in-tank air piping, including the in-tank mains and distribution headers, and diffusers shall be capable of being installed level within plus or minus 1/8 inch overall in all tanks and of remaining level under all conditions of operation whether the aeration tanks are full, partially full or empty. Features which allow possible deviation from level shall be cause for rejection.
4. Adequate space shall be provided between the distribution headers for in-place manual cleaning of the diffusers with liquid acid and pressure hosing.

E. Supports:
1. The design of all support systems including provisions for expansion and contraction of all air piping as described above shall be provided by the CONTRACTOR.
2. All supports, fasteners, expansion bolts, nuts and appurtenances shall be of stainless steel construction. Welded assemblies for supports under the in-tank mains shall be fabricated of Type 304L stainless steel and non-welded assemblies from Type 304 stainless steel. Welded assemblies for supports under the distribution headers shall be fabricated of Type 316L stainless steel and non-welded assemblies from Type 316 stainless steel.
3. Supports shall provide proper bracing and means for accurate field alignment and adjustment of air feed and distribution mains, vertically, laterally, and longitudinally. Each pipe section shall have at least 2 supports and supports shall not exceed 8 feet maximum spacing. Each support shall be anchored to the tank floor by Type 316 stainless steel anchor bolts designed for 10 times the calculated maximum uplift force. All supports shall include minimum 2-inch wide cradles for proper bearing of pipes.
4. Supports shall provide for expansion or contraction of the air manifold, and distribution headers resulting from temperature change. Each expansion joint shall provide for longitudinal expansion and contraction within the joint. Each system shall allow for expansion and contraction at a temperature differential of 100 F.
5. No additional expansion couplings are required in the drop legs except where shown on the Drawings. Bottom supports of drop legs shall be designed as fixed supports. Top supports shall be sliding type as shown on the Drawings.

F. Stainless Steel Welding:
1. All welding performed under this Specification shall be completed in the shop. Field welding will not be permitted. All stainless steel joining welds shall be made by a fully automatic, inert gas process. Before a longitudinal butt seam is welded, starting and run-off tabs

shall be heliarc spot welded to each end of the main. Ends shall be checked for trueness to the axis. Rigid jigs and fixtures shall be used for holding parts in proper alignment while welding.

2. During the welding operation the joint shall be backed up from the opposite side with a chill bar. The bar shall have a series of holes running its entire length through which gas is introduced to assure shielding to the interior of the joint. The welding of the joint shall be by automatic shielded arc, inert gas method. The gas shield shall be utilized top and bottom to assure that the weld is made in a completely inert atmosphere.
3. Filler wire shall be added to all gauges of material to provide for a cross section of weld metal equal to or greater than the parent metal. The filler wire shall be at least one grade higher than the parent metal and always of the extra low carbon grade. It shall be automatically fed to the weld with the rate of travel of the automatic welding machine. A nonconsumable tungsten electrode shall be used, with the shielding gas being either argon or helium.
4. The welds shall be fully penetrated, sound, and of uniform bead. Circumferential welds shall be made using the tungsten shielded arc process. Such welds shall have full penetration to the interior surface of the air main. Gas shielding shall be provided to the interior of the joint as well as to the exterior, to assure that the weld is made in a completely inert atmosphere.
5. In addition to the above requirements, all welds shall have a surface finish equal to the smoothness of a 2D sheet finish. Interior weld beads shall be smooth, evenly distributed, with an interior projection not exceeding 1/16 inch beyond the I.D., of the air main or fitting. Ripples or uneveness shall be finely ground to meet the above requirements. Major grinding of interior seams to remove excess projection of welds or severe uneveness will not be permitted.
6. The outside weld area shall be wire brushed. Brushes shall be of stainless steel and used only on stainless steel. All discoloration and deposits left by welding shall be removed by pickling.

G. UPVC Welding: UPVC expansion joints, diffuser element holders, and fittings, designed to be solvent welded to the pipe, shall be factory installed on the distribution header. No field solvent welding will be permitted. Solvent welds must be factory assembled and tested prior to shipment.

H. Final Cleaning and Shipment:
1. All fabricated stainless steel droplegs, in-tank mains and parts shall be completely immersed for a minimum of 15 minutes in a pickling solution of 6 percent nitric acid and 3 percent hydrochloric acid at 140 degrees F. All droplegs, in-tank mains and parts shall be free of iron particles or other foreign material. A complete neutralizing operation, by immersion in a continuous fresh water bath, will be required.
2. During shipment, flanged ends of all above described piping shall be protected with wooden or fiberboard planks. Plain ends shall be protected with wooden plugs. Plugs shall be firmly inserted and banded.
3. Diffuser elements shall be adequately crated to protect from damage.

2.3 DIFFUSER PRESSURE MONITORING SYSTEM

A. Each aeration grid shall be provided with a pressure monitoring system, consisting of a connecting box, tubing, carrier pipe and accessories for a complete system. A total of twenty four systems shall be provided. Two portable monitoring panels shall be supplied for use with the monitoring systems.

B. Each portable monitoring panel shall be of stainless steel construction and shall include pressure gauge, PVC or brass valves, polyethylene tubing, quick brass disconnects, and accessories.

C. The connecting box shall be of heavy duty fiberglass construction, and shall include PVC or brass ball valves, quick brass disconnects, polyethylene tubing and accessories.

D. Two sets of connecting leads of vinyl tubing and quick connect brass sockets for use with the monitoring panels and connecting boxes shall be furnished.

E. All other tubing shall be of polyethylene. Carrier pipes shall be of CPVC schedule 80. All support brackets and hardware shall be of Type 304 stainless steel.

2.4 SPARE PARTS

A. The following spare parts shall be included in the CONTRACTOR'S bid price:
   1. One hundred and ten percent of the number of diffusers, gaskets and hardware required to replace the diffusers and blanks.
   2. One percent of the total number of air feed and distribution main supports, including required nuts and bolts. The one percent shall be apportioned over the respective diameters furnished.
   3. One complete set of any special tools required for maintenance.

B. The spare parts shall be delivered carefully boxed or packaged and plainly marked for reordering. The CONTRACTOR shall inventory, store and safeguard these parts until completion of the Work, at which time they shall be inventoried, delivered and placed by the CONTRACTOR in an area designated by the ENGINEER.

PART 3 - SPECIAL SERVICES

3.1 FIELD TESTS

A. The following field tests shall be performed on the air diffusion system by the CONTRACTOR with the assistance of the supplier's serviceman prior to acceptance by the OWNER. Details of the test procedures shall be submitted to the ENGINEER for approval.

B. The following test shall be performed on the System prior to installation of the air distribution piping.
   1. Upon installation of the supports and prior to installation of piping, all of the supports of each type shall be tested by the CONTRACTOR with not less than 10 percent of the supports of each

type tested. The supports to be tested shall be chosen at random by the ENGINEER who shall witness the tests. Each support chosen for test shall be attached to a lever which shall be placed on a fulcrum. A static load shall be applied to the opposite end producing a vertical extracting force on the support tie-down equal to 10 times the calculated maximum buoyant force to which the support tie-downs will be subjected in normal operation.

C. After plant start-up and once stable operation is attained, the following tests shall be performed:
   1. The air diffusion system shall be field tested to verify operating pressure, uniform air distribution, and uniform mixing. The testing procedures shall be subject to the approval of the ENGINEER. All gauges, manometers, taps, pressure measuring devices, etc. for field tests of equipment shall be provided by the CONTRACTOR. If the equipment fails to pass the field tests, the CONTRACTOR shall repair or replace the equipment (including all labor and material costs) and retest until the system passes. All repairs or replacements shall be approved by the ENGINEER. All testing, retesting, modifications and replacements shall be performed by the CONTRACTOR at no additional cost to the OWNER.
   2. The CONTRACTOR shall perform a field leakage test for air feed headers and distribution mains. The procedure shall consist of operating the system and applying a soap solution to each field installed joint. As an alternate test procedure the CONTRACTOR may submerge all piping, apply pressure, and observe leaks, if any. The procedure will be subject to the approval of the ENGINEER.
   3. A pressure test shall be performed on the air diffuser system. The tanks shall be filled with non-potable water to the normal operating depth. The pressure shall be tested and recorded in each (56'X 30') tank at maximum conditions. The pressure shall be measured at the point of supplier responsibility. This measurement shall not exceed 9.0psig.
   4. An air distribution test shall be performed on each aeration tank, for a total of 2 tests. The tank shall be filled with non-potable water to a depth above the air feed main as approved by the ENGINEER. The system shall be operated at average condition with air flow uniformity being verified by means of visual inspection. If, in the opinion of the ENGINEER there are areas of consistent low or high air quantity release, the CONTRACTOR shall make all necessary adjustments to correct these deficiencies. During filling, observations shall be made when the water level is at the top of the diffuser elements. Diffusers shall be at the same elevation ±1/4 inch.
   5. In addition to the above tests, mixing test shall be performed. The test shall be made in an aeration tank selected by the ENGINEER. The mixing test shall be performed to ensure that a variation of MLSS concentration shall be not more than ±10 percent of the average value in the tanks tested. A minimum of ten samples at various tank locations and depths shall be analyzed for suspended solids using Whatman glass paper GF/A. The location and depth of sample points shall be as selected by the ENGINEER prior to the start of the test. Using the data recorded, the average MLSS concentration shall be computed for the air diffusion system. The variation allowed above

does not include analytical variation of sample analysis. Laboratory analyses shall be the responsibility of the OWNER. The accuracy and precision of all instruments used shall be determined by methods mutually agreed upon by the supplier and ENGINEER prior to the start of the test.

3.2 SUPPLIER'S SERVICES

A. The supplier shall furnish the services of a qualified factory- trained serviceman who shall assist in the installation of the air diffusion equipment, check the installation before it is placed into operation, assist with performance of the field tests required, assist with initial operations and instruct the plant operators in the care, operation and maintenance of the equipment.

B. The serviceman shall make a minimum of three visits to the site. The first visit shall be for a period of two 8-hour days to assist in the installation of the equipment. The second visit shall be for a period of up-to two 8-hour days to check the completed installation, and to start-up the system. The third visit shall be for a period of up to three 8-hour days to assist with the performance of the field tests, to instruct the plant operators in the proper operation and maintenance of the equipment.

C. All costs, including travel, lodging, meals and incidentals shall be considered as included in the CONTRACTOR'S lump sum bid price.

D. Instruction of OWNER's Operating Personnel:
   1. Comply with Section 1H5.
   2. Initial Instruction Course: After equipment is fully operational, and before OWNER will assume responsibility for the operation of the equipment, the equipment manufacturers operating specialists shall instruct the OWNER's operating personnel in the care, maintenance and proper operation of the equipment.
   3. Formal Instruction Course: After continuous operation of the equipment for a period of 30 consecutive calendar days, retain a qualified representative of the manufacturers for a minimum period of 8 hours to instruct OWNER personnel in the fundamentals, operation, troubleshooting and maintenance of the equipment and accessories specified herein.
   4. Instruction courses may be video taped by OWNER at OWNER's expense.

E. Manufacturer's Installation Report:
   1. Prepare manufacturer's installation reports and submit within 30 days after completion of field testing and operation instruction. The reports shall be prepared in accordance with the requirements of Section 1I3, Operation and Maintenance Data, and shall include the following:
      a. Field testing reports.
      b. Description of installation deficiencies not resolved to the OWNER's satisfaction.
      c. Description of problems or potential problems.
      d. Names of OWNER personnel who attended the operations and maintenance instruction courses.
      e. Record copy of materials used for the instruction courses including an outline summary of the course.

3.3 FINAL PURGE OF AIR PIPING

A. After the CONTRACTOR has installed the entire process air system, with the exception of the end caps for each grid and the dome assemblies, the CONTRACTOR shall provide and the supplier shall assist with cleaning (blow-out) of each grid system. Each grid shall be isolated and provided with air at a velocity in excess of 5,000 feet per minute to remove from the piping system all potential clogging material. After this blow-out procedure has been completed and approved by the ENGINEER for a given grid, the end caps shall be installed and the dome installation procedure completed.

+ + END OF SECTION + +

SECTION 11F10

AERATION BLOWERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install three rotary positive displacement blowers, complete and operational with electric motors and appurtenances.
2. Included, but not limited to, are the following components for each unit.
   a. Blower.
   b. Electric Motor.
   c. Accessories.

B. Related Sections:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 9L, Painting.
6. Section 11F7, Process Air Diffusion Equipment.
7. Division 13, Instrumentation and Control.
8. Division 15, Sections on Piping.
9. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have a minimum of 5 years of experience in the production of substantially similar equipment, and shall show evidence of satisfactory operation in at least 5 installations.

B. Shop Testing:
1. Blower Tests:
   a. Each blower shall be given a standard factory slip RPM test at one psig pressure. This slip RPM (uncorrected) shall not exceed 250 RPM.
   b. Each blower shall be checked for mechanical performance, including operation at the specified range, and monitoring of vibrations, lubrication, discharge pressure, temperature, etc.
   c. One blower shall be tested as specified below and in accordance with the applicable requirements of the ASME Power Test Code for Compressors and Exhausters, PTC-9.
   d. A test procedure shall be submitted for approval. As a minimum, it shall include a detailed description of the test procedure, a sketch showing the equipment layout and piping arrangement of the test compressor, a blank log-sheet for data collection, and sample calculations for adjusting the test results to the design conditions as specified in Paragraph 2.1.B.
   e. The blower shall be tested with the job motor.

f. The performance curve and the brake horsepower curve of the blower shall be developed for the test points as specified in Paragraph 2.1.B.
g. Vibration of the unit shall be monitored and recorded during the test. Maximum vibration at the inlet and outlet connections shall not exceed 1.25 mils in the vertical plane under all operating conditions.
h. All gages and other test instruments shall be calibrated within 30 days of the scheduled test date and certified calibration data shall be provided. Flow tube shall conform to PTC-9 requirements.
i. Each blower casing shall be hydrostatically tested at a minimum test pressure of 25 psig.
j. A Registered Professional Engineer, who may be an employee of the manufacturer, shall witness the test and shall sign and seal the test report of each compressor.
k. Each unit shall be guaranteed for satisfactory performance at the specified design conditions.

2. Motor Tests:
   a. Each motor shall be given a routine test at the manufacturer's factory. The test shall consist of: Running Light Current; Locked Rotor Current; Winding Resistance; High Potential; and Bearing Inspection.
   b. Eight copies of certified motor test results and data sheet shall be furnished for approval prior to shipment. The data sheets shall show winding resistances; speed versus torque curve; guaranteed minimum efficiencies at full, 3/4 and 1/2 load; power factors; slip; full load, locked rotor and running light amperes; temperature rises and results of dielectric tests. Data sheets shall be marked to indicate motor application, manufacturer, type, frame size, bearing type, lubrication medium, insulation type, and enclosure type.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Standards of the American Society for Testing and Materials.
2. National Electric Code.
3. Standards of National Electrical Manufacturers Association.
4. Institute of Electrical and Electronics Engineer.
5. American National Standards Institute.
6. ASME Power Test Code for Centrifugal Compressors and Exhausters.
7. AWS D1.1, Structural Welding Code.
8. AISC, Manual of Steel Construction.
9. AGMA Standards.
10. Joint Industrial Council.
11. OSHA.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, specifications and engineering data including: general arrangement, outline drawings, dimensions, materials, size, weight, performance data and curves showing overall efficiency, flow rate, discharge head, brake horsepower, motor horsepower, and speed.

2. Manufacturer's literature of all appurtenances.
3. Assembly, and installation of drawings.
4. Setting drawings, templates, and directions for the installation of anchorages.
5. Shop Drawings for panels and instruments shall be in conformance with Division 13, Instrumentation and Control Equipment.
6. Shop testing procedure and report as specified in Paragraph 1.2.B.1.
7. Certified test results and data of the electric motors as specified in Paragraph 1.2.B.2.
8. Results from the field testing as specified in Article 3.2.
9. Shop Drawings Showing: Fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall comply with JIC Standards.
10. All electronic and electrical equipment shall be furnished with complete and accurate manufacturers' schematic, wiring and electronic diagrams.

B. Operation and Maintenance Manuals: Submit six complete manuals including:
1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 1I3.

C. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site to insure uninterrupted progress of the Work.
1. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete in ample time not to delay that Work.
2. Ship blowers with openings sealed.

B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, and other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Store mechanical equipment in covered storage off the ground and prevent condensation.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. General:
1. The blowers shall be suitable for continuous operation at the specified design criteria below. The brake horsepower required shall not exceed the rated motor horsepower under all specified conditions.
2. The blower, when operating with motor and all appurtenances shall not have a noise level greater than 84 dBA emanating from the blower assembly at a distance of three feet from the blower assembly.

B. The blower shall conform to the following design criteria:

Number of Units	3
Flow Range, SCFM	740
Discharge Pressure, psig	10.5
Barometric Pressure, psia	14.1
Relative Humidity, %	70
Maximum Temperature, °F	120
Minimum Temperature, °F	30
Maximum BHP	56
Blower Inlet Connection, in.	8
Blower Discharge Connection, in.	8
Motor Horsepower	60
Blower Speed, rpm	1,495

2.2 DETAILS OF CONSTRUCTION

A. Manufacturer: Provide equipment of one of the following:
1. Dresser Industries, Roots Division, Model 616RCS.
2. M and D Pneumatics, Inc. Model 5518.
3. Or equal.

B. General:
1. Each blower unit shall be of the horizontal, rotary, positive displacement type. Each blower shall be rugged in construction and of such design that it may be disassembled and all parts inspected without disturbing the inlet or outlet piping. Identical parts shall be interchangeable. Equipment furnished shall be amply proportioned for all stresses that may occur during fabrication.
2. Vibration at the inlet and outlet connections shall not exceed 1.25 mils in the vertical plane under all operating conditions.
3. Rotating assemblies shall be statically and dynamically balanced.

C. Casing:
1. Casing shall be of close-grained gray cast iron suitably ribbed to prevent distortion under the specified service conditions. Casing shall be able to withstand a minimum of 25 psig at 350 F.
2. Inlet and outlet connections shall be flanged with drilling to conform to ANSI B16.1, Class 125.
3. Casing shall be provided with lifting lugs.

D. Impeller and Shaft:
1. Impeller and shaft shall be made from a common ductile iron casting. Impeller shall be of the straight, two lobe involute type and shall operate with rubbing or liquid seals or lubrication and shall be positively timed by a pair of accurately machined heat-treated alloy steel, spur tooth, timing gears. Timing gears shall be mounted on the impeller shafts on a tapered fit and properly secured.

E. Bearings:
1. Each impeller/shaft shall be supported by cylindrical roller bearings sized for a minimum of 100,000 hours B-10 life.

F. Bearing Seals:
   1. Provide a lip-type shaft seal at each bearing, designed to prevent lubricant from leaking into the air stream. Further provision shall be made to vent the lubrication system to atmosphere to eliminate any possible carry-over of lubricant into the air stream.

G. Lubrication:
   1. the timing gears and the bearings shall be splash oil lubricated from oil slingers mounted on the driving shaft and dipping in oil.

H. Motors:
   1. Each motor shall be heavy duty horizontal, TEFC, squirrel cage induction type and NEMA B design for the required starting torque and operating torque. Each motor shall be rated for continuous operation.
   2. Each motor shall be rated for 460 volts, 3 phase, 60 Hz.
   3. Each motor shall be supplied with Class F insulation suitable for 55 °C ambient temperature and 80 C (Class B) temperature rise at 1.15 service factor.
   4. Each motor shall be designed, constructed and tested in conformity with all requirements of the applicable standards of IEEE, NEMA and ANSI.
   5. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of service, and shall have a minimum B-10 life of 100,000 hours.
   6. Each motor shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, Hp, full load current, RPM, centigrade degree rise, manufacturer's name and serial number model, voltage, locked rotor KVA code, bearing numbers and a connection diagram.
   7. Motor terminal boxes shall be oversized to provide adequate space for connections and shall be constructed of cast iron or fabricated steel, neoprene gasketed and bolted. The motor leads shall be permanently marked in agreement with the connection diagram.
   8. Efficiencies shall be determined in accordance with NEMA Standard MG1-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MG1-12.53b.
   9. Product and Manufacturer: Motors shall be high efficiency design as manufactured by:
      a. Reliance Electric, Type XE.
      b. General Electric Energy Saver.
      c. Or equal.

I. Common Steel Base:
   1. Factory mount blower and motor, V-belt driven, on a common steel base, properly braced to form a rigid support for the entire unit. The units shall be factory aligned on the base prior to shipment.
   2. Furnish solid neoprene anti-vibration pads or strips, elastomer type, for use when mounting the common base on the concrete support pad.
      a. Manufacturer:
         1. Korfund Dynamics Corporation, Type "Elasto-Grap".
         2. Or equal.
   3. The V-belts shall be provided with OSHA approved guard of steel with minimum 14 gage plate thickness. Each guard shall be provided with a hinged inspection door.

J. Accessories: Furnish the following accessories for each blower:
   1. Suitable reinforced flexible connectors for both inlet and outlet piping. Flexible connectors shall be rated for a minimum pressure of 25 psi and for 250 F air temperature. Flanges shall conform to ANSI B16.1, Class 125.
   2. Silencers:
      a. Silencers shall be furnished and installed on each blower inlet and outlet as shown on the Drawings. External dimensions shall be consistent with those shown on the Drawings. The silencers shall be provided with ANSI 125-pound flanges on each end. The silencers shall have minimum attenuation characteristics equal to or greater than the following:

Frequency Band (CPS)	Attenuation (DB)
63	19
125	26
250	30
500	31
1000	30
2000	26
4000	22
8000	17

      b. Product and Manufacturer: Silencers shall be as manufactured by:
         1) Universal, Type UR (inlet), Type RD (outlet).
         2) Burgess Manning, Incorporated, Type BMSS (inlet), Type BMSS (outlet).
         3) Or equal.
   3. Vibration Switches:
      a. Vibration switches shall continuously monitor the vibration of the casing of each operating blower.
      b. Type:
         1) Accelerometer type.
      c. Required Features:
         1) Power: Operates on 120V AC, 60 Hz.
         2) DPDT switches 10 amps, 120V AC.
      d. Manufacturer:
         1) Robert Shaw.
         2) Or equal.
   4. Thermometers: Inlet and outlet thermometers shall be dial type industrial quality, having a hermetically sealed climate proof case, 3-inch glass cover, stainless steel stem, 1/2-inch male threaded bottom connection, and external reset adjustment.
   5. Air Filters: Each blower shall be equipped with a dry type air intake filter as shown on the Contract Drawings and as specified herein. The outlet connection shall have a 125 pound ANSI flange. Each filter shall be designed so that the face velocity does not exceed 300 fpm. The filtering medium shall be rated, as a minimum, 90 percent efficient on 10 micron particles and larger. Headloss through housing and filter when clean shall not exceed 1.5 inches of water at design air flowrate. Each filter shall have a capacity of not less than 120 percent of design volume. The filter enclosure shall be constructed of minimum 12 gage reinforced metal, painted as specified under Section 9L. Two additional spare filter elements shall be furnished for each air intake filter.

1. Product and Manufacturer: Filters shall be as manufactured by :
   a. Burgess Manning, Type BD.
   b. Universal
   c. Or equal.
6. Anchor Bolts: Anchor bolts, nuts, and washers shall be of Type 304 stainless steel, and shall be sized and installed in accordance with the recommendations of the blower manufacturer.

2.3 SPARE PARTS

A. Furnish and deliver the following spare parts carefully boxed or packaged and plainly marked for reordering:
   1. One set of bearings and seals for one blower and motor.
   2. One set of gaskets for one blower and motor.

B. CONTRACTOR shall store and safeguard spare parts until completion of the Work, at which time they shall be inventoried, delivered and placed in an area designated by OWNER.

C. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of one year. The list shall describe each part, the quantity recommended, and the unit price of the part. OWNER will purchase all, some, or none of the recommended spare parts at his option.

2.4 SURFACE PREPARATION AND SHOP PAINTING

A. Clean and prime coat ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 9L.

B. Coat machined, polished, and non-ferrous metal surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

C. Field painting is under Section 9L.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install blower equipment in complete accordance with the manufacturer's instructions and approved Shop Drawings.

B. Furnish and install all required oil and grease for initial operation.

C. All piping and accessories shall be adequately supported in accordance with the requirements of Section 15.

3.2 FIELD TESTS

A. After CONTRACTOR and ENGINEER have mutually agreed that the equipment installation is complete and ready for continuous operation, CONTRACTOR and a qualified field service representative of the manufacturer shall conduct a running test and a sound test of the blowers and controls in

the presence of ENGINEER to demonstrate that each blower and its controls will function correctly, and the sound levels do not exceed maximum limits.

1. Running Tests:
   a. All blower units together with their controls shall be field tested. Tests shall demonstrate to ENGINEER that each part and all parts together function in the manner intented. All necessary testing equipment and manpower shall be provided by CONTRACTOR at his expense. OWNER will furnish all power, and incidental material and labor required for the tests.
   b. In the event that the manufacturer is unable to demonstrate to ENGINEER that his equipment meets the requirements of the above described test, the deficient equipment will be rejected and CONTRACTOR shall adjust and/or modify and retest the equipment as often as necessary to meet the specified requirements. No separate payments will be made for adjustments and/or modifications.
2. Sound Tests:
   a. Perform an overall sound-pressure level test on one blower. Test results shall be rated in decibels in accordance with ANSI Standard S5.1.
   b. Take the overall sound pressure level at points evenly spaced around the blower and motor assembly and at three feet from the nearest part of the unit. Sound level shall not exceed 84 decibels at three feet distance measured on the A-weighted scale.
   c. It is the intent of this Specification that the complete unit as finally installed shall not exceed 84 dBA. Manufacturer shall submit a statement as to the unit's conformance with the Specification, whether remedial measures will be required, and if so, what remedial measures he proposes.
   d. CONTRACTOR shall provide all instruments, necessary labor, tools, and materials to conduct the field tests.

3.3 MANUFACTURER'S SERVICES

A. Furnish the services of a qualified factory-trained serviceman to assist in the installation of the equipment, check the installation before it is placed into operation, assist in the performance of field tests, supervise initial operations, and instruct plant operators in the care, operation, and maintenance of the equipment.

B. Serviceman shall not make less than two visits to the site. The first visit shall be for a period of not less than one 8-hour day to assist in the installation of the equipment. The second visit shall be for a period of not less than one 8-hour day to perform the field tests, supervise initial operations, and to instruct the operators in the proper care, operation, and maintenance of the equipment.

C. Serviceman shall verify the lubrication systems are complete, clean and filled with the proper grade of lubricants.

+ + END OF SECTION + +

SECTION 11F11

CHANNEL AERATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install one rotary positive displacement blower, complete and operational with electric motor and appurtenances.
2. Included, but not limited to, are the following components for each unit.
   a. Blower.
   b. Electric Motor.
   c. Accessories.

B. Related Sections:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 9L, Painting.
6. Section 11F7, Process Air Diffusion Equipment.
7. Division 13, Instrumentation and Control.
8. Division 15, Sections on Piping.
9. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have a minimum of 5 years of experience in the production of substantially similar equipment, and shall show evidence of satisfactory operation in at least 5 installations.

B. Shop Testing:
1. Blower Tests:
   a. Blower shall be given a standard factory slip RPM test at one psig pressure. This slip RPM (uncorrected) shall not exceed 250 RPM.
   b. Each blower shall be checked for mechanical performance, including operation at the specified range, and monitoring of vibrations, lubrication, discharge pressure, temperature, etc.
   c. One blower shall be tested as specified below and in accordance with the applicable requirements of the ASME Power Test Code for Compressors and Exhausters, PTC-9.
   d. A test procedure shall be submitted for approval. As a minimum, it shall include a detailed description of the test procedure, a sketch showing the equipment layout and piping arrangement of the test compressor, a blank log-sheet for data collection, and sample calculations for adjusting the test results to the design conditions as specified in Paragraph 2.1.B.
   e. The blower shall be tested with the job motor.

f. The performance curve and the brake horsepower curve of the blower shall be developed for the test points as specified in Paragraph 2.1.B.
g. Vibration of the unit shall be monitored and recorded during the test. Maximum vibration at the inlet and outlet connections shall not exceed 1.25 mils in the vertical plane under all operating conditions.
h. All gages and other test instruments shall be calibrated within 30 days of the scheduled test date and certified calibration data shall be provided. Flow tube shall conform to PTC-9 requirements.
i. Each blower casing shall be hydrostatically tested at a minimum test pressure of 25 psig.
j. A Registered Professional Engineer, who may be an employee of the manufacturer, shall witness the test and shall sign and seal the test report of each compressor.
k. Each unit shall be guaranteed for satisfactory performance at the specified design conditions.

2. Motor Tests:
   a. Each motor shall be given a routine test at the manufacturer's factory. The test shall consist of: Running Light Current; Locked Rotor Current; Winding Resistance; High Potential; and Bearing Inspection.
   b. Eight copies of certified motor test results and data sheet shall be furnished for approval prior to shipment. The data sheets shall show winding resistances; speed versus torque curve; guaranteed minimum efficiencies at full, 3/4 and 1/2 load; power factors; slip; full load, locked rotor and running light amperes; temperature rises and results of dielectric tests. Data sheets shall be marked to indicate motor application, manufacturer, type, frame size, bearing type, lubrication medium, insulation type, and enclosure type.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Standards of the American Society for Testing and Materials.
   2. National Electric Code.
   3. Standards of National Electrical Manufacturers Association.
   4. Institute of Electrical and Electronics Engineer.
   5. American National Standards Institute.
   6. ASME Power Test Code for Centrifugal Compressors and Exhausters.
   7. AWS D1.1, Structural Welding Code.
   8. AISC, Manual of Steel Construction.
   9. AGMA Standards.
   10. Joint Industrial Council.
   11. OSHA.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, specifications and engineering data including: general arrangement, outline drawings, dimensions, materials, size, weight, performance data and curves showing overall efficiency, flow rate, discharge head, brake horsepower, motor horsepower, and speed.

2. Manufacturer's literature of all appurtenances.
3. Assembly, and installation of drawings.
4. Setting drawings, templates, and directions for the installation of anchorages.
5. Shop Drawings for panels and instruments shall be in conformance with Division 13, Instrumentation and Control Equipment.
6. Shop testing procedure and report as specified in Paragraph 1.2.B.1.
7. Certified test results and data of the electric motors as specified in Paragraph 1.2.B.2.
8. Results from the field testing as specified in Article 3.2.
9. Shop Drawings Showing: Fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall comply with JIC Standards.
10. All electronic and electrical equipment shall be furnished with complete and accurate manufacturers' schematic, wiring and electronic diagrams.

B. Operation and Maintenance Manuals: Submit six complete manuals including:
1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 1I3.

C. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site to insure uninterrupted progress of the Work.
1. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete in ample time not to delay that Work.
2. Ship blowers with openings sealed.

B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, and other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Store mechanical equipment in covered storage off the ground and prevent condensation.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. General:
1. The blower shall be suitable for continuous operation at the specified design criteria below. The brake horsepower required shall not exceed the rated motor horsepower under all specified conditions.
2. The blower, when operating with motor and all appurtenances shall not have a noise level greater than 84 dBA emanating from the blower assembly at a distance of three feet from the blower assembly.

B. The blower shall conform to the following design criteria:

Number of Units	1
Flow Range, SCFM	30
Discharge Pressure, psig	3.0
Barometric Pressure, psia	14.1
Relative Humidity, %	70
Maximum Temperature, °F	120
Minimum Temperature, °F	30
Blower Inlet Connection, in.	
Blower Discharge Connection, in.	
Motor Horsepower	1.5
Maximum Blower Speed, rpm	1,495
Minimum Blower Speed, rpm	

2.2 DETAILS OF CONSTRUCTION

A. Manufacturer: Provide equipment of one of the following:
   1. Dresser Industries, Roots Division, Universal RAI, Model 22.
   2. Or equal.

B. General:
   1. Blower unit shall be of the horizontal, rotary, positive displacement type. Blower shall be rugged in construction and of such design that it may be disassembled and all parts inspected without disturbing the inlet or outlet piping. Identical parts shall be interchangeable. Equipment furnished shall be amply proportioned for all stresses that may occur during fabrication.
   2. Vibration at the inlet and outlet connections shall not exceed 1.25 mils in the vertical plane under all operating conditions.
   3. Rotating assemblies shall be statically and dynamically balanced.

C. Casing:
   1. Casing shall be of close-grained gray cast iron suitably ribbed to prevent distortion under the specified service conditions. Casing shall be able to withstand a minimum of 25 psig at 350 F.
   2. Inlet and outlet connections shall be flanged with drilling to conform to ANSI B16.1, Class 125.
   3. Casing shall be provided with lifting lugs.

D. Impeller and Shaft:
   1. Impeller shall be made from a common cast iron casting. Shaft shall be forged steel. Impeller shall be of the straight, two lobe involute type and shall operate without rubbing or liquid seals or lubrication and shall be positively timed by a pair of accurately machined heat-treated alloy steel, spur tooth, timing gears. Timing gears shall be mounted on the impeller shafts on a tapered fit and properly secured.

E. Bearings:
   1. Each impeller/shaft shall be supported by cylindrical roller bearings sized for a minimum of 100,000 hours B-10 life.

F. Lubrication:
   1. the timing gears and the bearings shall be splash oil lubricated from oil slingers mounted on the driving shaft and dipping in oil.

G. Motor:
   1. Motor shall be heavy duty horizontal, TEFC, squirrel cage induction type and NEMA B design for the required starting torque and operating torque. Each motor shall be rated for continuous operation.
   2. Motor shall be rated for 460 volts, 3 phase, 60 Hz.
   3. Motor shall be supplied with Class F insulation suitable for 55 °C ambient temperature and 80 C (Class B) temperature rise at 1.15 service factor.
   4. Motor shall be designed, constructed and tested in conformity with all requirements of the applicable standards of IEEE, NEMA and ANSI.
   5. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of service, and shall have a minimum B-10 life of 100,000 hours.
   6. Motor shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, Hp, full load current, RPM, centigrade degree rise, manufacturer's name and serial number model, voltage, locked rotor KVA code, bearing numbers and a connection diagram.
   7. Motor terminal boxes shall be oversized to provide adequate space for connections and shall be constructed of cast iron or fabricated steel, neoprene gasketed and bolted. The motor leads shall be permanently marked in agreement with the connection diagram.
   8. Efficiencies shall be determined in accordance with NEMA Standard MG1-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MG1-12.53b.
   9. Product and Manufacturer: Motors shall be high efficiency design as manufactured by:
      a. Reliance Electric, Type XE.
      b. General Electric Energy Saver.
      c. Or equal.

H. Common Steel Base:
   1. Factory mount blower and motor, V-belt driven, on a common steel base, properly braced to form a rigid support for the entire unit. The units shall be factory aligned on the base prior to shipment.
   2. Furnish solid neoprene anti-vibration pads or strips, elastomer type, for use when mounting the common base on the concrete support pad.
      a. Manufacturer:
         1. Korfund Dynamics Corporation, Type "Elasto-Grap".
         2. Or equal.
   3. The V-belts shall be provided with OSHA approved guard of steel with minimum 14 gage plate thickness. Each guard shall be provided with a hinged inspection door.

I. Accessories: Furnish the following accessories for each blower:
   1. Suitable reinforced flexible connectors for both inlet and outlet piping. Flexible connectors shall be rated for a minimum pressure of 25 psi and for 250 F air temperature. Flanges shall conform to ANSI B16.1, Class 125.

2. Silencers:
   a. Silencers shall be furnished and installed on each blower inlet and outlet.
   b. Product and Manufacturer: Silencers shall be as manufactured by:
      1) Universal.
      2) Burgess Manning, Incorporated.
      3) Or equal.
3. Thermometer: Outlet thermometer shall be dial type industrial quality, having a hermetically sealed climate proof case, 3-inch glass cover, stainless steel stem, 1/2-inch male threaded bottom connection, and external reset adjustment.
4. Air Filter: Blower shall be equipped with a dry type air intake filter as specified herein. The outlet connection shall have a 125 pound ANSI flange. Each filter shall be designed so that the face velocity does not exceed 300 fpm. The filtering medium shall be rated, as a minimum, 90 percent efficient on 10 micron particles and larger. Headloss through housing and filter when clean shall not exceed 1.5 inches of water at design air flowrate. Each filter shall have a capacity of not less than 120 percent of design volume. The filter enclosure shall be constructed of minimum 12 gage reinforced metal, painted as specified under Section 9L. Two additional spare filter elements shall be furnished for air intake filter.
   1. Product and Manufacturer: Filters shall be as manufactured by :
      a. Burgess Manning, Type BD.
      b. Universal
      c. Or equal.
5. Anchor Bolts: Anchor bolts, nuts, and washers shall be of Type 304 stainless steel, and shall be sized and installed in accordance with the recommendations of the blower manufacturer.

2.3 SPARE PARTS

A. Furnish and deliver the following spare parts carefully boxed or packaged and plainly marked for reordering:
   1. One set of bearings and seals for one blower and motor.
   2. One set of gaskets for one blower and motor.

B. CONTRACTOR shall store and safeguard spare parts until completion of the Work, at which time they shall be inventoried, delivered and placed in an area designated by OWNER.

C. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of one year. The list shall describe each part, the quantity recommended, and the unit price of the part. OWNER will purchase all, some, or none of the recommended spare parts at his option.

2.4 SURFACE PREPARATION AND SHOP PAINTING

A. Clean and prime coat ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 9L.

B. Coat machined, polished, and non-ferrous metal surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

C. Field painting is under Section 9L.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install blower equipment in complete accordance with the manufacturer's instructions and approved Shop Drawings.

B. Furnish and install all required oil and grease for initial operation.

C. All piping and accessories shall be adequately supported in accordance with the requirements of Section 15.

3.2 FIELD TESTS

A. After CONTRACTOR and ENGINEER have mutually agreed that the equipment installation is complete and ready for continuous operation, CONTRACTOR shall conduct a running test of the blower in the presence of ENGINEER to demonstrate that blower will function correctly.

3.3 MANUFACTURER'S SERVICES

A. Furnish the services of a qualified factory-trained serviceman to assist in the installation of the equipment, check the installation before it is placed into operation, assist in the performance of field tests, supervise initial operations, and instruct plant operators in the care, operation, and maintenance of the equipment.

+ + END OF SECTION + +

SECTION 11L1

CHLORINATION EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide a complete chlorination system as shown, specified and required.

B. General:
   1. Drawings show functional features and required external connections. They do not show all components required to accomplish the desired results or all components required to interface equipment. All parts, equipment and devices necessary to meet the functional requirements shall be provided.
   2. Drawings show a general arrangement of chlorination equipment, connected piping and valves. Drawings are not intended to show exact dimensions peculiar to any specific chlorination equipment. Dimensions of the equipment bases and connected piping shown, may have to be changed in order to accommodate the chlorination equipment furnished.

C. Limitations: All instrumentation and controls, control cabinets and the like, unless otherwise included herein shall be furnished under Section 13A.

D. Related Work Specified Elsewhere:
   1. Division 3, Concrete.
   2. Section 3I, Grout.
   3. Section 5G, Anchor Bolts, Expansion Anchors and Concrete Anchors.
   4. Section 13A, Instrumentation and Control.
   5. Division 15 Sections on Piping, Valves and Accessories.
   6. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Equipment shall be the standard product in regular production by manufacturers of chlorination equipment and shall essentially duplicate equipment that has been in satisfactory operation at five installations for a period of at least five years.
   2. All chlorination equipment shall be furnished by a single manufacturer who shall be responsible for proper operation and interfacing of the equipment.

B. Source Quality Control:
   1. All equipment shall be shop tested prior to shipment.

C. Reference Standards:
   1. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
      a. Standards of National Electrical Manufacturers Association.
      b. Recommendations of the Chlorine Institute, Inc.
      c. Occupational Safety and Health Act.
      d. Joint Industrial Council.
      e. Instrument Society of America.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer's literature, illustrations, specifications and engineering data including:
      a. Dimensions.
      b. Capacity.
      c. Weight.
      d. Materials.
      e. Injector capacity including water flow and pressure requirements.
   2. Drawings showing fabrication, assembly, installation piping and JIC Standard electrical diagrams.
   3. Bill of materials and detailed description of operation.
   4. All electronic and electrical equipment shall be furnished with complete and accurate manufacturer's schematic, wiring and electronic diagrams.

B. Certificates: Certification that equipment has been tested to operate as specified. Equipment shall not be shipped until the ENGINEER has approved the test reports.

C. Documentation that the manufacturer has produced, supplied and placed into satisfactory service, equipment similar to that specified herein. Criteria shall be a minimum of five installations in service for a minimum of five years.

D. Operation and Maintenance Manual: Submit complete operation and maintenance manuals for all equipment, including copies of all approved Shop Drawings.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Inspect equipment delivered to the job site for damage. If the equipment is damaged, notify the ENGINEER.

B. If the ENGINEER determines that damaged equipment can be repaired at the site, all repairs shall be made by the manufacturer or in accordance with the manufacturer's instructions and under his supervision. Repairs made shall be subject to the approval of the ENGINEER.

C. Damaged equipment rejected by the ENGINEER shall be removed from the site.

D. Comply with the manufacturer's recommendations in handling and storing equipment. Store all equipment to permit easy access for inspection and identification.

PART 2 - PRODUCTS

2.1 CHLORINATION SYSTEM

A. General: The chlorine feed equipment shall be of the vacuum operated solution feed type. The chlorinator for the RAS pumps shall have a capacity of 100 PPD with manual feedrate control. The chlorinator for the filter shall have a capacity of 50 PPD with manual feedrate control. The chlorinator for the chlorine contact tank shall have a capacity of 100 PPD with flow proportioning control. The chlorinator for the effluent pumps shall have a capacity of 100 PPD with compound loop control. The chlorinator for the influent sewer shall have a capacity of 50 PPD with manual feedrate control. The chlorinator for odor control shall have a capacity of 500 PPD with ORP control.

B. The chlorination system shall contain the following major components:
1. 2 - 500 PPD direct ton container mounted vacuum regulators.
2. 1 - 500 PPD wall mounted automatic switchover module.
3. 4 - 100 PPD wall mounted remote gas flowmeters.
4. 1 - 500 PPD wall mounted remote gas flowmeter.
5. 1 - 50 PPD wall mounted remote gas flowmeter.
6. 1 - 100 PPD wall mounted automatic gas control valve.
7. 1 - 500 PPD wall mounted odor control gas feeder.
8. 1 - 100 PPD wall mounted compound loop chlorine gas feeder.
9. 4 - 100 PPD ejector assemblies.
10. 1 - 52 PPD ejector.
11. 1 - 500 PPD ejector.
12. 1 - Chlorine scale for 2 ton container.
13. 1 - Chlorine gas leak detector.
14. 1 - Chlorine residual analyzer, wall mounted.

2.2 TON CONTAINER MOUNTED VACUUM REGULATORS

A. General: The remote vacuum regulators shall mount directly on the ton containers by means of a positive yoke type gasket connection.

B. Number furnished: 2.

C. Each vacuum regulator shall contain a 0-500 PPD indicating gas flowmeter, visual loss of chlorine gas indicator, silver gas filter, monel drip leg and 25 watt heater for 120 VAC operation.

D. Capacity: 0-500 pounds per day.

E. Electrical requirements: 120 VAC, single phase, 60 Hz.

F. Vacuum regulator valves specified herein shall reduce full gas supply pressure to a vacuum pressure for all units. Units shall be designed to close automatically should the operating ejector vacuum fail. Each unit shall be equipped with a manual gas shutoff.

G. Manufacturer:
1. Capital Controls Model 203C5
2. Or equal.

2.3 AUTOMATIC SWITCHOVER MODULE

A. General: The automatic switchover module shall be vacuum operated, switching from an empty gas source to a full source. Switchover module shall be wall mounted and not require any manual resets or field adjustments.

B. Manufacturer:
   1. Capital Controls Model AS100C.
   2. Or equal.

2.4 REMOTE METER PANELS

A. Type: Each meter panel shall consist of an indicating chlorine gas flowmeter and solid silver rate valve and sleeve assembly all mounted on a chemical resistant panel for wall mounting. Each meter panel shall indicate the chlorine gas flow to 1/20 of the maximum capacity of the meter panel with an accuracy of ± 4%.

B. Number required:
   1. One 0 - 50 PPD panel.
   2. Four 0 - 100 PPD panels.
   3. One 0 - 500 PPD panel.

C. Manufacturer:
   1. Capital Controls Model RM 100C.
   2. Or equal.

2.5 AUTOMATIC CHLORINE GAS CONTROL VALVE

A. Type: The automatic gas control valve shall be an electromechanical servo type design to automatically control the chlorine gas feed rate. The gas flow shall be totally linear from the fully opened to the fully closed position.

B. Feed range: The manual dosage adjustment shall provide for gas flow rates to be 20% of maximum feed rate (minimum dosage) with a 100% input signal to 100% of the valve capacity (maximum dosage) with a 50% input signal.

C. Mounting of Units: Wall.

D. Features:
   1. A manual/auto switch and a manual rate adjustment knob shall be provided for manually increasing or decreasing the valve position in the event of a power loss, loss of input signal or manual override.
   2. A self contained, LED bar graph indicator shall display 0-100% of valve capacity and valve position.
   3. An alarm contact shall be provided to indicate a fully closed valve condition.

E. Capacity: 0 - 100 PPD.

F. Electrical Requirements: 120 VAC, single phase, 60 Hz.

G. Manufacturer:
   1. Capital Controls Model 1410C.
   2. Or equal.

2.6 COMPOUND LOOP CHLORINATOR

A. General: The fiberglass cabinet shall contain the compound loop electronic controller, automatic gas control valve, indicating gas flowmeter, manual bypass valve and manual rate valve. The fiberglass cabinet shall have a hinged front cover to provide easy access to all internal components. The base of the cabinet shall contain connections for vacuum inlet and outlet and vent.

B. Mounting: Wall.

C. Capacity: 0 - 100 PPD.

D. Electrical Requirements: 120 VAC, single phase, 60 Hz.

E. Control: The cabinet controller shall automatically process 4-20 mADC flow and 4-20 mADC chlorine residual input signals and position the automatic valve accordingly. The controller shall have selectable internal switches for either flow proportioning, residual or compound loop operation. The controller shall be factory pre-wired to the automatic valve. The controller shall have test switches to simulate a flow or residual signal for monitoring the controller and valve action. The controller shall also have DPDT alarm contacts for high or low residual deviation and no flow condition based on flow signal or valve condition. The controller shall also have an automatic/manual operation switch and a switch to manually open or close the automatic valve. Indicating lights on the controller face plate shall indicate power on, automatic valve direction when changing position, high or low deviation and no flow condition. The controller shall contain a terminal strip for all field electrical connections.

F. Manufacturer:
   1. Capital Controls Model 4131C.
   2. Or equal.

2.7 ODOR CONTROL CHLORINATOR

A. General: The fiberglass cabinet shall contain electronic controller, automatic gas control valve, indicating gas flowmeter, manual bypass valve and manual rate valve. The fiberglass cabinet shall have a hinged front cover to provide easy access to all internal components. The base of the cabinet shall contain connections for vacuum inlet and outlet and vent.

B. Mounting: Wall.

C. Capacity: 0 - 500 PPD.

D. Electrical Requirements: 120 VAC, single phase, 60 Hz.

E. Control: The cabinet controller shall automatically process a 4-20 mADC ORP input signal and position the automatic valve accordingly. The controller shall be factory pre-wired to the automatic valve. The

controller shall have a test switch to simulate an ORP signal for monitoring the controller and valve action.
The controller shall also have DPDT alarm contact for no flow condition based on ORP signal or valve condition. The controller shall also have an automatic/manual operation switch and a switch to manually open or close the automatic valve. Indicating lights on the controller face plate shall indicate power on, automatic valve direction when changing position, high or low deviation and no flow condition. The controller shall contain a terminal strip for all field electrical connections.

F. Manufacturer:
   1. Capital Controls Model 4123C.
   2. Or equal.

2.8 CHLORINE EJECTORS

A. Type: The ejectors shall be of the fixed throat type and be equipped with an internal check valve.

B. Number required:
   1. One 0 - 50 PPD ejector.
   2. Four 0 - 100 PPD ejectors.
   3. One 0 - 500 PPD ejector.

C. Mounting: Wall type with mounting brackets.

D. Connections:
   1. 0 - 50 PPD, 3/4".
   2. 0 - 100 PPD, 3/4".
   3. 0 - 500 PPD, 1¼".

E. Design Requirements:

Area	Injector Back Pressure (psi)	Capacity PPD (psi)	Water Supply Pressure (psi)	Water Supply flow (gpm)
Chlorine Contact Tank	10	0 - 100	40	5.8
Filter	5	0 - 100	40	4.4
Return Act. Sludge Pumps	15	0 - 100	50	6.7
Odor Control	5	0 - 300	45	21
Influent	5	0 -50	25	3
Effluent Pumps	110	0 - 100	167	12

F. Manufacturer:
   1. Capital Controls EJ100C and EJ 500C.
   2. Or equal.

2.9 CHLORINE WEIGHING SCALE

A. Features:
   1. Units Required:
      a. One 2 container chlorine scale.
   2. Type: Hydraulic load-cell type.
   3. Scale frame shall be epoxy finished and sized to accept the number Of 3,600 pound chlorine containers specified above.
   4. Scale shall be furnished with the required number of heavy duty bushed roller bearing trunnions installed for each container to permit container rotation. Roller trunnions shall conform to the units specified hereinafter under Article 2.11.
   5. Chlorine weighing scale shall be of such a size that it is within the dimensions of the containers it supports.
   6. Hydraulic cell shall be of the temperature stable, rolling diaphragm type. Load plate shall be able to tilt to four degrees without affecting accuracy.
   7. Flexible hose shall lead from the cell to allow easy remote installation of the weight indicator and shall be a minimum of 25 feet in length.
   8. The weight indicator shall have a 360 degree dial not less than 12 inches in diameter with maximum capacity of 8,000 pounds for the 2 container scale. Dial shall have provisions for tare adjustment.
   9. Dial shall be temperature stable and equipped with a damper to prevent shock damage. Accuracy of dial shall be better than 1/2 of 1 percent.
   10. Weight indicator shall be furnished with an adjustable low weight dry contact switch, SPDT, minimum 5 ampre, 115 VAC capacity for remote alarm actuation.

B. Manufacturer:
   1. Force Flow Equipment, Chlor-Scale, Series 12D160 and 12D200.
   2. Or equal.

2.10 CHLORINE GAS LEAK DETECTOR

A. Number of Units: 1.

B. General:
   1. Type: Surface mounted on 1/2 inch thick panel, amperometric type with self-cleaning sensor continuously wetted in electrolyte solution and in constant contact with blower-driven sample air. Detector shall operate from remote locations using blower to receive drawn samples.
   2. Sensitivity: 1 and 3 ppm chlorine gas (by volume).
   3. Detector shall have indicating lights, a reset button and three dry contacts each rated at minimum of 5 amperes at 120 VAC for external alarms. Unit shall automatically reset after a power failure.
   4. Electrical Requirements: 120 VAC, 60 Hz, single phase.
   5. Accessories: 4 feet of drain tubing; sample inlet PVC pipe; 2 years' supply of electrolyte; felt wicking for electrode holder; orifice cleaning materials; spare fuses and orifices; two 4-ounce packages of activated carbon for recharging air filter; wall mounting accessories; and chlorine gas generating test kit.

C. Manufacturer:
   1. Fisher Porter, Chloralert Model 17CA1010-120V.
   2. Or equal.

2.11 CHLORINE RESIDUAL ANALYZER

A. General: The chlorine analyzer shall be of the amperometric type. The unit shall be equipped with a three digit LCD display housed in a NEMA 4X enclosure. The residual analyzer shall incorporate an electrode self cleaning system and reagent feed system not requiring any chemical feed pumps. Reagents shall be gravity fed from a storage bottle mounted on the analyzer. Storage bottle shall contain sufficient reagent for 7 days of operation. Separate high and low set point alarm contacts with indicating lights shall be adjustable from 0 - 100% of the range selected. Provide extra dry contacts for high and low chlorine residual.

B. Range: Selectable range of 0 - 5 PPM.

C. Mounting: wall type.

D. Electrical Requirements: 120 VAC, single phase, 60 Hz.

E. Accuracy: 2% of range selected.

F. Response Time: 4 seconds.

G. Standard Accessories: One year supply of premixed buffer solution.

H. Number Required: Two.

I. Manufacturer:
   1. Capital Controls Model 1870C.
   2. Or equal.

2.12 MISCELLANEOUS ACCESSORIES

A. General: The following miscellaneous accessories shall be furnished:
   1. One chlorine container lifting bar suitable to lift one ton container. Lifting bar shall be constructed of steel channels positioned back to back with a spacing to allow for hooks and grab bars. Lifting bar shall be capable of lifting safely a load of 4,000 pounds. Grab bars shall be constructed from either 3/4 inch or one inch thick steel plate. Lifting bar shall receive a corrosion-resistant finish and shall be as manufactured by Chlorine Specialties, Inc., Model C-262, Chlor-O-Quip, Division of Filtronics, Inc., Model 273, Capital Controls Model BM-992, or equal.
   2. Two pairs of chlorine ton container trunnions. Each chlorine cylinder trunnion shall be constructed from either an aluminum alloy or gray cast iron casting with cadmium plated steel rollers with bronze bushings. Rollers shall be equipped with high strength shafts fitted with an alemite grease fitting for lubrication. Chlorine ton container trunnions shall be Chlorine Specialties, Inc., Model C-256, Chlor-O-Quip, Model 272, or equal.
   3. One emergency repair kit for making repairs to tone containers. The kit shall be Emergency Repair Kit "B" as recommended by the Chlorine Institute, Inc., Equipment shall be furnished in a steel box. Kit shall be as supplied by Chlorine Specialties, Inc.
   4. One gallon bottle of aqueous ammonia (18° Baume minimum) for chlorine leak testing.

2.13 GAS MASKS

A. Each gas mask shall be a self-contained breathing unit which shall provide complete respiratory protection in any area of oxygen deficiency or concentration of toxic gases. Each unit shall provide a positive pressure within the facepiece so as to prevent possible inward leaks of chlorine gas. Each unit shall be NIOSH certified.

B. Each unit shall include an air cylinder large enough for a30-minute air supply, chest or belt mounted pressure demand regulator, harness, full vision faceplate, and an automatic alarm to signal diminishing air supply.

C. Each unit shall be furnished with a lockable steel or fiberglass wall case and one spare 30-minute air supply air cylinder similar to that specified above. Wall cases shall be as suitable for indoor use and shall be suitable to house a gas mask and a spare air cylinder.

D. Manufacturer:
   1. Scott Pressure-Pak IIa.
   2. Mine Safety Appliance (MSA).
   3. Or equal.

2.14 CHLORINE SOLUTION DIFFUSERS

A. Type: Threaded P.V.C. type channel diffuser with bracket.
   1. Unit shall be furnished with multiple orifices and any adapters necessary for connection to solution piping.
   2. Manufacturer: Capital Controls.
   3. Feed Point: Chlorine Contact basin, Filters and Influent Sewer, Odor Control.

B. Type: Stuffing Box.
   1. One 1-inch solution diffuser shall be mounted in the pipe. The diffuser shall be a factory assembly consisting of a stuffing box, clamps, chain, a silver solution tube and a bronze corporation cock.
   2. Installation shall include offsetting elbows, a short length of rubber hose and clamps to permit withdrawal of the tube from the pipe.
   3. Manufacturer: Capital
   4. Location: RAS pump discharge pipe, effluent pump discharge.

2.15 PAINTING

A. All ferrous metal surfaces shall be blast cleaned in accordance with SSPC-SP10 and shop primed and field painting in accordance with the requirements of Section 9L.

B. Items of equipment which could be damaged by blast cleaning, shall be finish painted by the manufacturer with his best grade finish paint system in accordance with Section 9L. Color shall be as approved by the ENGINEER. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of all equipment shall be in complete accordance with the manufacturer's instructions and recommendations and the approved Shop Drawings.

B. Equipment shall be set on concrete bases, secured with anchor bolts and grouted with nonshrink grout conforming to Section 3I.

3.2 START-UP AND TEST

A. All equipment shall be operationally-tested in accordance with the requirements of this Section and Sections 1H3 and 1H4 by the CONTRACTOR at the job site following installation of the equipment, controls, valves and piping. Should the tests indicate any malfunction, the CONTRACTOR shall make all necessary repairs and/or adjustments. Tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent, continuous operation.

3.3 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall provide the services of a qualified, factory-trained representative of the manufacturer to check and approve the installation before it is placed in service, supervise initial operation and testing in the presence of the ENGINEER and instruct the OWNER'S personnel in operation and maintenance of the equipment. A minimum of two, 8-hour days, which may not necessarily be consecutive, shall be provided for these services. In the event of trouble with the equipment, the manufacturer's representative shall revisit the job site as often a necessary until all trouble is corrected and the installation is entirely satisfactory.

+ + END OF SECTION + +

SECTION 11Z2

METAL LABORATORY FURNITURE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all metal laboratory furniture Work. The Work also includes:
      a. Providing openings in metal laboratory furniture Work to accommodate the Work under this and other Sections and building into the metal laboratory furniture Work all items such as sleeves, anchor bolts, inserts and all other items to be built into the metal laboratory furniture Work for which placement is not specifically provided under other Sections.
   2. The extent of metal laboratory furniture is shown and scheduled.
   3. The types of metal laboratory furniture Work required include, but is not necessarily limited to, the following:
      a. Base Cabinets.
      b. Wall Cabinets.
      c. Cabinet Understructure.
      d. Tops.
      e. Sinks.
      f. Fixtures.
      g. Accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate them with the Work of this Section.

C. Related Sections:
   1. Section 4C1, Unit Masonry Construction.
   2. Section 15I1, Potable Water Piping System.
   3. Section 15I2, Waste and Vent Drainage System.
   4. Section 16, Electrical Work.

1.2 QUALITY ASSURANCE

A. Provide metal laboratory furniture, tops, sinks, and service fixtures as required, manufactured or furnished by the same laboratory furniture company for single responsibility.

B. Product and manufacturer: Provide one of the following:
   1. Contempra Series by Fisher Scientific Company.
   2. Or equal.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 366, Steel Carbon, Cold-Rolled Sheet, Commercial Quality.
   2. ASTM Method D 570, Water Absorption of Plastics.

3. ASTM Method D 651, Tensile Strength of Molded Electrical Insulating Materials.
4. ASTM Method D 695, Compressive Properties of Rigid Plastics.
5. ASTM Method D 785, Rockwell Hardness of Plastics and Electrical Insulating Materials.
6. ASTM Method D 790, Flexural Properties of Plastics and Electrical Insulating Materials.
7. NFPA No. 58 Regulations.

D. Catalog Standards: Manufacturer's catalog numbers are shown on Drawings or Fixture Schedule for identifying certain laboratory cabinet or fixture work. Unless modified by notation on the Drawings or otherwise specified, the catalog description for the indicated number constitutes the requirements for each such cabinet or fixture.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Shop Drawings for metal laboratory furniture, accessories, fixtures and equipment showing plans, elevations, ends, cross- sections, service run spaces, location and type of service fixtures with lines thereto. Show details and location of anchorages and fitting to floors, walls, and base. Include layout of units with relation to surrounding walls, doors, windows and other building components.
2. Copies of manufacturer's data and installation instructions for each type of metal laboratory furniture, accessories, fixtures, and equipment.
3. Coordinate Shop Drawings with other work involved.
4. Complete selection of manufacturer's standard, custom and two-tone color selections.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Coordinate delivery of tops, sinks, accessories, fixtures and equipment with laboratory furniture items.

B. Handling of Materials: Protect finished surfaces from soiling and damage during handling and installation. Keep covered with polyethylene film or other protective covering.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Metals: Prime furniture steel, stretcher or roller leveled, free of scales, buckles, or other defects; ASTM A 366, E finish.

B. Minimum Metal Gage: Provide steel laboratory furniture components of the following minimum U.S. Standard gages:
1. 20 Gage: Back panels, inner door panels, drawer outer pan, inner pan and body, and shelves. Add reinforcement of use 18 gage material for shelves over 36-inches long.

2. 18 Gage: Sides, ends, fixed backs, bottoms, tops, soffits, and outer door pans. Bottoms may be 20 gage if reinforced. Other items not otherwise noted.
3. 16 Gage: Intermediate horizontal rails, table frame aprons and cross rails, center posts, top gussets.
4. 14 Gage: Drawer runners, sink supports.
5. 12 Gage: Leveling and corner gussets.

C. Tops, Box Curbs, Splash Rim: Provide smooth, clean, exposed tops and edges, in uniform plane free of defects. Make exposed edges and corners uniformly rounded.

D. Top Sizes: Furnish tops in maximum lengths available.

E. Service Fixtures: Provide units complete with washers, locknuts, unions, nipples and other accessories for positive mounting to supporting laboratory units. Include wall and deck flanges, escutcheons, handle extension rods, remote valves, and similar items required. Fabricate units to withstand test pressure of 100 pounds per square inch.

F. Service Outlet Identification: Provide colored plastic index discs with embossed identification letters at each service fixture handle or knob. Secure discs to fixture handles to be virtually tamperproof. Color-code discs as follows:
1. Hot Water - Red
2. Cold Water - Green

G. Handles: Provide 3 arm or 4 arm forged brass handles for valves, stops, faucets, remote controls, and cocks, except for ground key cocks, steam valves, and micro-adjustable needle cocks.

H. Water Valves or Faucets: Provide units with renewable barrel locked in valve body. Barrel shall contain all wearing parts, with renewable discs.

I. Hand of Fixtures: Furnish right-hand fixtures.

2.2 FABRICATION

A. General:
1. Furnish all metal furniture required in strict accordance with the description and details hereinafter provided. Construction and design shall develop maximum strength and rigidity in each sectional unit.
2. Fabricate each sectional unit, ready for placement in the laboratory furniture and equipment assembly, completely rigid, integral unit in itself so as to permit relocation at any subsequent time.
3. Provide removable door and drawer heads for purposes of decontamination and/or cleaning.
4. Doors and drawers shall be sound deadened and readily removable, with door hinges easily replaceable.
5. All hinges shall be applied to case and door bodies as hereinafter specified. Welding of hinges to either door or case will not be permissible.

6. Where units are joined together in assemblies, they shall be fastened by bolting through side panels with 1/4-20 bolts.
7. All component parts shall be die-formed, insuring uniformity and interchangeability, and shall be assembled in jigs for accurate alignment.
8. All cabinet parts shall not only be electrically welded, but also shall be notched, keyed, and overlapped forming interlocking joint construction. The electro-welding shall comprise of spot- welding, arc-welding and heliarc-welding.
9. Any notching, piercing, bending or framing not specifically called for in the construction specifications and/or on the Drawings will not be permitted.
10. All construction shall insure a smooth, cleanable interior of all units.
11. All die-pierced slots and perforations, required for mounting of case channels, hinges or shelf brackets shall not be visible from the exterior of the assembled cabinet. Screws shall not be used in the construction of the unit proper and shall only be used where backs, pans and panels are required to be removable for accessibility.
12. Standard cabinet units shall be so constructed that they will permit quick and easy change, after installation, from drawers to doors, or vice versa, or a substitution of two half-depth drawers in place of a standard depth drawer without the use of drills or machinery with only the purchase of the necessary parts.
13. All sectional units to be located on the laboratory floor shall be equipped with leveling devices easily adjustable from within the units, to compensate for unevenness in the laboratory floor.

B. Base Units:
1. End uprights shall be formed into not less than a channel construction at front, top, bac, and bottom. Upright shall be keyed to mating horizontal members which shall be electro-welded at all junctures.
2. Bottom front horizontal toe space rail shall be formed to provide a rectangular recessed toe space fully enclosed, having a channel formation at the face and bottom. Toe space shall be integral with cabinet 3-inch deep by 5-inch high and dust-proof.
3. The frame assembly shall consist of upper and lower angular sections welded to left and right angular upright sections forming outer frame. Vertical and horizontal intermediates shall be channel sections. The frame assembly shall be readily removable as a unit for complete and unhindered access to base unit interior. The frame shall have a cushioning neoprene gasket against which all drawers and doors will close to prevent dust gaps, provide sound-deadening, and to seal out spillage from the cabinet. The frame shall be designed so that all drawers and doors are separated by concealed horizontal support rails.
4. Cupboard bottom shall be full depth and width of all cases to prevent dirt from entering the cabinet. Bottom shall be both arc-welded and spot-welded in place to provide rigidity in the base of the unit. Four 7/8-inch diameter holes shall be punched in the cupboard bottom directly over and for access to unit leveling bolts.

5. Backs of all units shall be designed with a top and bottom rail, and the section between the rails shall be left open for simple access to plumbing lines without disassembling entire unit. All units shall be supplied with removable backs (removable without the use of tools) to close this space between the top and bottom rails.
6. Adjustable shelves shall be constructed with double channels at front and rear, formed down on ends. Shelves shall be supported by a shelf support channel which shall rest on adjustable shelf clips.
7. Roll-out shelves shall be provided on all single cupboard units, 18-inch or 24-inch in width to provide safe access to rear of shelves. Shelves shall be constructed with a rolled front edge for use as a strengthener and shelf pull, and allow shelf to be used as a tote tray. All other cupboard units shall have half depth adjustable shelves.
8. Drawer assembly shall consist of a drawer back, drawer body, inner drawer head and outer drawer head. Entire drawer head assembly shall not be less than 3/4-inch thick. Drawer shall operate quietly and smoothly on a nylon roller channel suspension with front ball-bearing rollers set into case channels and rear nylon rollers set into drawer channels. No steel-to-steel contact shall be permitted. The suspension system shall maintain alignment of drawer and be equipped with integral drawer stops to eliminate inadvertent removal of the drawer. Removal of the drawer shall be possible without the use of tools. All drawers shall be assisted in self-closing during approximately the last 3-inch of travel and shall lock in fully open position requiring a slight lifting of the drawer from a level position to actuate the self- closing feature. All drawers shall be sound deadened and shall close against neoprene-coated urethane foam gasketing on the unit frame. All drawer parts shall be phosphate coated and completely painted before final assembly.
9. Door assembly shall consist of an inner and outer door pan. Door assembly shall be 3/4-inch thick. Outer pan shall be punched for attachment of door pull. Inner door pan shall be perforated and embossed for installation of lock. A 14 gage hinge re- inforcement shall be welded to inner pan at hinge locations before pan assembly. All parts of door assembly, which will be concealed after door is assembled, shall be painted completely before assembly of door. Door is so assembled that it may be readily taken apart for decontamination when necessary. Each door shall be provided with a waffle type sound deadener, cut to correct size and thickness, and installed before door assembly. All doors, when mounted on the case, shall swing 180 degrees and will support, without sagging, a 200 pound weight suspended at the outer edge of the door while it is being swung. The door catches shall be of steel with two-way compression springs attached in such a manner that no turning of handles is needed to open the door nor shall the catches wear on any painted surface or edge. All doors shall close against the cushioning neoprene- coated urethane foam gasket on the unit frame. The left hand door on double cupboard units shall have a rubber astragal on the outer vertical edge to dust-seal interior of cabinet.

2.3 STEEL CABINET FINISH

A. Pretreatment: After assembly, thoroughly clean all surfaces of grease, dirt, oil and other foreign matter by physical and chemical means. Treat entire unit with metallic phosphate process leaving surfaces with uniform, fine-grained, crystalline phosphate coating providing excellent bond for subsequent finish.

B. Top Coats: One coat high-bake primer followed by one or more coats of high-bake chemical-resistant enamel, to provide a hard and smooth, satin luster finish, applied to all treated surfaces.

C. Color shall be selected by ENGINEER from manufacturer's complete selection of standard and custom colors.

2.4 CABINET HARDWARE AND ACCESSORIES

A. Provide manufacturer's standard, satin finish hardware units, unless otherwise indicated.

B. Hinges: Institutional type, 5 knuckle. Provide one pair for doors less than 4 feet high and 1-1/2 pair for doors over 4 feet high.

C. Pulls: Solid metal, for drawers and swing doors, mounted with 2 screws fastened from back. For sliding doors, provide recessed flush pulls. Provide 2 pulls for drawers over 24-inches wide.

D. Door Catches: Nylon roller spring catch or dual self-aligning permanent magnet type. Provide 2 catches on doors over 4 feet high.

E. Drawer Stops: Designed to permit easy removal, and yet prevent inadvertent drawer removal. Provide on all drawers, located on the inside.

F. Label Holders: Provide where indicated, size to receive standard label cards approximately 1-inch by 2-inch nominal size, finished to match other exposed hardware.

G. Drawer and Cupboard Locks: Half-mortise type, 5 pin tumbler and dead bolt, round cylinder only exposed, brass with plated finish.

H. Sliding Door Hardware Sets: Manufacturer's standard, to suit type and size of sliding door units.

I. Cabinet Base Molding: Extruded vinyl or rubber, black, 4-inches high. Provide on all exposed sides and fronts of floor-mounted cabinets.

J. Leg Shoes: Extruded vinyl or rubber, black, open bottom type.

K. Shelf clips for adjustable shelves shall be nickel plated steel. A channel shall be provided to support the half-depth shelves.

2.5 FABRICATION

A. Fabricate metal laboratory furniture to dimensions, profiles, and details shown.

B. Assemble units in the shop in as large components as practicable to minimize field jointing.

C. Install hardware uniformly and precisely after final finishing is complete. Set hinges snug and flat in mortises unless otherwise indicated. Turn screws to flat seat. Adjust and align hardware so that moving parts operate freely and contact points meet accurately. Allow for final field adjustment after installation.

2.6 TABLE TOPS AND WORKING SURFACES

A. Epoxy resin tops shall be cast of modified thermosetting epoxy resin in as long components as possible in order to minimize joints. Tops shall be a uniform mixture throughout and not depend on a surface coating which is easily removed by physical or chemical abuse. Tops shall have a raised, rounded dripguard feature on the front edge and shall have a 3/4-inch thick working surface. Tops with curbs shall have an integral 8-3/4-inch high, 3/8-inch thick curb with a 3/4-inch radius at the junction between top and curb. All other edges shall be finished square.

B. Product and Manufacturer: Provide one of the following:
   1. Epoxyn by Fisher Scientific Company.
   2. Or equal.

C. Color: Black.

2.7 SINKS, CUPS, TROUGHS

A. Custom size as follows: 2 foot-6 inches long by 16-inches wide by 8-inches deep epoxy resin to match counter top.

B. Outlets: 1-1/2-inch diameter, 6-inch minimum length, fabricated of either silicon iron, cast epoxy resin, stainless steel, glass, or lead; of same material as sink wherever possible, or as otherwise acceptable to ENGINEER.

C. Overflows: Furnish hereunder for sinks, except cup sinks, of standard beehive or open top type with separate strainer. Height 2-inch less than sink depth. Of same material as sink.

2.8 SERVICE ACCESSORIES

A. Potable Hot and Cold Water Mixing Outlets: Use for mixing of hot and cold water (HCW) as noted on the Drawings and as follows:
   1. HCW: Swivel goose-neck with vacuum breaker.
   2. Product and Manufacturer: Provide one of the following:
      a. No. 91-462PV by Fisher Scientific Company.
      b. Or equal.

B. Electrical Service Outlet, Flush Mount Type Fixtures: Furnish the following flush mounted fixture units as shown on Drawings:
   1. E. Flush receptacle in single gang box, single stainless steel face plate with 20 amp, 125 volt, duplex, single phase, 3 wire polarized grounding type receptacles. F. Flush receptacle in single gang box,

single stainless steel face plate with 20 amp, 250 volt, single phase, 3 wire polarized grounding type receptacles.

2. Product and Manufacturer: Provide one of the following:
   a. No. 91-436 and 91-436-1 by Fisher Scientific Company.
   b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates and conditions under which the Laboratory Furniture is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install plumb, level, true and straight with no distortions. Shim as required using concealed shims. Where metal laboratory furniture abuts other finished work, scribe and apply filler strips for accurate fit with all fasteners concealed where practicable.

B. Base Cabinets: Set cabinets straight, plumb and level. Adjust sub-tops within 1/16-inch of a single plane. Fasten each individual cabinet to floor at toe space, with fasteners spaced 24 inches on center. Bolt continuous cabinets together. Secure individual cabinets with not less than 2 fasteners into floor, where they do not adjoin other cabinets.
   1. Where required, assemble units into one integral unit with joints flush, tight; and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16-inch.
   2. Provide holes for mechanical and electrical work as shown or as directed by trades involved.

C. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF TOPS

A. Field Jointing: Where practicable, make in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Locate field joints as shown on accepted Shop Drawings, factory prepared so that there is no job site processing of top and edge surfaces.

B. Fastenings: Use concealed clamping devices in accordance with manufacturer's instructions to exert a constant, heavy clamping pressure at joints.
   1. For epoxy tops, secure to cabinets with epoxy cement applied at each corner and along perimeter edges at not more than 48 inches on center.

C. Workmanship: Abut top and edge surfaces in one true plane, with internal supports placed to prevent any deflection. Provide flush hairline joints in top units using clamping devices. At stone-type material joints, use manufacturer's recommended adhesives and holding devices to provide joint widths not more than 1/16-inches wide at any location, completely filled and flush with abutting edges.
   1. Where necessary to penetrate tops with fasteners, countersink heads approximately 1/8-inches and plug hole flush with material equal in chemical resistance, color, hardness and texture to top surface.
   2. After installation, carefully dress joints smooth, remove any surface scratches, clean and polish entire surface.
   3. Provide all holes and cut-outs as required for all mechanical and electrical service fixtures.
   4. Provide scribe moldings for closures at junctures of top, curb and splash with walls as recommended by manufacturer for materials involved. Use chemical resistant, permanently elastic sealing compound where recommended by manufacturer.

3.4 INSTALLATION OF SINKS

A. Underside Installation: Use manufacturer's recommended adjustable support system for table-type and cabinet-type installations.
   1. Set top edge of sink unit firmly pressed to counter top, set in manufacturer's recommended chemical resistant sealing compound to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement.

3.5 INSTALLATION OF ACCESSORIES

A. Install in a precise manner in accordance with manufacturer's directions. Turn screws to a flat seat; do not drive. Adjust moving parts to operate freely without excessive bind.

3.6 CLEANING AND PROTECTION

A. Repair or remove and replace defective work as directed upon completion of installation.

B. Clean shop-finished surfaces, tough-up as required, and remove or refinish damaged or soiled areas, as acceptable to ENGINEER.

C. Protection: Advise CONTRACTOR of procedures and precautions for protection of materials and installed laboratory furniture from damage by the work of other trades until acceptance of the work by OWNER.

SCHEDULE A

LABORATORY FURNITURE SCHEDULE

Key No.	Description	Fisher Model No.
Provide all fixtures with 31-inch wide epoxy table top with 8-inch wide by 8-3/4-inch high box curb. Provide manufacturer's standard strut assemblies to support the ledge. Mount all laboratory services on the box curb. Provide all necessary drainline supports and pipe clamp assemblies. Provide all necessary trim closure panels for a completely flush installation.		
C	Eight-Drawer Cabinet	97-363Q
J	Wall Cabinet with Shelves and Glass Doors	91-831 w/91-812
K	Laboratory Pegboard	91-163
M	Sink Cabinet with Double Door Cupboard	97-490Q

+ + END OF SECTION + +

SECTION 11Z9

LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all loading dock equipment Work.
   2. The extent of loading dock equipment is shown.
   3. The types of loading dock equipment Work includes, but is not necessarily limited to, the following.
      a. Dock bumpers.
      b. Miscellaneous fasteners, anchors and other accessories.

B. Coordination:
   1. Furnish inserts and anchoring devices which must be set in concrete for the installation of units. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.
   2. See concrete Sections of these Specifications for installation of inserts and anchorage devices.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
   1. Provide loading equipment as complete units produced by a single manufacturer, including necessary accessories, fittings and anchorages.
   2. Take field measurements prior to preparation of Shop Drawings and fabrication where possible, to ensure proper fitting of the Work. However, do not delay job progress; allow for adjustment wherever the taking of field measurements before fabrication might delay the Work.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Shop Drawings for fabrication and erection of loading dock equipment. Include plans, elevations, and large scale details. Show anchorages and accessory items. Provide location template Drawings for items supported or anchored to permanent construction.
   2. Copies of manufacturer's specifications and installation instructions for all materials required.

PART 2 - PRODUCTS

A. Provide dock bumper units fabricated of heavy duty molded rubber compound reinforced with nylon, rayon or fyrex cord. Furnish units not less than 3-inches thick, complete with built-in reflectors predrilled anchor holes and stainless steel anchor bolts, nuts, and washers to suit installation shown.

B. Product and Manufacturer: Provide one of the following:
   1. Style R by R.C. Musson Rubber Company.
   2. Style B by Pawling Rubber Corporation.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the substrates and conditions under which the loading dock equipment Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install loading dock equipment in accordance with manufacturer's written instructions and approved Shop Drawings.

B. Dock Bumpers: Attach to structure as shown. Verify and coordinate location and size of inserts to which bumpers are shown to be attached. See concrete Sections of these Specifications for installation of cast-in-place inserts and anchors to receive dock bumper attachment.

3.3 ADJUSTMENT AND CLEANING

A. Make necessary adjustments for safe, efficient operation of loading dock equipment.

B. After installation restore marred or abraded surfaces to original condition.

+ + END OF SECTION + +

SECTION 12B

BLINDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all blind Work.
   2. The extent of blind units is shown.
   3. The types of blind Work required includes, but is not necessarily limited to, the following:
      a. Vertical blinds.
      b. Miscellaneous fasteners and mounting brackets.

1.2 QUALITY ASSURANCE

A. Quality Source Control:
   1. Provide each blind as complete unit produced by one manufacturer, including hardware, accessory items, mounting brackets, and fastenings.
   2. Provide all blind units by one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations unless otherwise shown or specified:
   1. NAAMA, Metal Finishes Manual.

1.3 SUBMITTALS

A. Samples: Submit for approval 6-inch samples of blinds in all colors for selection by ENGINEER.

B. Shop Drawings: Submit for approval Shop Drawings for special blind components which are not fully dimensioned or detailed on manufacturer's data sheets. Include typical elevation layout indicating proposed division between blind units and meeting edges at corners.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials:
   1. Manufacturer's standard head channel, not more than 2-inches wide and not more than 1-1/2-inches high, equipped with end caps, and formed to accommodate required operating mechanism as follows:
      a. For free-hanging blinds, provide channel track at head only. Furnish metal linkage as suitable for stabilizing and coordinating position of louver blades at the bottom.
      b. Material and Finish: Extruded aluminum with baked enamel finish.

2. Pivot Mechanism: Manufacturer's standard geared mechanism providing full syncronous 180 degrees rotation for each louver blade. Cord linkages are not acceptable as the rotating mechanism.
   For traversing blinds furnish geared pivot mechanisms in each carrier, operated by keyed rod and geared operator assembly in channel end caps.
3. Traversing Mechanism: Manufacturer's standard carriers with ball-bearing wheels (not glides), equipped with rotating mechanism. Furnish mechanism equipped to traverse each blind in a bi-parting operation and to ensure positive spacing of louver blades, unless otherwise indicated. Include special anodized aluminum lead screw carriers which are traversed by a helical rod with pulleys, gears and nickel-plated beaded chain cord system. No plastic gears shall be used.
4. Louver Blades: Manufacturer's standard louver blades, flat, washable, flame-resistant, opaque, integrally colored, extruded perforated polyvinyl chloride, 3-1/2-inch wide with 0.025-inch minimum blade thickness and 0.050-inch thick beaded edges. Fabricate without warp, bow, or twist, with manufacturer's standard end connections. Provide full selection of manufacturer's standard and custom colors. Perforations shall provide 24 percent void per blade.
5. Louver Blade Attachment: Bracket or clip system, designed for easy removal of blade, formed of stainless steel or aluminum. Design assembly to yield when subjected to interference, without damage to blade or any part of the assembly. Design assembly to limit light gap to a minimum of 3/8-inches between ends of blades and channel track section. Provide equal spacing of all blades for all locations.
6. Product and Manufacturer: Provide one of the following:
   a. Model MRRP by Louver Drape, Incorporated.
   b. Or equal.

C. Fabrication and Operation:
1. Prior to fabrication, verify actual opening dimensions by accurate site measurements. Adjust dimensions for proper fit at all openings.
2. Fabricate components of blinds from non-corrosive, non-staining, non-fading materials which are compatible with each other, and which do not require lubrication during normal expected life. Use dissimilar metals or plastics for contact surfaces which slide against each other in operation of blinds.
3. Fabricate blind units to completely fill the openings as shown, from head-to-sill and jamb-to-jamb. For continuous window wall installations, fabricate blinds so that ends occur only at mullions or other defined vertical separations, unless otherwise shown.
4. Gear all operating equipment for reduction of the ratio of hand-movement to blind-movement, so that blinds will operate easily and can be set accurately and smoothly.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the substrates and conditions under which the blinds are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install blinds where shown, as ordered in writing by ENGINEER and in accordance with the manufacturer's instructions. Position units plumb and true, securely anchored in place with proper clips, brackets and bolts for the type of mounting required.

B. Provide adequate clearance between sash and blinds to permit unemcumbered operation of sash hardware.

+ + END OF SECTION + +

SECTION 13A1

PLANT MONITORING AND CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish, install, calibrate, test, start-up and place in satisfactory operation a complete plant monitoring and control system in accordance with the requirements of the 13A Sections of the Contract Specifications and the Contract Drawings. The system includes, but is not necessarily limited to the following equipment:
   1. Primary sensors/transducers, field instruments, and associated mounting hardware.
   2. Main Control Panel.
   3. Interconnecting wiring between primary sensor/transducers, associated transmitters, field instruments, motor control center telemetry and all related appurtenances.
   4. Off-site alarm telemetry equipment and wiring.

B. The plant monitoring and control system shall be designed to monitor, display and record process and equipment operating information and alarms and to perform various process control functions. Various process variables shall be continuously indicated and trended. The trends and process variable values shall be continuously displayed on analog recorders and indicators where shown and/or specified.

C. The Contract Drawings and the 13A Sections of the Contract Specifications shall be used by the system supplier for design and implementation of the system including selecting equipment and instrumentation, calibration and start-up and providing system checkout and training.

D. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. Section 1H4, Field Tests of Equipment.
   3. Section 1H5, Instruction of Operating Personnel.
   4. Section 1I3, Operation and Maintenance Data.

1.2 QUALITY ASSURANCE

A. General:
   1. The plant monitoring and control system shall be furnished by a single supplier who shall assume responsibility for providing a complete and integrated system.
   2. All equipment, components and materials required shall be furnished by the single supplier who shall assume the responsibility for adequacy and performance of all items.

B. Supplier's Qualifications:
   1. Shall be a financially sound firm having at least 5 years continuous experience in designing, implementing, supplying and supporting

monitoring and control systems for municipal wastewater treatment facilities which are comparable to the project in terms of equipment cost and complexity.

2. Shall have a demonstrated experience record of successful monitoring and control system equipment installations.
3. Shall have in existence at the time of bid advertisement, an experienced engineering and technical staff capable of designing, implementing, supplying and supporting the monitoring and control system and handling the submittal and training requirements.
4. Shall have a thorough working knowledge of wastewater treatment processes and control philosophy in accordance with standard practices of the wastewater treatment industry.
5. Shall provide monitoring and control system components of standardized designs and therefore shall furnish a system which is not a highly unique, custom one-of-a-kind system.
6. Shall be capable of providing training for Owner's personnel in general instrumentation and process control applications and in operation and maintenance of the control system and equipment.
7. Shall have a record of prompt shipments in accordance with contract obligations required for previous projects.
8. Shall have a demonstrated record of prompt positive response to field failures.

C. Manufacturer's Qualifications: The manufacturers of monitoring and control equipment provided under the 13A Sections and other equipment Sections shall have experience in producing similar equipment, shall show evidence of installations in satisfactory operation, and shall meet the following qualifications:

1. Shall provide and manufacture monitoring and control system components which are of fully developed, field-proven standardized designs.
2. Shall have a system of "burn-in" for all critical components and available supportive documentation in compliance with MIL STD's.
3. Shall have a demonstrated record of prompt positive response to field failures.
4. Shall have a documented program of failure analysis.
5. Shall have a warranty covering parts and labor and in the case of microprocessor-based components and appurtenances, a guaranteed availability clause (95% minimum).
6. Shall have proof of compliance with relevant NEC, OSHA, MIL, NRC, ISA, SAMA, NFPA, UL, API. Standards as well as all relevant state and local codes.
7. Shall have a quality assurance organization which complies with MIL-STD-9858A and shall apply MIL-HDBK-217D, SAMA Handbook PMC-32-1981 and SAMA Standard PMC 32.1-1976 for reliability calculations as required.
8. Shall have a documented product safety policy relevant to all products to be furnished by the Contractor.

D. Supplier's Responsibilities: The Contractor shall retain the system supplier to assume the responsibilities specified below. However, execution of these specified duties by the system supplier shall not relieve the Contractor of the ultimate responsibility for the monitoring and control system equipment.

1. Design, implementation of the monitoring and control equipment and instrumentation and all subsystems in accordance with the Contract Documents and all referenced standards and codes.
2. Preparation, assembly and correction of all monitoring and control equipment submittals in accordance with the Contract Documents.
3. Proper interfacing of the monitoring and control equipment with field equipment, instruments, devices and panels including required interfacing with package control systems furnished by other equipment suppliers, such as Manufacturer's Furnished Panels (MFP), and with the plant electrical system.
4. Review and approval of Shop Drawings for equipment, valves, and piping for the purpose of insuring proper locations and installation of in-line instruments and instrument taps.
5. Direct, detailed supervision of the installation of the instruments, panels, wiring and other components as well as related wiring and piping connections.
6. Calibration, testing and start-up of the system.
7. Handling of all warranty obligations for the control system components.
8. Training of OWNER personnel in operation and maintenance of the monitoring and control equipment.

E. Reference Standards: The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature and define parameters of configuration and construction.
1. ISA - Instrument Society of America
2. API - American Petroleum Institute
3. UL - Underwriters' Laboratories, Inc.
4. AWWA - American Water Works Association
5. NEMA - National Electrical Manufacturers Association
6. NRC - Nuclear Regulatory Commission
7. OSHA - Occupational Safety and Health Administration
8. EPA - Environmental Protection Agency
9. ANSI - American National Standards Institute
10. MIL - Military Standards.
11. NFPA - National Fire Protection Association
12. SAMA - Scientific Apparatus Manufacturers Association
13. JIC - Joint Industrial Council
14. IEEE - Institute of Electrical and Electronic Engineers
15. NEC - National Electrical Code

F. Source Quality Control:
1. The system supplier shall supply his company quality assurance (QA) plan, and also the quality assurance plans of the instrumentation and control component manufacturers. QA plans shall be based on and conform to MIL-9858A for the items that are supplied under this Specification. Plans shall state, but not be limited to: methods of testing, raw material criteria, methods of documentation, station control, "burn-in", final tests, and serialization coding, packaging; application of MIL 883B, HDBK-217D relevant sections, to be documented as a submittal.
2. If any of the above operations are not 100 percent then the manufacturer is to supply his company quality assurance sampling plan. Said plan shall be in accord with MIL-105D.

1.3 COORDINATION AND PROGRESS MEETINGS

A. The Contractor shall be responsible for the scheduling and coordinating the system installation with regard to all other work on the site and in accordance with the provisions of the General Conditions. Said coordination shall be documented on the project schedule.

B. Routine progress and coordination meetings will be scheduled by the Engineer. The Contractor and a representative of the system supplier shall be required to attend a minimum of two meetings.

C. The purpose of the meetings shall be to review the progress of the work involving the monitoring and control system and provide coordination for installation of the equipment to ensure construction schedules are met.

D. Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit the Contractor and system supplier to agreed procedures and schedules.

1.4 SYSTEM SUPPLIER PROJECT PERSONNEL

A. The Contractor shall require the system supplier to provide the following project personnel.
   1. Project Manager:
      a. The system supplier shall appoint a project manager who shall coordinate and schedule all work and assure that project schedule is met.
      b. The project manager shall act as the liaison with the Contractor for the installation of the monitoring and control system equipment and shall assist in all matters required for proper coordination and interfacing of the equipment and processes.
   2. Field Engineer:
      a. The system supplier shall appoint a field engineer with responsibilities as follows:
         1) Provide advice and technical consultation relative to installation techniques and procedures for equipment furnished.
         2) Installed system checkout, calibration, adjustment and start-up, including tuning of every control loop.
         3) Involvement in the on-site system training of plant personnel.
         4) Resolving of control problems encountered during initial start-up and testing of the instrumentation and control equipment.
      b. The field engineer shall have a minimum of 5 years experience in systems engineering and start-up and shall have a thorough working knowledge of the equipment furnished.
   3. Training Personnel: Comply with requirements of Paragraph 1.9.

1.5 SUBMITTALS

A. Shop Drawings:
   1. General:
      a. Make shop drawing submittals in accordance with the requirements of Section 1E4.

b. Manufacture of the monitoring and control equipment system shall not commence until related submittals have been approved by the Engineer.
c. Shop drawings shall be submitted in complete packages grouped to permit review of related items as generally outlined in subparagraph 2, Submittal Requirements, below.
d. Review of Shop Drawings will be for conformance with Contract Documents and with regard to functions shown and/or specified to be provided.
e. On shop drawing resubmittals the Contractor/supplier shall respond to all comments made by the Engineer either by making the noted correction or stating why it was not revised. Any resubmittal received by the Engineer on which responses to comments have not been made shall be returned to the Contractor marked "No Response To Previous Comments." No further review by the Engineer shall be performed until the Contractor responds to these comments. The Owner shall have the right to deduct monies due the Contractor for handling shop drawings with incomplete responses.

2. Submittal Requirements:
   a. Product information for all sensors/transducers and field instruments and for all panel mounted monitoring and control components. Include the following:
      1) Manufacturer's product name and model number.
      2) Instrument tag number.
      3) Manufacturer's standard catalog product data.
      4) Description of construction features.
      5) Performance and operation data.
      6) Installation and mounting details, instructions and recommendations.
      7) Service requirements.
      8) Dimensions.
   b. Product information for the controllers. Provide descriptive information on the controllers for approval. Include the following information as a minimum:
      1) Hardware description including layout and installation requirements and all environmental constraints.
      2) Operational description explaining how control and monitoring functions are performed and displayed.
      3) Functional descriptions covering procedures for programming.
   c. Panel Information:
      1) Layout drawings, include the following:
         a) Front, rear, end and plan views to scale.
         b) Dimensional information.
         c) Tag number and functional name of components mounted in and on the panel.
         d) Product information on all panel components.
         e) Nameplate location and legend including text, letter size and colors to be used.
         f) Location of anchoring connections and holes.
         g) Location of external wiring and/or piping connections.
         h) Mounting and installation details.
      2) Wiring and/or piping diagrams, include the following:
         a) Name of panel.
         b) Wiring sizes and types.

c) Piping sizes and types.
d) Terminal strip numbers.
e) Color coding.
f) Functional name and manufacturer's designation for components to which wiring and piping are connected.

3) Electrical control schematics in accordance with JIC standards.
4) Plan showing equipment layout in each area.

d. Field wiring and piping diagrams, include the following:
1) Wiring and piping sizes and types.
2) Terminal strip numbers.
3) Color coding.
4) Conduits in which wiring is to be located.
5) Location, functional name and manufacturer's designation of items to which wiring and/or piping are connected.
6) Point-to-point wiring diagrams.

e. Instrument loop diagrams for all analog display and control loops prepared using ISA standard symbols in accordance with ISA Standard S5.4, include the following:
1) Instrument tag numbers.
2) Functional name of each item.
3) Manufacturer's model, product, or catalog number for each item.
4) Location of each item.

B. Control System Operation and Maintenance Manuals:
1. Furnish O&M manuals for the plant monitoring and control system in accordance with the requirements of Section 1I3 and the supplemental requirements below:
2. Submit O&M manuals prior to the time the monitoring and control system equipment is delivered to the site.
3. O&M manuals shall be submitted in hard-back 3-ring loose leaf binders with a complete table of contents and drawing indexes for each binder and dividers for each section.
4. The O&M manuals shall include the following as a minimum:
a. Name, address and telephone number of the monitoring and control system supplier's local service representative.
b. Names, addresses and telephone numbers of the major monitoring and control components manufacturers' local sales and service representatives, service centers and parts stocking centers.
c. Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.
d. Copy of all approved submittal information and system shop drawings as specified in Paragraph 1.5.A.3 with corrections made to reflect actual system as tested and delivered to the site for installation. Half-size black line reproductions shall be provided for all shop drawings larger than 11x17 inches.
e. Complete up-to-date system software documentation for each controller.
f. Manufacturer's original copies of hardware, software and installation, assembly and operations manuals for the field instruments, controllers, recorders, indicators and all other control system components. Manuals shall include the following information:

1) General descriptive information covering the basic features of the equipment.
2) Physical description covering layout and installation requirements and all environmental constraints.
3) Functional and operational descriptions covering the procedures for operation, start-up, shutdown, and calibration of the instruments and control system equipment and explaining how the various control functions are performed.
4) Principles of operation explaining the logic of operation; provide information covering operation to a component level.
5) Maintenance procedures covering checkout, troubleshooting, and servicing. Checkout procedures shall provide the means to verify the satisfactory operation of equipment. Troubleshooting procedures shall serve as a guide in determining faulty components. Servicing procedure shall cover requirements and recommended time schedule for calibration, cleaning and other housekeeping and preventive maintenance procedures.
6) Wiring, schematic and logic diagrams.
7) Safety considerations relating to operation and maintenance procedures.

C. Control System Record Drawings and Documentation:
1. The Contractor and system supplier shall revise all system shop drawings and submittals to reflect as-built conditions in accordance with the requirements of Section 1I2 and the supplemental requirements below.
2. Submit copies of all revised shop drawings and documentation to the Engineer to supplement and to replace out-dated drawings and documentation contained in system O&M manuals. Number of copies shall be as specified in Section 1I3 for operation and maintenance data. Half-size black line sets shall be provided for all drawings larger than 11x17. Specific instructions for out-dated drawing removal and replacement shall be provided with the record drawing submittal.
3. Half-size black line prints of wiring diagrams applicable to each control panel shall be placed inside a clear plastic envelope and stored in a suitable print pocket or container inside each control panel.

D. Reports: Four copies of the Installation Inspection, Field Calibration, and Field Testing Reports as specified in Paragraph 1.8. shall be submitted to the Engineer.

1.6 FACTORY TESTING

A. Each control panel shall be tested at the factory prior to shipment. All panel components and wiring shall be tested to insure that there are no defects.

B. Controllers, recorders, totalizers and other display, control and alarming components shall be tested to demonstrate proper operation and the ability to perform the functions as specified in the 13A Sections of the Contract Specifications and as shown on the Electrical Drawings.

Testing shall be accomplished using simulated input signals and shall demonstrate controller and control loop functioning and response under equipment start-up, shutdown, steady-state and transient operating conditions and upon power failure and power fail restart conditions.

C. The Contractor shall notify the Owner and Engineer in writing at least 2 weeks before the expected beginning of the test in order that the test may be witnessed, if so desired. Witnessing the test does not relieve the Contractor or system supplier of conforming to the requirements of the Contract Documents and shall in no way imply acceptance of the panel and system equipment.

D. Panel and control component modifications and corrections required as a result of the testing shall be completed and documented before shipment of the panels.

1.7 EQUIPMENT DELIVERY, HANDLING AND STORAGE

A. The Contractor shall make all arrangements for transportation, delivery and storage of the equipment and materials in accordance with the requirements of Section 1H1, requirements of the system supplier, and requirements of equipment manufacturers.

B. Plant monitoring and control system equipment shall be packaged at the factory prior to shipment to protect each item from damage during shipment and storage. Containers shall be protected against impact, abrasion, corrosion, discoloration and/or other damages. Clearly label contents of each container and provide information on the required storage conditions necessary for the equipment. Keep Owner and Engineer informed of equipment delivery.

C. All equipment shall be handled and stored in accordance with manufacturer's instructions and relevant organization standards. Equipment shall be protected from weather, moisture and other conditions which could cause damage. Items which require a controlled environment for storage such as panels and microprocessor units shall be stored in a climate-controlled warehouse. System supplier shall notify Contractor in writing with copies to the Owner and Engineer of the storage requirements and recommendations for the equipment prior to shipment.

1.8 SYSTEM START-UP AND FIELD TESTING

A. System Check-out and Start-up Responsibilities:
   1. The Contractor shall be responsible for providing all equipment and coordinating all activities necessary for check-out and start-up of the equipment.
   2. The Contractor shall retain the services of the system supplier to supervise and/or perform check-out and start-up of all system components. As part of these services, the system supplier shall include for those equipment items not manufactured by him the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.

B. System Start-up and Check-out Requirements:
   1. The Contractor under the supervision of the system supplier, and other instrument suppliers as applicable, shall perform the following:
      a. Check and approve the installation of all monitoring and control equipment and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.
      b. Conduct a complete system check-out, start-up and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
   2. The Contractor shall provide all test equipment necessary to perform the testing during system check-out and start-up.
   3. The Contractor and system supplier shall be responsible for initial operation of the monitoring and control equipment and shall make any required changes, adjustment or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended.
   4. The Contractor shall furnish to the Engineer certified calibration and loop tuning reports for field instruments and panel-mounted instruments and control devices specified in Part 2, Products, as soon as calibration is completed.
   5. The Contractor shall furnish to the Engineer an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The reports shall be signed by authorized representatives of both the Contractor and the system supplier.

C. System Field Test and Commissioning Run:
   1. Following system check-out and initial operation, the Contractor, under the supervision of the system supplier, shall perform a complete system test to verify that all monitoring and control equipment is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by the Contractor and then retested to demonstrate proper operation.
   2. The Contractor shall notify the Owner and the Engineer in writing of his readiness to perform the system field test and commissioning run once system check-out and initial operation is completed. All certified calibration reports and installation inspection reports for all equipment shall be furnished to the Engineer prior to the notification.
   3. Following receipt of the notification, Owner and Engineer shall meet with the Contractor to coordinate arrangements, establish a start date and agree upon the duration of the system field testing and commissioning run.

1.9 TRAINING

A. General System Training Responsibilities:
   1. The Contractor shall be responsible for providing and coordinating all required training at times acceptable to the Owner.

2. The Contractor shall retain the services of the system supplier to provide operation and maintenance training for all monitoring and control equipment as specified herein.
3. For equipment items not manufactured by the system supplier, he shall provide for on-site training by an authorized representative of the equipment manufacturer as part of his services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.
4. The Contractor shall be responsible for all costs associated with training and shall provide all required materials, texts and required supplies.

B. On-Site Training Requirements:
1. Provide initial on-site operation and maintenance training by system supplier and the equipment manufacturer's representatives prior to placing the monitoring and control system components and the related process systems and equipment into continuous operation. Initial system training shall be conducted for a minimum of two 8-hour days. Training by the various equipment manufacturer's representatives shall be conducted as specified in subaragraph 1.9.B.4 below.
2. Provide formal on-site operations and maintenance training by the system supplier 30 consecutive calendar days after the continuous operation of the instrumentation and control system and associated process systems and equipment. Training shall be conducted for a minimum period of two 8-hour days.
3. Training shall accomplish the following:
   a. Provide instruction covering use and operation of the instruments, controls and equipment to perform the intended functions.
   b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance including equipment and instrument calibration.
   c. Explain procedures for placing the equipment in and out of operation including safety precautions to be followed.
4. The services of equipment manufacturers' representatives shall be provided for the following minimum time periods for each type of instrument provided:
   a. Primary Sensors/Transducers and Field Instruments: 4 hours.
   b. Controllers: 8 hours.

1.10 GENERAL DESIGN REQUIREMENTS

A. Power Supplies:
1. All electrically powered equipment and devices shall be suitable for operation on 115 volt ± 10%, 60 Hz ± 2 Hz power. If a different voltage or closer regulation are required, a suitable regulator or transformer shall be provided.
2. Appropriate power supplies shall be furnished by the Contractor for all 2-wire transmitters, loops for monitoring discrete inputs and all necessary outputs.
3. Design all power supplies for a minimum of 150% of the maximum simultaneous current draw.
4. A power on-off switch or an air circuit breaker shall be furnished for each item requiring electrical power.

5. Provide isolation transformers and power line filter/surge protection, for each control panel and other instrumentation and control components to eliminate electrical noise and/or transients and harmonic distortion entering on the primary power line. Ferro resonant transformers shall not be used.

B. Signal Requirements:
1. The control system shall be designed to use 4 to 20 mA dc analog signals, unless otherwise specified.
2. Signal converters and repeaters shall be provided where required.
3. Signals shall be isolated from ground.
4. Signals shall not have a transient dc voltage exceeding 300 volts over one millisecond or a dc component over 300 volts.
5. The monitoring and control system and associated input/output wiring will be used in a wastewater treatment plant environment where there can be high energy ac fields, dc control pulses, and varying ground potentials between the sensors/transducers or input contact locations and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.

C. Miscellaneous:
1. All instrumentation, monitoring, display units and control system components shall be heavy duty types, designed for continuous service in a municipal wastewater treatment plant environment. The system is to contain products of a single manufacturer, when possible, and to consist of equipment models which are currently in production.
2. All instrumentation, monitoring, display units and control system components shall be designed to automatically return to accurate measurement within 15 seconds upon restoration of power after a power failure or when transferred to standby power supply.
3. Surge protection shall be provided for all instruments and all other control system components which could be damaged by electrical surges or transients.
4. All field-mounted instruments and system components shall be designed for installation in humid and slightly corrosive service conditions. All field mounted instrument enclosures, junction boxes and appurtenances shall conform to NEMA 4X requirements unless otherwise specified.
5. Field-mounted instruments and system components located in hazardous locations shall be explosion proof or intrinsically safe for the location classification in which they are installed.
6. All interconnections to field devices and other control panels shall be wired through terminal blocks. Terminals as part of a relay base are not an acceptable alternate.
7. All panel-mounted instruments, annunciators, switches, and other devices shall be selected and arranged to present a pleasing coordinated appearance. All devices for mounting on the panel front shall be of the same manufacturer and model line.
8. All components furnished including field and rear of panel instruments shall be tagged with the nomenclature indicated on the Contract Documents and/or approved shop drawings and with the item number established by the system supplier.
9. Failure of one device in a loop shall not cause failure of other devices in that or any other loop.

10. All panel and rack mounted devices shall be repairable without removing power from other devices mounted in the rack.
11. Ranges and scales specified herein shall be coordinated to suit equipment actually furnished.
12. Field-mounted devices shall be treated with an anti-fungus spray.
13. Field-mounted devices shall be protected from exposure to freezing temperatures.
14. Painting:
    a. All monitoring and control system components shall be factory finished with the manufacturer's standard coating system, unless otherwise specified herein.
    b. Colors shall be as selected by the Engineer from the manufacturer's standard selection of colors.
    c. Field painting will not be permitted without the Engineer's written consent and shall normally be limited to miscellaneous hardware.

D. Environmental Conditions:
1. The monitoring and control system shall be designed and constructed for continuous operation under the following temperature and humidity conditions:
    a. Main Control Room and Electrical Rooms:
        1) Ambient Temperature: 60 F to 85 F.
        2) Relative Humidity: 80%, maximum.
    b. Other Indoor Locations:
        1) Ambient Temperature: 40 F to 120 F.
        2) Relative Humidity: 98%, maximum.
    c. Outdoor Locations for Instruments:
        1) Ambient Temperature: -20 F to 140 F.
        2) Relative Humidity: 100%, maximum.
2. Equipment shall be constructed to provide adequate protection against corrosion from gases which may commonly be found in a wastewater treatment plant environment, such as hydrogen sulfide, methane and chlorine.
3. Portions of the monitoring and control system will be located in areas outside of the Main Control Room and Electrical Rooms. These areas may not be free from vibration. The monitoring and control system supplier shall specify any vibration limitations which are required for his equipment and provide vibration-proof mountings accordingly.
4. The Main Control Room and Electrical Rooms will normally be air-conditioned to maintain the above limits. No positive control of relative humidity is provided or contemplated. However, in the event of a failure of air-conditioning and during initial plant start-up, the control system components shall be capable of continuous and satisfactory operation in ambient temperatures from 40 F to 110 F, and for short periods (24 hours or less) at up to 120 F. At such times, it shall also operate continuously and satisfactorily with a relative humidity of up to 95% non-condensing.

E. System Designs:
1. Range, scale and setpoint values specified are for initial setting and configuration. Modifications to these values may be required based on actual equipment furnished and as necessary to implement proper and stable process action which are determined as systems are placed in operation. These modifications shall be done at no additional cost to the Owner.

2. For any items where ranges, scales and setpoints may not have been specified, the Contractor shall submit a recommendation to the Engineer for review.

+ + END OF SECTION + +

SECTION 13A20

PRIMARY SENSORS/TRANSDUCERS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Furnish, install, calibrate, test, adjust and place into satisfactory operation the primary sensors/transducers and field instruments as shown on the Drawings and specified herein.
2. The Drawings and specifications illustrate and specify functional and general construction requirements of the sensors/transducers and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. The CONTRACTOR shall provide all components, piping, wiring accessories and labor required for a complete workable and integrated system.

B. Coordination:
1. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

C. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 13A.

B. Acceptable Manufacturers:
1. Furnish primary sensor/transducers and field instruments by the named manufacturers or equal equipment by other manufacturers.
2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
3. Obtain all sensor/transducers and field instruments of a given type from the same manufacturer.

C. Manufacturers' Responsibilities and Services:
1. Design and manufacture of the primary sensors/transducers and field instruments in accordance with the applicable general design requirements specified in Section 13A and the detailed specifications herein.
2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 13A.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements specified in Section 13A.

PART 2 - PRODUCTS

2.1 GENERAL

A. Identification Tags: All sensor/transducers and field instruments shall have an identification tag meeting the following requirements:
   1. Tag numbers of all sensor/transducer and field instruments shall be as listed on the Contract Drawings.
   2. The identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device with stainless steel rivets or self tapping screws of appropriate size.
   3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of stranded stainless steel wire rope.
   4. All sensor/transducers and field instruments mounted on or within panels shall have the stainless steel identification tag installed so that the numbers are easily visible to service personnel. Panel mounted devices shall have the tag attached to the rear of the device.

B. Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters:
   1. Material: Copper Water Tube, ASTM B-88, Soft Anneated, Type L.
   2. Pressure Rating: 150 psi.
   3. Size: 1/2 inch O.D. for water.
   4. Connections: Brass Compression Type, "Swagelok" by Crawford, or equal.
   5. Shut-off Valves:
      a. Type: Ball.
      b. Pressure Rating: 150 psi.
      c. Body, Ball and Stem: Brass.
      d. Packing, High Density TFE.
      e. Handle: Nylon with metal travel stops.
      f. Support Rings: TFE coated brass.
      g. End Connections: Removeable "Swageloks", or equal.
      h. Model: Whitey 45 series for water, 43 series for air; or equal.
   6. Manifolds:
      a. Type: 5-valve and 3-valve meter manifolds.
      b. Materials: 316 SS Body, Bonnets and Stems; Delrin seats; Teflon Packing.
      c. Manufacturer: Anderson-Greenwood; or equal.

C. Pressure Sensing Lines and Accessories for Pressure Gauges and Pressure Switches not assembled as part of in-line pressure sensor assemblies:
   1. For Process Sensing Taps in Ductile Iron Steel and Stainless Steel Piping Systems:
      a. Material and Fittings: Type 304 Stainless Steel Pipe (ASTM A/312) and threaded fittings and adapters (ASTM A403).
      b. Sizes: 1/2 inch minimum for main sensing piping and 1/4 inch gauge and switch connections.
      c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in relevant mechanical sections.
      d. Accessories:
         1) For applications not requiring diaphragm seals, provide separate 1/4 inch Type 316 stainless steel threaded gauge cocks for each gauge and switch.

2) For applications requiring diaphragm seals, provide a separate 1/2 inch threaded Type 316 stainless steel ball valve for seal process side shut-off for each gauge and switch. Ball valves shall be provided in accordance with relevant mechanical specification.

2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
   a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. Copper pipe and fittings shall be provided in accordance with the requirements of relevant mechanical sections. PVC and CPVC pipe and fittings shall be provided in accordance with the requirements of relevant mechanical sections.
   b. Sizes: 1/2 inch minimum for main process sensing piping and 1/4 inch for gauge and switch connections.
   c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in relevant mechanical sections.
   d. Accessories:
      1) For copper piping systems seals, provide a separate 1/4 inch minimum threaded brass or bronze gauge cock for each gauge and switch.
      2) For PVC piping systems with or without diaphragm seals, provide a separate 1/2 inch threaded ball valve for seal side or process sensing line shut-off for each gauge and switch. Ball valves shall be provided in accordance with the relevant mechanical specifications.

2.2 FIELD INSTRUMENTS

A. Magnetic Flowmeter System:
   1. Magnetic Flowmeter:
      a. The magnetic flowmeter shall be of the electromagnetic induction type and shall produce a DC current signal directly proportional to the liquid rate of flow.
   2. Flowmeter:
      a. The magnetic flowmeter shall be furnished with a polyurethane liner.
      b. Periodic shutdown for liner cleaning shall not be necessary.
      c. The ratio of flow velocity to reference voltage signals generated shall be identical for all sizes so that any 60 Hertz meter shall be compatible with any 60 Hertz secondary readout instrument without the necessity of circuit modifications.
   3. Electrodes:
      a. Electrodes shall be Type 316 stainless steel and shall be of the bullet nosed type.
   4. Connections: End connections shall be 125# ANSI flanged.
   5. Accuracy: Accuracy of the metering system, including the readout instrument shall be 1.0 percent of full scale for maximum flow velocity of 1.0 to 31 fps, with a 10 to 1 turn-down and 0.1 percent of scale below 10 percent of full scale.
   6. Housing:
      a. The meter housing shall be NEMA 4X design.
      b. The meter shall be capable of continuous submergence to 30 feet.
      c. The meter shall be provided with stainless steel grounding rings or lugs.
      d. Cable connections shall be accessible by removal of a single gasketed cover.

7. Power: The meter shall be designed for operation on 120 VAC ±10 percent, 60 Hertz power supply. Individual replaceable nonresettable line fuses sized to protect the instrument shall be provided.
8. Output:
   a. The meter shall be designed for use with a remote signal converter.
   b. Signal cable shall be provided for interconnection of meter and signal converter.
9. Signal Converter:
   a. The magnetic flowmeter signal converter shall be of the solid state feedback type suitable for mounting as shown on the Drawings. The converter shall change a low level DC input signal from a magnetic flowmeter into a proportional analog DC signal for display on a local, built-in, externally visible meter in engineering units, and for transmission to remote instrumentation. The input span shall be continuously adjustable between 0-3 and 0-31 feet/second and the range adjustment shall be of the direct reading dial type. The converter shall include adjustable dampening circuitry which shall be adjusted by vendor to suit each condition of usage. The signal converter output shall be 4-20 mAdc for scales as listed. Low flow dropout shall be provided. Flow readout shall be provided in engineering units on an LCD display with totalizer.
10. Product Manufacturer: Provide one of the following:
    a. Fisher Porter.
    b. Brooks.

B. Electronic Differential Pressure Transmitters:
1. Type: Strain gage or capacitance.
2. Function: Measure the differential between two pressures and produce an analog output signal directly proportional to that differential. Provide internal square root extraction for flow applications.
3. Performance Specifications:
   a. Span: Field adjustable and suitable for intended operation.
   b. Accuracy: ±0.25 percent of calibrated span.
   c. Repeatability: ±0.05 percent of span.
   d. Deadband: ±0.0± percent of span.
   e. Temperature Limitations: Minus 10 to 120 F.
   f. Output Signal: 4 to 20 mAdc.
4. Required Features:
   a. Adjustable internal damping.
   b. Electronic zero and span adjustments.
   c. Elevation and suppression capability.
   d. Static pressure compensation.
   e. Positive overrange protection to 200 psi.
   f. Measuring element protected by sealing diaphragms.
   g. Solid-state electronic components.
   h. NEMA 4X enclosure.
   i. Vent control.
   j. Breather drain.
   k. 1/2-inch internal NPT electrical conduit connection.
   l. 1/2-inch internal NPT process connections.
   m. Bracket suitable for mounting transmitter on a 2-inch pipe. Provide 3 valve manifold for flow applications.
   n. For flow applications provide internal square root extraction.

5. Materials: Use transmitters constructed of the following materials:
   a. Wetted Parts: Type 316 stainless steel.
   b. Filling Liquid: Silicone.
   c. Base and Cover: Die cast low copper aluminum.
   d. O-rings: Viton or Teflon.
6. Product Manufacturer: Provide one of the following:
   a. Bristol Babcock.
   b. Rosemount.
   c. Or equal.

C. Pressure Switches:
1. Required Features:
   a. Pressure switches shall be furnished with stainless steel or brass internals and a case conforming to NEMA 4X requirements. Switches shall be diaphragm type, with snap action switches and SPDT contacts rated at not less than 10 amps at 120 volts.
   b. All switches shall be adjustable over the full range and shall have visible indicating set point scales. Accuracy shall be ±2 percent of set point. Deadband shall be 2 percent maximum.
   c. Provide single or two stage independently adjustable switches as required.
2. Product Manufacturer: Provide one of the following:
   a. ASCO.

D. Turbidity Monitoring Systems:
1. Extent: Provide systems in quantities as shown on the Drawings
   a. Arrangement: Mount units supplied for filter effluent service on free standing panels and/or as shown on the Drawings.
2. Turbidimeters:
   a. General: Turbidimeters shall be of the type which continuously monitor a sample stream, tapped from the flowing stream.
   b. Sensing module shall have a continuous monitor unit consisting of monitoring head with flexible tubing connections. Sensor shall operate at a sample flow rate from 0.1 to 1.5 gpm and be designed for a working pressure of not less than 50 psig.
   c. Analyzer:
      1) Outputs: 4-20 mAdc.
      2) Enclosure: NEMA 4X
      3) Method: Nephelometric/Turbidimetric.
      4) Adjustable Ranges: 0-1, 10, 100, 1000 NTU.
      5) Linearity: ±1% of full scale
      6) Repeatability: ±1% of full scale.
      7) Sensitivity: 0.01 NTU change.
      8) Response: Immediate, all ranges.
      9) Electrical Requirements: 120 VAC. Provide suitable for hardwiring.
      10) Required Optional Features:
         a) Signal Damping
      11) Accessories required for each turbidimeter:
         a) Thread-in measuring cuvettes (2).
         b) Discrete sample cuvette (1).
         c) Light shield.
         d) Reference standard.
         e) Desiccant discs.
         f) Interconnecting cable; sensor to analyzer.
         g) Spare lamp and fuses.
         h) Accessory case.

d. Acceptable Products:
   1) HACH.
   2) Great Lakes.

E. Current Isolator:
1. General: The isolating unit shall be a two wire, loop powered device. It shall accept a 4-20 mAdc input signal and deliver a 4-20 mAdc output.
2. Required Features:
   a. Repeatability: ±1% of span.
   b. Ambient Temperature Range: -25 F to +185 F.
   c. Linearity: ±1% of full scale.
   d. Provide one spare isolator.
3. Acceptable Products:
   a. Moore Industries.
   b. AGM.

F. Pressure Gages:
1. Extent and Ranges: Refer to Instrument List.
2. Case Size: 4-1/2 inches.
3. Bourdon Tube: Bronze.
4. Case: Flanged phenol for surface or stem mounting.
5. Connection: 1/4 inch NPT - Bottom.
6. Accuracy: 1/2%.
7. Acceptable Products: Ametek "Solfrunt 1980 Series" with stainless steel Permatron bushed stainless steel movement, or equal.

G. Level Switch:
1. General: The device shall be capable of detecting fluid level and initiating a signal.
2. Type: Direct acting float.
3. Required Features:
   a. Molded plastic body (approximately 5 inch diameter).
   b. Redundant foam fill
   c. One normally open mercury switch contact.
   d. Heavy duty synthetic rubber or PVC jacketed three conductor cable with length as required.
   e. Cable entry to body shall be sealed watertight.
   f. Switch rating shall be 5 amp at 120 VAC.
   g. Provide suspension weights as required.
4. Product and Manufacturer: Provide one of the following:
   a. Flygt Corporation.
   b. Consolidated Electric Company.
   c. Switch System, Incorporated.
   d. Or equal.

H. Diaphragm Seals:
1. General:
   a. Furnish diaphragm seals at the locations shown on the Drawings.
2. Construction Features required for all seals:
   a. Filling Liquid: Silicone.
   b. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
   c. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid.

d. Instrument Connection: 1/4-inch NPT.
e. Process Connection: 1/2-inch NPT.
f. Housing: Wetted parts Type 316 stainless steel.

3. Seal Construction Features for Chlorination System Instruments.
   a. Housing, Instrument Side: Type 316 stainless steel.
   b. Housing, Process Side: PVC.
   c. Diaphragm: Teflon.
   d. O-ring Material: Teflon.
   e. Gasket Material: Teflon.
4. Manufacturer and Model:
   a. AMETEK - Mansfield Green.

I. Temperature Transmitting System:

1. General: Temperature Transmitting System shall consist of thermocouples, thermowells and temperature transmitters.
   a. Thermocouples:
      1) Type: Thermocouples shall be ANSI Type J.
      2) Required Features:
         a. Temperature Range: See Instrument LIst.
         b. Temperature Check: At high end of span and tagged to 0.1°F.
         c. Error of Temperature Check: 0.5°F (uncertainty of reading).
         d. Wires: 14AWG.
      3) Manufacturer:
         a. Bristol Babcock.
   b. Thermowells:
      1) General: The thermowell shall be a straight type assembly comprised of a dual-element thermocouple housed in a metal protection tube with a Universal Head for terminal connections.
      2) Required Features:
         a. Dual element with 14 AWG wires in 4-hole ceramic insulation.
         b. Grounded to bottom of tube.
         c. "U" Dimension: See Instrument List.
         d. Head Assembly: Aluminum head, twist cap (tapped for ½ inch NPT conduit).
         e. Protection Tube Material: Same as piping to which it is connected.
         f. 1-½ inch diameter protection tube.
      3) Manufacturer:
         a. Bristol Babcock.
         b. Rosemount.
   c. Temperature Transmitter:
      1) General: The temperature transmitter shall be a temperature transducer suitable for use with Type J thermocouples.
      2) Required Features:
         a. Range: As indicated on Instrument List.
         b. Output: 4 to 20 mAdc.
         c. NEMA 4 construction.
      3) Manufacturer:
         a. Bristol Babcock.
         b. Rosemount.

J. Ultrasonic Flow System (Level Type):
   1. General: The ultrasonic system shall be suitable for the span and ranges indicated on the Instrument List, and shall include appropriate mounting brackets.
   2. Type: Non-contact flow sensor.
   3. Required Features:
      a. Preamp: Adjustable.
      b. Output: 4-20 mAdc, dry contacts for high and low alarm.
      c. Readout: LED.
      d. Scales: See Instrument List.
      e. Range: See Instrument List.
      f. Input Power: 120 VAC, 60 Hz.
      g. Cable: Supply all special cable between sensor and transmitter.
      h. Sensor Beam Pattern: 5° cone (for level).
      i. Operating Temperatures:
         1) Sensor: -20 to +170°F.
         2) Transmitter: +32 to 140°F.
      j. Construction: NEMA 4X enclosure for transmitter. NEMA 7 for hazardous areas. Stainless steel or plastic construction for sensor.
   4. Product and manufacturer: Provide one of the following:
      a. Enterra.
      b. Fischer and Porter.

K. Electronic Pressure Transmitter:
   1. General: Pressure transmitters shall be indicating force-balance type. The transmitters shall be bellow type and operate on pressure produced in the system. Transmitters shall have solid state circuitry. Transmitters shall be differential pressure type.
   2. Output: 4 to 20 mAdc, linear to pressure.
   3. Accuracy: ±0.35 percent of span over the range of 8 to 1.
   4. Transmitter shall be 2 wire type.
   5. Ambient Temperature: Minus 20 to 130°F.
   6. Static Pressure Rating: 200 psig.
   7. Transmitter shall be equipped with local indicator, calibration and range as per Instrument List.
   8. Transmitter shall have 100 percent suppression and elevation adjustments for level transmission.
   9. Three Valve Manifold: Nickel plated, brass.
   10. Enclosure: NEMA 4.
   11. Product and Manufacturer: Provide one of the following:
      a. Rosemount.

L. Dissolved Oxygen Measurement System:
   1. General: The dissolved oxygen measurement system shall be designed for precise-continuous monitoring of dissolved oxygen wastewater and consist of an analyzer probe and all required mounting hardware for the intended purpose.
   2. Required Features:
      a. Dual Range Capability:
         1) 0-5 mg/l (PPM) dissolved oxygen.
         2) 0-15 mg/l (PPM) dissolved oxygen.
         3) -20 to +50 C for receiver temperature.
      b. Automatic Temperature Compensation:
         1) 0.1 percent/C shift.
      c. Accuracy:
         1) ±2 percent of full scale over normal operating range.

d. Repeatability:
   1) Better than 0.1 mg/l on 0-15 mg/l scale.
   2) Better than .02 mg/l on 0-3 mg/l scale.
e. Response Time:
   1) 40 seconds for 90 percent response to step change.
f. Stability:
   1) Less than 1 percent of F.S. long term after 15 minute warm up.
g. Power Requirements:
   1) 120 VAC, 60 Hz.
h. Outputs:
   1) 4-20 mAdc.
i. Connections:
   1) Terminal blocks.
j. Construction: NEMA 4X for analyzer.
k. Electrodes:
   1) Lead anodes are not acceptable.
l. Flow Requirements:
   1) Probe shall not require continuous flow.
m. All cabling between probe and transmitter shall be provided.
n. Provide one additional probe for each probe being provided.

3. Manufacturer:
   a. Great Lakes Model 90D1F1B0N.
   b. Enterra.
   c. Royce.

M. Thermal Mass Flow Sensor (Aeration Basin Blower Header):
1. Type: Thermal dispersion type linear flowmeter that measures the differential temperature between two RTD's and produces an output signal linear to the mass flow rate of air.
2. Performance Requirements:
   a. Accuracy:
      1) ± 1% of full scale for turn-downs of 10:1 or less and straight upstream/downstream piping runs of 20 diameters/ 10 diameters.
      2) ± 2% of FS or better when installed at locations shown on the Drawings and operating over a 6:1 turn-down range with full scale as value as specified in the Instrument List.
   b. Repeatability: ± 1% of full scale.
   c. Signal Output: 4-20 mA, 1200 ohms max. load.
   d. Operating Pressure: Maximum of 1250 psig.
   e. Flow Element Range: 0.25 to 200+FPS @ standard conditions.
   f. Power Input: 115 VAC, ± 15 VAC, 16 watts max.
   g. Operating Temperature:
      1) Flow Element: - 50°F to 350°F.
   h. Flow Range: As specified in Instrument List.
   i. Pipeline Size: As shown on the Drawings.
   j. Calibration: Factory calibrated as specified flow range under given conditions.
3. Construction Features:
   a. Process Connection: Threaded NPT, 1" minimum.
   b. Insertion Length: Tip of probe to extend one (1) inch past centerline of pipe. See Drawings for pipe size.
   c. Process Wetted Parts: 316 stainless steel.
   d. Sensor Housing: Explosion proof Class 1, Group C and D, Division 1 and 2.

e. Remote Electronics Housing: NEMA-4 enclosure painted with corrosion resistant epoxy paint system (NEMA 4X).
f. Mounting:
1) The Remote Electronics Housing shall be remotely mounted from the sensor housing at location shown on the Drawings. Provide complete 316 88 mounting hardware.
2) For aeration basin drop pipe meters, provide hot-tap type flow element mounting with isolation valve and packing gland for removal/reinsertion of element without shutting down the line. Materials shall be compatible with process air piping material as specified in Division 15.

4. Required Options and Accessories:
a. Provide one (1) portable calibrator unit for field checking and adjusting flowmeter calibration.
b. Local Indication:
1) Flow Rate Indicator: Liquid crystal display with 3-1/2 digits scaled in SCFM.
2) Totalizer: 8 digit liquid crystal display counter with lithium battery backup.
c. Interconnecting Cable: Provide standard interconnecting cable between sensor head housing and remote electronic housing. Cable length as required per installation shown on Contract Drawings.
d. Provide special temperature compensation circuitry for 90°F process temperature range.

5. Manufacturer and Model Number:
a. Fluid Components, Inc., Model LT81A.
b. Or equal.

N. Parshall Flume:

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O. Ultrasonic Level Measurement:
1. General: The ultrasonic level system shall consist of a sensor and a transmitter.
2. Sensor: The sensor shall be flange mounted type on a 2-inch, 150 lb., ANSI flatface flange. The unit shall be furnished with 10 feet of special cable. The sensor beam angle shall be 7 degrees (conical). The range shall be 0-20 feet.
3. Transmitter: The transmitter shall be field mounted outdoors. A local meter shall indicate level in feet. The output signal shall be 4-20 MADC. The input power shall be 117 VAC, 60 Hz. The outdoor temperature range shall not exceed +32°F to 122°F. Accuracy shall be within 1/2% of full scale. Four alarm points independently adjustable, rated 5 amps, shall be provided.
4. Manufacturer:
a. XERTEX Model No. 8100

P. Pressure Switches:
1. Required Features:
a. Pressure switches shall be furnished with stainless steel or brass internals and a case conforming to NEMA 4X requirements. Switches shall be diaphragm type, with snap action switches and SPDT contacts rated at not less than 10 amps at 120 volts.

b. All switches shall be adjustable over the full range and shall have visible indicating set point scales. Accuracy shall be ±2 percent of set point. Deadband shall be 2 percent maximum.
c. Provide single or two stage independently adjustable switches as required.

2. Product Manufacturer: Provide one of the following:
a. ASCO.

Q. Propeller Flowmeter:
1. General: The propeller flowmeter shall be in-line type with local rate indicator, totalizer and remote mounted conversion module.
2. The flow element shall be manufactured to comply with the applicable provisions of the American Water Works Association Standard No. C704-70 for propeller type flowmeters. The impeller and drive assembly are removed and replaced through the open end of the meter tube. Magnetic drive, instantaneous flow rate indicator, straight reading totalizer and optical pulse transmitter. The flow element shall be provided with 150 lbs. AWWA Class D flanges and straightening vanes.
3. The conversion module shall accept a scaled pulsed input linear with flow and output a 4-20 MADC analog signal. The module shall be suitable for remote mounting.
4. Manufacturer:
a. A meter/McCrometer Model MW 500/MZ500 with Model EA610-00 optical pulse transmitter and Model EA210-00 current conversion module.

R. CL2 Residual Analyzer:

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PART 3 - EXECUTION

3.1 INSTALLATION

A. Install each item in accordance with manufacturers recommendations and in accordance with the Contract Documents. Transmitters and instruments requiring access for periodic calibration or maintenance shall be mounted so they are accessible while standing on the floor.

B. All items shall be mounted and anchored using stainless steel hardware unless otherwise noted.

C. Conform to all applicable provisions of NEMA standards and NEC when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, AND TESTING AND TRAINING

A. Comply with the requirements of Section 13A.

3.3 INSTRUMENT AND ANNUNCIATOR LISTS

A. Comply with the requirements of the Instrument and Annunciator Lists.

B. By vendor on Instrument List means item is provided as part of the packaged controls for the piece of equipment.

+ + END OF SECTION + +

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	NA 206		INFLUENT STATION			ICP	X	X
	PAL 206		INFLUENT STATION			ICP	X	X
	UA 206		INFLUENT STATION	13A50	2.9D	MSP	I	I
	UA 206A		INFLUENT STATION			CMP	X	X
	QS 206		INFLUENT STATION			MCC	X	X
	NS 206		INFLUENT STATION			MCC	X	X
	PI 206		INFLUENT STATION			F	X	X
	NA 207		INFLUENT STATION			ICP	E	E
	NA 207A		INFLUENT STATION	13A50	2.9D	MSP	I	I
	NA 207B		INFLUENT STATION	13A50	2.9F	CMP	I	I
	QI 207		INFLUENT STATION	13A50	2.9F	CMP	I	I
	QS 207		INFLUENT STATION			MCC	E	E
	NS 207		INFLUENT STATION			MCC	E	E
	PI 207		INFLUENT STATION			F	M	M
	ZS 207		INFLUENT STATION			F	M	M
	NA 208		INFLUENT STATION			ICP	E	E
	NA 208A		INFLUENT STATION	13A50	2.9D	MSP	I	I
	NA 208B		INFLUENT STATION	13A50	2.9F	CMP	I	I
	QS 208B		INFLUENT STATION			MCC	E	E
	NS 208		INFLUENT STATION			MCC	E	E
	PI 208		INFLUENT STATION			F	M	M
	ZS 208		INFLUENT STATION			F	M	M
	FY 209		INFLUENT FLOWMETER	13A50	2.9E	MSP	I	I
	ZI 209		INFLUENT FLOWMETER	13A50	2.9A	MSP	I	I
	FIC 209		INFLUENT FLOWMETER	13A50	2.9B	MSP	I	I
	FIQ 209		INFLUENT FLOWMETER	13A50	2.9E	MSP	I	I
	FIQ 209		INFLUENT FLOWMETER	1350	2.9F	CMP	I	I
	ZT 209		INFLUENT FLOWMETER			F	M	M
	FIT 209		INFLUENT FLOWMETER	13A20	2.2J	F	I	I
	FE 209		INFLUENT FLOWMETER	13A20	2.2J	F	I	I
	FE 209A		INFLUENT FLOWMETER	13A20	2.2N	F	I	M

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	LAH 210		SCREEN	13A50	2.9D	MSP	I	I
	KS 210		SCREEN			LCP	E	E
	QI 210		SCREEN	13A50	2.9F	CMP	I	I
	NA 210		SCREEN			ICP	E	E
	XAL 210		SCREEN			ICP	E	E
	UA 210		SCREEN	13A50	2.9F	ICP	I	I
	UA 210		SCREEN	13A50	2.9F	CMP	I	I
	LSH 210		SCREEN			F	M	M
	NS 210		SCREEN			MCC	E	E
	QS 210		SCREEN			MCC	E	E
	AI 301 (DO)		AERATION	13A50	2.9A	MSP	I	I
	AY 301 (DO)		AERATION			LCP	M	M
	AAH 301 (DO)		AERATION			LCP	M	M
	AAH 301A (DO)		AERATION	13A50	2.9D	MSP	I	I
	AAH 301B (DO)		AERATION	13A50	2.9F	CMP	I	I
	AI 301B (DO)		AERATION	13A50	2.9F	CMP	I	I
	AIT 301 (DO)		AERATION	13A20	2.2L	F	I	I
	AE 301 (DO)		AERATION	13A20	2.2L	F		
	AI 302 (DO)		AERATION	13A50	2.9A	MSP	I	I
	AY 302 (DO)		AERATION			LCP	M	M
	AAH 302 (DO)		AERATION			LCP	M	M
	AAH 302A (DO)		AERATION	13A50	2.9D	MSP	I	I
	AAH 302B (DO)		AERATION	13A50	2.9F	CMP	I	I
	AI 302B (DO)		AERATION	13A50	2.9F	CMP	I	I
	AIT 302 (DO)		AERATION	13A20	2.2L	F	I	I
	AE 302 (DO)		AERATION	13A20	2.2L	F	I	I
	FI 303		AERATION			F	M	M
	FE 303		AERATION			F	M	M
	FI 304		AERATION			F	M	M
	FE 304		AERATION			F	M	M
	FI 305		AERATION			F	M	M
	FE 305		AERATION			F	M	M

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	FI 306		AERATION			F	M	M
	FE 306		AERATION			F	M	M
	FI 307		AERATION			F	M	M
	FE 307		AERATION			F	M	M
	FI 308		AERATION			F	M	M
	FE 308		AERATION			F	M	M
	LAH 309		AERATION EFFLUENT	13A50	2.9D	MSP	I	I
	LAH 309A		AERATION EFFLUENT	13A50	2.9F	CMP	I	I
	LSH 309		AERATION EFFLUENT	13A20	2.2G	F	I	I
	XAH 310		SECONDARY CLARIFIER			LCP	M	M
	XAH 310A		SECONDARY CLARIFIER	13A50	2.9D	MSP	I	I
	XAHH 310		SECONDARY CLARIFIER	13A50	2.9F	LCP	M	M
	XAHH 310A		SECONDARY CLARIFIER	13A50	2.9D	MSP	I	I
	XAHH 310B		SECONDARY CLARIFIER	13A50	2.9F	CMP	I	I
	NA 310		SECONDARY CLARIFIER			LCP	M	M
	NA 310A		SECONDARY CLARIFIER	13A50	2.9D	MSP	I	I
	NA 310B		SECONDARY CLARIFIER	13A50	2.9F	CMP	I	I
	QI 310		SECONDARY CLARIFIER	13A50	2.9F	CMP	I	I
	XSH 310		SECONDARY CLARIFIER			F	M	M
	XSHH 310		SECONDARY CLARIFIER			F	M	M
	XI 310		SECONDARY CLARIFIER			F	M	M
	NS 310		SECONDARY CLARIFIER			MCC	E	E
	QS 310		SECONDARY CLARIFIER			MCC	E	E
	LI 311		SLUDGE WET WELL	13A50	2.9A	MSP	I	I
	LI 311A		SLUDGE WET WELL	13A50	2.9F	CMP	I	I
	LAL 311		SLUDGE WET WELL	13A50	2.9D	MSP	I	I
	LAL 311A		SLUDGE WET WELL	13A50	2.9F	CMP	I	I
	LAH 311		SLUDGE WET WELL	13A50	2.9D	MSP	I	I
	LAH 311A		SLUDGE WET WELL	13A50	2.9F	CMP	I	I
	LIT 311		SLUDGE WET WELL	13A20	2.9P	F	I	I
	LE 311		SLUDGE WET WELL	13A20	2.9P	F	I	I
	LSH 311		SLUDGE WET WELL	13A20	2.9P	F	I	I
	LSL 311		SLUDGE WET WELL	13A20	2.9P	F	I	I

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	QI 312		RAS/WAS STATION	13A50	2.9F	CMP	I	I
	NA 312		RAS/WAS STATION	13A50	2.9D	MSP	I	I
	UA 312		RAS/WAS STATION	13A50	2.9F	CMP	I	I
	PAH 312		RAS/WAS STATION	13A50	2.9D	MSP	I	I
	PSH 312		RAS/WAS STATION	13A20	2.9C	F	I	I
	NS 312		RAS/WAS STATION			MCC	E	E
	QS 312		RAS/WAS STATION			MCC	M	M
	PI 312		RAS/WAS STATION			F	M	M
	PI 312A		RAS/WAS STATION			F	M	M
	NA 313		RAS/WAS	13A50	2.9D	MSP	I	I
	PAH 313		RAS/WAS	13A50	2.9D	MSP	I	I
	UA 313		RAS/WAS	13A50	2.9F	CMP	I	I
	QI 313		RAS/WAS	13A50	2.9F	CMP	I	I
	PSH 313		RAS/WAS	13A20	2.9C	F	I	I
	NS 313		RAS/WAS			MCC	E	E
	QS 313		RAS/WAS			MCC	E	E
	PI 313		RAS/WAS			F	M	M
	PI 313A		RAS/WAS			F	M	M
	KS 314		WAS SOLVENT			LCP	M	M
	FY 315		RAS FLOW	13A50	2.9E	MSP	I	I
	FIQ 315		RAS FLOW			LCP	M	M
	FIQ 315A		RAS FLOW	13A50	2.9E	MSP	I	I
	FIQ 315B		RAS FLOW	13A50	2.9F	CMP	I	I
	FIT 315		RAS FLOW	13A20	2.2A	F	I	I
	FE 315		RAS FLOW	13A20	2.2A	F	I	I
	FIQ 316		WAS FLOW			LCP	M	M
	FIQ 316A		WAS FLOW	13A50	2.9E	MSP	I	I
	FIQ 316B		WAS FLOW	13A50	2.9F	CMP	I	I
	FIT 316		WAS FLOW	13A20	2.2A	F	I	I
	FE 316		WAS FLOW	13A20	2.24	F	I	I
	FY 316		WAS FLOW	13A50	2.9E	MSP	I	I

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	PDAH 401		BLOWER FILTER			LCP	E	E
	UA 401		BLOWER FILTER	13A50	2.9D	MSP	I	I
	UA 401A		BLOWER FILTER	13A50	2.9F	CMP	I	I
	PDSH 401		BLOWER FILTER	13A20	2.2C	F	I	I
	PDAH 402		BLOWER FILTER			LCP	E	E
	PDSH 402		BLOWER FILTER	13A20	2.2C	F	I	I
	PDAH 403		BLOWER FILTER			LCP	E	E
	PDSH 403		BLOWER FILTER	13A20	2.2C	F	I	I
	PAL 404		BLOWER			LCP	E	E
	PSL 404		BLOWER	13A20	2.2C	F	I	I
	PI 404		BLOWER			F	M	M
	PAL 405		BLOWER					
	PSL 405		BLOWER					
	PI 405		BLOWER					
	PAL 406		BLOWER			LCP		
	PSL 406		BLOWER	13A20	2.2C	F	I	I
	PI 406		BLOWER			F	M	M
	II 407		BLOWER			LCP	E	E
	VAH 407		BLOWER			LCP	E	E
	NA 407		BLOWER	13A50	2.9D	MSP	I	I
	NA 407A		BLOWER	13A50	2.9F	CMP	I	I
	QI 407		BLOWER	13A50	2.9F	CMP	I	I
	IE 407		BLOWER			F	E	E
	VSH 407		BLOWER			F	M	M
	NS 407		BLOWER			MCC	E	E
	QS 407		BLOWER			MCC	E	E

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	II 408		BLOWER			LCP	E	E
	VAH 408		BLOWER			LCP	E	E
	NA 408		BLOWER	13A50	2.9D	MSP	I	I
	NA 408A		BLOWER	13A50	2.9F	CMP	I	I
	QI 408		BLOWER	13A50	2.9F	CMP	I	I
	IE 408		BLOWER			MCC	E	E
	VSH 408		BLOWER			F	M	M
	NS 408		BLOWER			MCC	E	E
	QS 408		BLOWER			MCC	E	E
	II 409		BLOWER			LCP	E	E
	VAH 409		BLOWER			LCP	E	E
	NA 409		BLOWER	13A50	2.9D	MSP	I	I
	NA 409A		BLOWER	13A50	2.9F	CMP	I	I
	QI 409		BLOWER	13A50	2.9F	CMP	I	I
	IE 409		BLOWER			MCC	E	E
	VSH 409		BLOWER			F	M	M
	NS 409		BLOWER			MCC	E	E
	QS 409		BLOWER			MCC	E	E
	TAH 410		BLOWER			LCP	E	E
	TSH 410		BLOWER			F	M	M
	TI 410		BLOWER			F	M	M
	PI 410		BLOWER			F	M	M
	TAH 411		BLOWER			LCP	E	E
	TSH 411		BLOWER			F	M	M
	TI 411		BLOWER			F	M	M
	PI 411		BLOWER			F	M	M
	TAH 412		BLOWER			LCP	E	E
	TSH 412		BLOWER			F	M	M
	TI 412		BLOWER			F	M	M
	PI 412		BLOWER			F	M	M

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ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	FI 413		AIR MANIFOLD FLOW	13A50	2.9A	MSP	I	I
	FIR 413		AIR MANIFOLD FLOW	13A50	2.9F	CMP	I	I
	FIT 413	0.25-200 FPS	AIR MANIFOLD FLOW	13A20	2.2M	F	I	I
	FE 413		AIR MANIFOLD FLOW	13A20	2.2M	F	I	I
	HS 414		BLOWER RM SUMP PUMPS			LCP	M	M
	QS 414		BLOWER RM SUMP PUMPS			MCC	E	E
	FSH 414		BLOWER RM SUMP PUMPS			F	M	M
	QS 414A		BLOWER RM SUMP PUMPS			MCC	E	E
	FSH 414A		BLOWER RM SUMP PUMPS			F	M	M
	LSH 414		BLOWER RM SUMP PUMPS			F	M	M
	LSM 414		BLOWER RM SUMP PUMPS			F	M	M
	LSL 414		BLOWER RM SUMP PUMPS			F	M	M
	LAH 414		BLOWER RM SUMP PUMPS			LCP	M	M
	LAH 414A		BLOWER RM SUMP PUMPS	13A50	2.9D	MSP	I	I
	LAH 414B		BLOWER RM SUMP PUMPS	13A50	2.9F	CMP	I	I
	FIQ 501		POTABLE WATER	13A50	2.9E	MSP	I	I
	FIQ 501A		POTABLE WATER	13A50	2.9F	CMP	I	I
	FIT 501		POTABLE WATER	13A20	2.2R	F	I	I
	FE 501		POTABLE WATER	13A20	2.2R	F	I	I
	FY 501		POTABLE WATER	13A50	2.9E	MSP	I	I
	AIR 502 (TURB)		EFFLUENT TURBIDITY	13A50	2.9C	MSP	I	I
	AIR 502A (TURB)		EFFLUENT TURBIDITY	13A50	2.9F	CMP	I	I
	AIT 502 (TURB)		EFFLUENT TURBIDITY	13A20	2.2D	F	I	I
	AE 502 (TURB)		EFFLUENT TURBIDITY	13A20	2.2D	F	I	I
	FY 503		CL2 TANK EFFLUENT	13A50	2.9E	MSP	I	I
	FIQ 503		CL2 TANK EFFLUENT	13A20	2.9A	MSP	I	I
	FIQ 503A		CL2 TANK EFFLUENT	13A50	2.9F	CMP	I	I
	FIT 503		CL2 TANK EFFLUENT	13A20	2.2R	F	I	I
	FE 503		CL2 TANK EFFLUENT	13A20	2.2R	F	I	I
	LAH 504		FILTER INFLUENT LEVEL	13A50	2.9A	MSP	I	I
	LAH 504A		FILTER INFLUENT LEVEL	13A50	2.9F	CMP	I	I
	LSH 504		FILTER INFLUENT LEVEL	13A20	2.2G	F	I	I

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	LAH 505		EFFLUENT PUMP WET WELL			LCP	M	M
	LAH 505A		EFFLUENT PUMP WET WELL	13A50	2.9D	MSP	I	I
	LAH 505B		EFFLUENT PUMP WET WELL	13A50	2.9F	CMP	I	I
	LSH 505		EFFLUENT PUMP WET WELL	13A20	2.2G	F	I	I
	LSL 505		EFFLUENT PUMP WET WELL	13A20	2.2G	F	I	I
	LE 505		EFFLUENT PUMP WET WELL	13A20	2.2G	F	I	I
	PIR 506A		EFFLUENT PUMP STATION	13A50	2.9F	CMP	I	I
	PIR 506		EFFLUENT PUMP STATION	13A50	2.9C	MSP	I	I
	PI 506		EFFLUENT PUMP STATION			LCP	M	M
	PY 506 (H)		EFFLUENT PUMP STATION			LCP	M	M
	PY 506 (M)		EFFLUENT PUMP STATION			LCP	M	M
	PY 506 (L)		EFFLUENT PUMP STATION			LCP	M	M
	HS 506		EFFLUENT PUMP STATION			LCP	M	M
	NA 506		EFFLUENT PUMP STATION			LCP	M	M
	NA 506A		EFFLUENT PUMP STATION	13A50	2.9D	MSP	I	I
	NA 506B		EFFLUENT PUMP STATION	13A50	2.9F	CMP	I	I
	NS 506		EFFLUENT PUMP STATION			MCC	E	E
	QS 506		EFFLUENT PUMP STATION			MCC	E	E
	PI 506		EFFLUENT PUMP STATION			F	M	M
	PSH 506		EFFLUENT PUMP STATION	13A20	2.2C	F	I	I
	NA 507		EFFLUENT PUMP STATION			LCP	M	M
	NA 507A		EFFLUENT PUMP STATION	13A50	2.9D	MSP	I	I
	NA 507B		EFFLUENT PUMP STATION	13A50	2.9F	CMP	I	I
	NS 507		EFFLUENT PUMP STATION			MCC	E	E
	QS 507		EFFLUENT PUMP STATION			MCC	E	E
	PI 507		EFFLUENT PUMP STATION			F	M	M
	PSH 507		EFFLUENT PUMP STATION	13A20	2.2C	F	I	I
	AIC 508		EFFLUENT PUMP STATION			F	M	M
	NA 508		EFFLUENT PUMP STATION			LCP	M	M
	NA 508A		EFFLUENT PUMP STATION	13A50	2.9D	MSP	I	I
	NA 508B		EFFLUENT PUMP STATION	13A50	2.9F	CMP	I	I
	NS 508		EFFLUENT PUMP STATION			MCC	E	E
	QS 508		EFFLUENT PUMP STATION			MCC	E	E
	PI 508		EFFLUENT PUMP STATION			F	M	M
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	NA 509		FILTER BRIDGE	13A50	2.9D	MSP	I	I
	NA 509A		FILTER BRIDGE	13A50	2.9F	CMP	I	I
	QI 509		FILTER BRIDGE			CMP	I	I
	NS 509		FILTER BRIDGE			MCC	M	M
	QS 509		FILTER BRIDGE			MCC	M	M
	AIR 510 (CL2)		CL2 TANK EFFLUENT	13A50	2.9C	MSP	I	I
	AY 510 (L)		CL2 TANK EFFLUENT	13A50	2.7	MSP	I	I
	AAL 510 (CL2)		CL2 TANK EFFLUENT	13A50	2.9D	MSP	I	I
	AAL 510A (CL2)		CL2 TANK EFFLUENT	13A50	2.9F	CMP	I	I
	AIR 510A (CL2)		CL2 TANK EFFLUENT	13A50	2.9F	CMP	I	I
	AY 510 (H)		CL2 TANK EFFLUENT	13A50	2.7	MSP	I	I
	AAH 510 (CL2)		CL2 TANK EFFLUENT	13A50	2.9D	MSP	I	I
	AAH 510A (CL2)		CL2 TANK EFFLUENT	13A50	2.9F	CMP	I	I
	AIT 510		CL2 TANK EFFLUENT	13A20	2.2S	F	M	M
	AE 510		CL2 TANK EFFLUENT	13A20	2.2S	F	M	M
	AI 511 (CL2)		IRRIGATION SYSTEM	13A50	2.9A	MSP	I	I
	AY 511 (L)		IRRIGATION SYSTEM	13A50	2.7	MSP	I	I
	AAL 511 (CL2)		IRRIGATION SYSTEM	13A50	2.9D	MSP	I	I
	AAL 511A (CL2)		IRRIGATION SYSTEM	13A50	2.9F	CMP	I	I
	AIR 511 (CL2)		IRRIGATION SYSTEM	13A50	2.9F	CMP	I	I
	AY 511 (H)		IRRIGATION SYSTEM	13A50	2.7	MSP	I	I
	AAH 511 (CL2)		IRRIGATION SYSTEM	13A50	2.9D	MSP	I	I
	AAH 511A (CL2)		IRRIGATION SYSTEM	13A50	2.9F	CMP	I	I
	AIT 511 (CL2)		IRRIGATION SYSTEM			F	M	M
	AE 511 (CL2)		IRRIGATION SYSTEM			F	M	M
	FIQ 512		IRRIGATION SYSTEM			LCP	M	M
	FIQ 512A		IRRIGATION SYSTEM	13A50	2.9E	MSP	I	I
	FIQR 512		IRRIGATION SYSTEM	13A50	2.9F	CMP	I	I
	FIT 512		IRRIGATION SYSTEM	13A20	2.2R	F	I	I
	FE 512		IRRIGATION SYSTEM	13A20	2.2R	F	I	I
	AIC 512		IRRIGATION SYSTEM			F	M	M

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	UA 513		POTABLE WATER PUMPS	13A50	2.9D	MSP	I	I
	UA 513A		POTABLE WATER PUMPS	13A50	2.9F	CMP	I	I
	QI 513		POTABLE WATER PUMPS	13A50	2.9F	CMP	I	I
	QI 513A		POTABLE WATER PUMPS	13A50	2.9F	CMP	I	I
	NS 513		POTABLE WATER PUMPS			MCC	E	E
	QS 513		POTABLE WATER PUMPS			MCC	E	E
	PI 513		POTABLE WATER PUMPS			F	M	M
	PI 513A		POTABLE WATER PUMPS			F	M	M
	PSH 513		POTABLE WATER PUMPS			F	M	M
	NS 513A		POTABLE WATER PUMPS			MCC	E	E
	QS 513A		POTABLE WATER PUMPS			MCC	E	E
	PI 513B		POTABLE WATER PUMPS			F	M	M
	PI 513C		POTABLE WATER PUMPS			F	M	M
	PSH 513A		POTABLE WATER PUMPS			F	M	M
	PAL 514		POTABLE WATER	13A50	2.9D	MSP	I	I
	PAL 514A		POTABLE WATER	13A50	2.9F	CMP	I	I
	PSL 514		POTABLE WATER	13A20	2.2C	F	I	I
	PI 601		CHLORINE ROOM			F	M	M
	WAL 601		CHLORINE ROOM			LCP	M	M
	WAL 601A		CHLORINE ROOM	13A50	2.9D	MSP	I	I
	WAL 601B		CHLORINE ROOM	13A50	2.9F	CMP	I	I
	WI 601		CHLORINE ROOM			F	M	M
	WSL 601		CHLORINE ROOM			F	M	M
	AAH 602 (LEAK)		CHLORINE ROOM			LCP	M	M
	AAH 602A (LEAK)		CHLORINE ROOM	13A50	2.9D	MSP	I	I
	AAH 602B (LEAK)		CHLORINE ROOM	13A50	2.9F	CMP	I	I
	AI 602 (LEAK)		CHLORINE ROOM			F	M	M
	ASH 602 (LEAK)		CHLORINE ROOM			F	M	M

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	NA 603		CL2 BOOSTER PUMPS	13A50	2.9D	MSP	I	I
	UA 603		CL2 BOOSTER PUMPS	13A50	2.9F	CMP	I	I
	NS 603		CL2 BOOSTER PUMPS			MCC	E	E
	QS 603		CL2 BOOSTER PUMPS			MCC	E	E
	PSH 603		CL2 BOOSTER PUMPS	13A20	2.2C	F	I	I
	PI 603		CL2 BOOSTER PUMPS			F	M	M
	QI 603		CL2 BOOSTER PUMPS	13A50	2.9F	CMP	I	I
	NA 604		CL2 BOOSTER PUMPS	13A50	2.9D	MSP	I	I
	NS 604		CL2 BOOSTER PUMPS			MCC	E	E
	QS 604		CL2 BOOSTER PUMPS			MCC	E	E
	PSH 604		CL2 BOOSTER PUMPS			F	I	I
	PI 604		CL2 BOOSTER PUMPS	13A20	2.2C	F	M	M
	QI 604		CL2 BOOSTER PUMPS	13A50	2.9F	CMP	I	I
	UA 605		CL2 BOOSTER PUMPS			LCP	M	M
	HC 606		CHLORINATOR			F	M	M
	HC 607		CHLORINATOR			F	M	M
	HC 608		CHLORINATOR			F	M	M
	PI 609		POTABLE WATER			F	M	M
	PI 610		POTABLE WATER			F	M	M
	PI 611		CL2 TO RECLAMATION PUMP STATION			F	M	M
	AI 701 (ORP)		ODOR CONTROL SYSTEM			LCP	M	M
	AI 701A (ORP)		ODOR CONTROL SYSTEM	13A50	2.9A	MSP	I	I
	AIR 701 (ORP)		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	AIT 701 (ORP)		ODOR CONTROL SYSTEM			F	M	M
	AE 701 (ORP)		ODOR CONTROL SYSTEM			F	M	M
	HS 702		ODOR CONTROL SYSTEM			LCP	M	M

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	NA 703		ODOR CONTROL SYSTEM			LCP	M	M
	NA 703A		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	NA 703B		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	NS 703		ODOR CONTROL SYSTEM					
	QS 703		ODOR CONTROL SYSTEM					
	PI 703		ODOR CONTROL SYSTEM					
	PSH 703		ODOR CONTROL SYSTEM					
	PAH 703		ODOR CONTROL SYSTEM			LCP	M	M
	UA 703		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	UA 703A		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	QI 703		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	LAL 705		ODOR CONTROL SYSTEM			LCP	M	M
	LI 705		ODOR CONTROL SYSTEM			F	M	M
	LSL 705		ODOR CONTROL SYSTEM			F	M	M
	PAH 706		ODOR CONTROL SYSTEM			LCP	M	M
	PSH 706		ODOR CONTROL SYSTEM			F	M	M
	NA 706		ODOR CONTROL SYSTEM			LCP	M	M
	NA 706A		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	NA 706B		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	QS 706		ODOR CONTROL SYSTEM			MCC	M	M
	NS 706		ODOR CONTROL SYSTEM			MCC	M	M
	PAH 707		ODOR CONTROL SYSTEM			LCP	M	M
	PSH 707		ODOR CONTROL SYSTEM			F	M	M
	NA 707		ODOR CONTROL SYSTEM			LCP	M	M
	NA 707A		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	NA 707B		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	QS 707		ODOR CONTROL SYSTEM			MCC	M	M
	NS 707		ODOR CONTROL SYSTEM			MCC	M	M
	PAH 708		ODOR CONTROL SYSTEM			LCP	M	M
	PSH 708		ODOR CONTROL SYSTEM			F	M	M
	PI 708		ODOR CONTROL SYSTEM			F	M	M
	NA 708		ODOR CONTROL SYSTEM			LCP	M	M

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	NA 708A		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	F
	NA 708B		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	NS 708		ODOR CONTROL SYSTEM			MCC	M	M
	QS 708		ODOR CONTROL SYSTEM			MCC	M	M
	PAH 709		ODOR CONTROL SYSTEM			LCP	M	M
	PSH 709		ODOR CONTROL SYSTEM			F	M	M
	PI 709		ODOR CONTROL SYSTEM			F	M	M
	NA 709		ODOR CONTROL SYSTEM			LCP	M	M
	NA 709A		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	NA 709B		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	NS 709		ODOR CONTROL SYSTEM			MCC	M	M
	QS 709		ODOR CONTROL SYSTEM			MCC	M	M
	PAH 710		ODOR CONTROL SYSTEM			LCP	M	M
	PSH 710		ODOR CONTROL SYSTEM			F	M	M
	PI 710		ODOR CONTROL SYSTEM			F	M	M
	NA 710		ODOR CONTROL SYSTEM			LCP	M	M
	NA 710A		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	NA 710B		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	NS 710		ODOR CONTROL SYSTEM			MCC	M	M
	QS 710		ODOR CONTROL SYSTEM			MCC	M	M
	PAH 711		ODOR CONTROL SYSTEM			LCP	M	M
	PSH 711		ODOR CONTROL SYSTEM			F	M	M
	PI 711		ODOR CONTROL SYSTEM			F	M	M
	NA 711		ODOR CONTROL SYSTEM			LCP	M	M
	NA 711A		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	NA 711B		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	NS 711		ODOR CONTROL SYSTEM			MCC	M	M
	QS 711		ODOR CONTROL SYSTEM			MCC	M	M
	PAH 712		ODOR CONTROL SYSTEM			LCP	M	M
	PSH 712		ODOR CONTROL SYSTEM			F	M	M
	PI 712		ODOR CONTROL SYSTEM			F	M	M
	NA 712		ODOR CONTROL SYSTEM			LCP	M	M

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	NA 712A		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	NA 712B		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	NS 712		ODOR CONTROL SYSTEM			MCC	M	M
	QS 712		ODOR CONTROL SYSTEM			MCC	M	M
	AI 713 (PH)		ODOR CONTROL SYSTEM			LCP	M	M
	AY 713 (PH)		ODOR CONTROL SYSTEM			LCP	M	M
	AAH 713		ODOR CONTROL SYSTEM			LCP	M	M
	AI 713A (PH)		ODOR CONTROL SYSTEM	13A50	2.9A	MSP	I	I
	AIR 713 (PH)		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	AAH 713A (PH)		ODOR CONTROL SYSTEM	13A50	2.9D	MSP	I	I
	AAH 713B (PH)		ODOR CONTROL SYSTEM	13A50	2.9F	CMP	I	I
	AIT 713 (PH)		ODOR CONTROL SYSTEM			F	M	M
	AE 713 (PH)		ODOR CONTROL SYSTEM			F	M	M

INSTRUMENT LIST

ITEM	TAG NO.	RANGE/SETPOINT	DESCRIPTION	SPEC. REFERENCE	MAT'L. REFERENCE	LOCATION	FURNISHED BY	INSTALLED BY
	LI 201		INFLUENT STATION			ICP	X	X
	FI 201		INFLUENT STATION			ICP	X	X
	PI 201		INFLUENT STATION			ICP	X	X
	PAL 201		INFLUENT STATION			ICP	X	X
	PSL 201		INFLUENT STATION			ICP	X	X
	PS1 201		INFLUENT STATION			ICP	X	X
	PS2 201		INFLUENT STATION			ICP	X	X
	PS3 201		INFLUENT STATION			ICP	X	X
	PSL 201		INFLUENT STATION			ICP	E	E
	PSH 201		INFLUENT STATION			ICP	E	E
	LE 201		INFLUENT STATION	13A20	2.2G	F	I	I
	NA 202		INFLUENT STATION	13A50	2.9F	ICP	E	E
	NA 202A		INFLUENT STATION	13A50	2.9D	MSP	I	I
	NA 202B		INFLUENT STATION			LCP-	E	E
	QI 202		INFLUENT STATION	13A50	2.9F	CMP	I	I
	UA 202		INFLUENT STATION	13A50	2.9F	CMP	I	I
	QS 202		INFLUENT STATION			MCC	E	E
	NS 202		INFLUENT STATION			MCC	E	E
	NA 203		INFLUENT STATION			ICP	E	E
	NA 203A		INFLUENT STATION	13A50	2.9D	MSP	I	I
	NA 203B		INFLUENT STATION			LCP	E	E
	NS 203		INFLUENT STATION			MCC	E	E
	QS 203		INFLUENT STATION			MCC	E	E
	LAH 204		INFLUENT STATION SUMP PUMP			CMP	X	X
	NA 205		INFLUENT STATION			ICP	X	X
	PAL 205		INFLUENT STATION			ICP	X	X
	UA 205		INFLUENT STATION	13A50	2.9D	MSP	I	I
	UA 205A		INFLUENT STATION			CMP	X	X
	QS 205		INFLUENT STATION			MCC	X	X
	NS 205		INFLUENT STATION			MCC	X	X
	PSL 205		INFLUENT STATION			F	X	X
	PI 205		INFLUENT STATION			F	X	X

SECTION 13A30

WET STREAM TREATMENT SYSTEMS
OPERATIONAL AND FUNCTIONAL REQUIREMENTS

PART 1 - MEASUREMENTS AND MONITORING

1.1 MAJOR CONTROL LOOP DESCRIPTIONS

A. Influent Pump Station:

1. The sewage influent enters the Lift Station wet-well through two sewage grinders. Each grinder shall be provided with a lock-out stop pushbutton at the grinder location and a start/stop pushbutton at the Influent Pump Control Panel. The local panel shall annunciate a malfunction, provide an interlock to shut down the grinder, and include an ON/OFF indicating light. The Main Status Panel (MSP), located in the plant operations building, shall monitor grinder malfunction and run status. The Central Monitoring Panel (CMP), located at Cholla Water Treatment Plant, shall monitor malfunction and run status.
2. Each influent pump shall be provided with a lockout stop pushbutton at the pump location and a Hand-Off-Auto switch at the Influent Pump Control Panel.
3. In the "HAND" position, the pumps shall operate continuously, until the wet well level reaches low level. In the "AUTO" position, one of the 350 gpm pumps (Run) will start when the level in the wet well rises to the run start level. At high level one of the 3,000 gpm pumps shall start and pump into the existing 24-inch sewer. At High-High level, the second 3,000 gpm pump will start. The pumps will be sequenced to shut down on descending water level. Pumps No. 3 and 4 shall be provided with an alternator. The local Influent Pump Control Panel shall annunciate an alarm due to a malfunction and will be interlocked to shutdown the pump, and shall include an ON/OFF indicating light. The MSP shall monitor pump malfunction and run status. The CMP shall monitor pump malfunction, pump high discharge pressure and run status.

B. Influent Flow Measurement:

1. An Ultrasonic flow meter shall monitor influent flow through a parshall flume. The meter shall transmit the analog signal linearly proportional to flow rate to the MSP which shall contain a flow totalizer and a flow indicating controller. The flow controller shall compare influent flow with the set point and the output shall modulate the motorized control gate located at the Flow Diversion Chamber. Excess influent flow shall be diverted to the existing 24-inch sewer. The CMP shall also monitor and totalize flow.

C. Rotary Screen:

1. The rotary screen shall be provided with a lock-out stop pushbutton at the screen location and a Hand-Off-Auto selector switch at the local Manufacturer's Furnished Panel (MFP).
2. The Screen drive motor shall be started manually when the selector switch is in the "HAND" position. The screen drive motor shall be interlocked with the 350 gpm influent pump, such that whenever the influent pump is running the screen shall run. When the influent

pump shuts down, the Screen shall shut down after an adjustable timer has timed out.

3. The local screen control panel shall annunciate an alarm due to a screen overload malfunction and provide an interlock to shut down the screen, and shall also include an ON/OFF indicating light. The MSP shall monitor malfunction, run status, and record elapsed run time. The CMP shall monitor malfunction and run status.

D. Aeration/Blower Control:

1. Dissolved Oxygen (DO) levels in the aeration basins will be monitored by a DO analyzer. A local probe will transmit a signal to a DO indicator. Should the basin DO level exceed the alarm setpoints, the local blower control panel shall annunciate an alarm at the MSP and CMP.
2. The local blower MFP control panel shall annunciate alarms as shown on the Drawings. The MSP shall annunciate all alarms and show run status. The CMP shall monitor all alarms, and the run status.

E. Clarifiers:

1. Sludge collector drive shall be provided with a lock-out stop pushbutton and start-stop pushbutton at the drive location.
2. Torque on the collector drive shaft shall be monitored with a torque indicator and torque switch. When the sludge collector drive torque reaches the high torque setpoint an alarm is annunciated at the MFP Control Panel for pending High-High torque shut down. When the sludge collector drive torque reaches the High-High torque an interlock will shut down the drive unit and an alarm shall be annunciated on the MFP Control Panel. A sludge collector drive motor malfunction will annunciate an alarm and an interlock will shutdown the motor. The alarm annunciator and an ON/OFF indicating light are included in the local panel.
3. The MSP shall monitor the High torque alarm, High-High torque alarm and shut down, sludge collector drive malfunction, run status, and record elapsed run time. The CMP shall monitor the High and High-High torque alarms, sludge collector drive malfunction, and run status.

F. Return/Waste (RAS) Sludge Pumping System:

1. Sludge pumps shall be provided with lock-out stop pushbuttons at the pump location and with Hand-Off-Auto selector switches at the RAS Pump Control Panel.
2. Return sludge is collected in the clarifier sludge well and flows by gravity to the RAS wet well. Return sludge flow rate is controlled by manually adjusting the telescopic valve. The return sludge flow rate shall be monitored by a flow meter which shall transmit an analog signal linearly proportional to flow rate to the RAS Pump Control Panel. The level in the return sludge wet well is monitored by an Ultrasonic level monitor which transmits an analog signal to a level indicator which actuates high and low level alarms using a current alarm relay. The pump is interlocked with a level switch to shutdown an low level. The local panel shall annunciate an alarm due to a pump malfunction and high pump discharge pressure. The panel will have an interlock to shutdown the pump on high pressure and shall have an ON/OFF indicating light. The MSP shall monitor flow rate, totalize flow, pump malfunction, high pump discharge pressure and run status. The CMP shall monitor the pump flow rate,

totalize flow, pump malfunction, high pump discharge pressure and run status.

3. The waste valve shall be controlled by means of an adjustable timer located in the RAS Pump Control Panel. When the timer times out it starts the pump for a predetermined time and pumps to the existing 24-inch sewer. The pump is interlocked with the low level switch in the wet well and it will shut down or not start on low level. The local panel shall annunciate an alarm due to a pump malfunction and high pump discharge pressure. The panel will have an interlock to shut down the pump in high discharge pressure and shall have an ON/OFF indicating light. The MSP shall monitor pump malfunction, high pump discharge pressure and run status. The CMP shall monitor pump malfunction, high pump discharge pressure and run status.
4. Waste sludge flow shall be monitored by a flow meter which shall transmit an analog signal to indicate and totalize flow at the RAS Pump Control Panel. The MSP shall monitor and totalize flow. The CMP shall monitor and totalize flow.

G. Filters:

1. Filters shall be provided with a Hand-Off-Auto selector switch and a lockout stop pushbutton at the local MFP.
2. In the "AUTO" mode, backwashing shall be controlled by two methods. The normal backwashing operation shall start when the high level probe on the filter carriage is activated, indicating a dirty filter. The carriage shall backwash the complete filter. If the water in the filter tank does not reach high level a timer in the filter carriage will time out and start the backwashing. The filter carriage contains a probe that will deactivate the backwashing at low level.
3. The MSP and the CMP shall monitor run status and filter panel malfunction.

H. Effluent Pumping:

1. Each effluent pump shall be provided with a lockout stop pushbutton at the pump location. A Hand-Off-Auto selector switch shall be provided at the local MFP.
2. The effluent from the Chlorine Contact tank flows by gravity to lake storage. The turbidity shall be monitored upstream of the lake by a turbidity meter. A flow meter shall transmit an analog signal to the Effluent Pump Control Panel, MSP and CMP.
3. The effluent pumps draw from the lake by means of a gravity pipe and suction barrels. Effluent level shall be monitored with a level probe which shall transmit a contact closure to the Effluent Pump Control Panel. The panel shall annunciate an alarm due to high and/or low level. The high level alarm shall be interlocked with the Influent Pumps and will shut down the Influent Pumps on high level. The low level alarm shall be interlocked with the Effluent Pumps and will shut down the Effluent Pumps on low level.
4. The Effluent Pumps are controlled by discharge pressure. The discharge pressure shall be monitored by a pressure transmitter which shall transmit an analog signal to the Effluent Pump Control Panel which shall indicate pressure. The MFP shall provide an interlock to shut down the Effluent Pumps on High pressure. The local control panel shall also annunciate an alarm due to a pump malfunction and shall include an ON/OFF indicating light. The MSP shall monitor high pump discharge pressure, pump malfunction and run

status. The CMP shall monitor the high pump discharge pressure, pump malfunction, and run status.

5. A flow meter shall be provided. A flow transmitter shall transmit an analog signal linearly proportional to flow to the Effluent Pump Control Panel. Flow shall be indicated and totalized at the local panel. The MSP and CMP shall monitor and totalize flow.

I. Odor Control System:

1. A Wet Scrubber Odor Control System shall be used to reduce odors at the lift station wet well, influent diversion box and rotary screen room. A local MFP shall monitor the process variables, status, and alarm conditions for the centrifugal fans, scrubber, recirculation pumps, and chemical feed pumps. A pH probe and an oxidation-reduction potential (ORP) probe shall be used to control the chlorine and caustic solution chemical feed rates respectively. Sample taps will be provided on the inlet and outlet side of the scrubber unit to determine H_2S removal/efficiency. A local MFP shall monitor the status and alarm conditions for the centrifugal fans and pumps. A manometer will also be installed on the scrubber unit to indicate internal scale buildup.
2. In addition to polishing the air from the wet scrubber, the carbon adsorbers will also provide flexibility to adsorb odorous gases directly from the aeration basins. A manometer will be installed on each carbon bed to measure differential across the carbon bed.
3. Scrubber fan shall operate continuously. The scrubber fan shall be started manually from the local panel. Pump and fan malfunctions shall be annunciated at the local panel at the MSP and the CMP.
4. Each recirculation scrubbant pump shall be started manually when the Hand-Off-Auto selector is in the "HAND" position. A scrubbant pump shall start automatically when the selector switch is in the "AUTO" position and the scrubber fan has started. The scrubbant pump will stop in the "AUTO" position when the scrubber fan stops. The local panel shall monitor run status and malfunction. The MSP and CMP shall monitor pump run status and malfunction.

J. Chlorination:

1. A chlorine residual analyzer shall monitor, record and alarm the level of chlorine present in effluent chlorine contact tank. High and low residual alarms shall be annunciated and chlorine residual shall be monitored at the MSP and CMP. Residual shall be recorded at the CMP.
2. A chlorine residual analyzer shall monitor, and alarm the level of chlorine present in the plant effluent to the irrigation system. High and low residual alarms and residual level shall be monitored at the MSP and CMP. The residual level shall be recorded at the CMP. Low chlorine and chlorine leak alarms shall be annunciated at the local monitor panel, MSP, and CMP.

+ + END OF SECTION + +

SECTION 13A50

PANELS, ENCLOSURES AND CONSOLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope of Work: Furnish and place into satisfactory operation the control panels and consoles shown on the Drawings and as specified.

B. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. Section 13A1, Plant Monitoring and Control System General Requirements.

1.2 QUALITY ASSURANCE

A. Standards, Codes and Regulations:
   1. Construction of enclosures, panels, consoles and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
      a. Joint Industrial Council (JIC) Standards.
      b. National Electrical Code (NEC).
      c. National Electrical Manufacturer's Association (NEMA) Standards.
      d. Local and State Building Code.
      e. Operational Safety and Health Administration (OSHA) Regulations.
   2. All electrical materials and equipment shall be new and shall bear the label of the Underwriters Laboratory (UL), Inc., Factory Mutual (FM) or equivalent where standards have been established and label service regularly applies.

B. General Design Requirements:
   1. Comply with the requirements of Section 13A1.

C. Factory Assembly and Testing:
   1. Fully assemble and test each enclosure, console, and panel at the factory prior to shipment demonstrating that all specified functions can be performed.

1.3 SUBMITTALS

A. Comply with the requirements of Section 13A1.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 13A1.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION REQUIREMENTS

A. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels complete and operational units.

B. Locate and install all devices and components so that connections can be easily made and so that there is ample room for servicing each item.

C. Equipment for installation on consoles shall be located as shown on the Drawings.

D. Where permitted by location and layout as shown on the Drawings, panels and consoles shall have full height rear access doors. Where rear doors are not possible, panels shall have full height front access doors.

E. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

F. Provide mounting strips for installation of all relays and other components where mounting strips are practical.

G. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise specified.

H. Provide the following convenience accessories inside of each control panel:
   1. Circuit breaker and at least one 120 VAC, 20A duplex, grounding type receptacle wired through the circuit breaker.
   2. One 120 VAC, incandescent, guarded light fixture with 100 watt lamp.
   3. One 120 VAC, 20A, snap switch in an outlet box with a cover to turn on the light.

2.2 IDENTIFICATION

A. Provide laminated plastic nameplates for identification of panels, enclosures and consoles and components mounted thereon as follows:
   1. Nameplates shall be of a phenolic type with white surface and black letter engraving.
   2. Panel identification nameplates to have 1/2-inch high letter engravings.
   3. Panel mounted component identification (i.e. control devices, indicating lights, selector switches, etc.) nameplates to have 1/4 inch high letter engravings.
   4. Nameplates shall be attached to the panel face with stainless steel fasteners.
   5. Nameplate engravings shall include the instrument or equipment tag number and descriptive title indicated on the Drawings and Specifications.

B. Tag all panel mounted instruments in accordance with Section 13A20.

C. Tag all electrical components and devices mounted within control panel enclosures with embossed plastic tape labels.

D. Numerically code terminals on terminal strips.

E. Color code and/or numerically code wiring as required by applicable standards. Wires shall be identified at each end with permanent number codes.

2.3 PANELS, ENCLOSURES

A. General:
1. Panels and enclosures shall meet the NEMA requirements for the type specified.
2. Size: Sizes shown on the Drawings are estimates. CONTRACTOR shall furnish enclosures of the size required to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, tubing and other components installed in the enclosures.

B. Construction Features:
1. Control panels located inside and outside of control room areas.
   a. Fabricate enclosures using minimum 14 gauge steel for wall or frame mounted enclosures and minimum 12 gauge for free standing enclosures.
   b. Fabricate enclosures in accordance with the NEMA ratings shown and specified.
   c. Continuously weld all exterior seams and grind smooth.
   d. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
   e. Use pan type construction for doors. Door widths shall not exceed 36 inches.
   f. Mount doors with full length heavy duty piano hinge with stainless steel hinge pins.
   g. Provide gasket completely around each door opening.
   h. Provide handle-operated key-lockable three point stainless steel latching system for each door on NEMA 12 rated enclosures.
   i. Use stainless steel fasteners throughout.
   j. Provide interior mounting panels and shelves constructed of minimum 12 gauge steel with a white enamel finish.
   k. Provide steel print pocket with white enamel finish.
   l. Provide enclosure mounting supports as required for floor, frame, or wall mounting.
   m. All panels outside of control rooms shall have solid bottoms.
   n. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom unless otherwise noted. All conduit and piping openings and all conduits shall be sealed watertight.
   o. For enclosures other than NEMA 4X stainless steel, completely clean all surfaces so they are free of corrosive residue then phosphatize for corrosion protection, prime with two coats and finish with one coat of factory finished textured polyurethane. Color to be selected by the OWNER.

C. Electrical Systems:
   1. Control of Environment:
      a. Indoor Panels:
         1) Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure.
   2. Power Source and Internal Power Distribution:
      a. General: Control panel power supply source type, voltage, number of circuits and circuit ratings shall be as shown on the Electrical Drawings.
      b. The panels, consoles and enclosures shall be provided with an internal 120 VAC power distribution panel with number of circuits and separate circuit breakers sized as required to distribute power to the panel components. The distribution panel shall contain two spare breakers minimum.
   3. Electrical Systems:
      a. Internal wiring shall be Type THHN stranded copper wire with thermoplastic insulation rated for 600 V at 85 C for single conductors, color coded and labeled with wire identification.
      b. For DC signal wiring, use No. 18 minimum AWG shielded.
      c. For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 amps, use sizes required by NEC and JIC standards.
      d. Install wiring runs in wires troughs per Paragraph 2.f., along horizontal or vertical routes to present a neat appearance. Angled runs are not acceptable.
      e. Separate and shield DC signal wiring from power and control wiring by a minimum of 6 inches.
      f. Group of bundle parallel runs of wire using covered troughs. Maximum bundle size to be 1 inch. Troughs shall have 40 percent spare capacity.
      g. Adequately support and restrain all wiring runs to prevent sagging or other movement.
      h. Use insulated crimped forked spade lugs on wire ends or use captive screw type terminals with self-lifting pressure wire clamps for connecting wiring to terminals.
      i. All wiring shall be installed such that if wires are removed from any one device, power will not be disrupted to any other device.
      j. Terminate all wiring at terminal strips, and identify terminals. All alarms generated external to the panel, spare alarm, and repeat contacts shall be wired out to therminal blocks.
      k. Use barrier type terminal strips with screwed connections, 600 V rating, and numeric identifiers beside each connection. Soldered type connections are not acceptable.
      l. Provide spare terminals equal in number to 20 percent of the terminals used for each type of wiring (DC signal and AC power).
      m. Provide a separate terminal for grounding each shielded cable.
      n. Use separate 5/16-inch diameter copper grounding studs for instrument signal cable shields and AC power.
      o. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.

p. When DC power and/or low voltage AC power is required, provide and install the necessary power supplies and transformers in the panel.
q. Provide circuit breakers to protect each circuit, with no more than six instruments on a single circuit.
r. Provide a 40-watt fluorescent service light within the enclosure near access door. Use easily accessible switch.
s. Provide a 120 VAC duplex convenience outlet within the enclosure located so that it is accessible from access door.
t. The service light with switch and duplex outlet shall have its own separate breakered power supply.
u. Provide complete wiring diagram showing "as-built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.

2.4 CONTROL RELAYS

A. Type: General purpose, plug-in type rated for continuous duty.

B. Construction Features:
1. Coil Voltages: 24 VDC, and 120 VAC as required.
2. Contacts:
   a. Silver cadmium oxide, gold flashed except in cases for switching low energy circuits (200 mA) where fine silver, gold flashed contacts shall be provided.
   b. Rating: Compatible with AC or DC throughout voltage and current of devices simultaneously operated by contacts but not less than the following:
      1) Silver cadmium oxide, gold flashed not less than 5 amperes resistive at 120 VAC or 28 VDC continuous.
      2) Fine silver, gold flashed not less than 3 amperes resistive at 120 VAC or 28 VDC continuous.
3. Relays to have clear plastic dust cover.
4. Relays to be UL recognized.

C. Manufacturer:
1. Square D Company, Type R and/or Type K.
2. Or equal.

2.5 TIME DELAY RELAYS

A. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break or interval operation.

B. Construction Features:
1. MOS digital circuit with transformer coupled power.
2. Switch selectable ranges as follows:
   a. 1 second.
   b. 10 seconds.
   c. 1 minute.
   d. 10 minutes.
   e. 1 hour.
   f. 10 hours.
3. Minimum Setting: 3 percent of range, except 50 ms for 1 second range.

4. Contacts:
   a. Type: DPDT.
   b. Rating: 7 amperes resistive at 120 VAC, 7 amperes at 24 VDC.
5. Housing: Plug-in design with dust and moisture resistant molded plastic case.
6. Power Input: 120 VAC and 24 VDC as required.
7. Relays to be UL recognized.

C. Manufacturer and Model:
   1. Automatic Timing and Controls Company, Series 328.
   2. Or equal.

2.6 TIMERS

A. Type: Adjustable, microprocessor based type timer.

B. Construction Features:
   1. Switch selectable ranges as follows:
      a. 0-9.99 seconds.
      b. 0-99.9 seconds.
      c. 0-999 seconds.
      d. 0-9.99 minutes.
      e. 0-99.9 minutes.
      f. 0-999 minutes.
      g. 0-9.99 hours.
      h. 0-99.9 hours.
      i. 0-999 hours.
   2. Repeat Accuracy: ± 0.01 seconds on all range.
   3. Timer Modes: Time up or time down from setpoint; jumper selectable.
   4. Cycle Progress Display: 3 digit display, programmable as follows: down and stop, down and go, up and stop, or up and go.
   5. Load Relays:
      a. Type: DPDT.
      b. Number: One instantaneous and one delayed.
      c. Contact Ratings: 7 amperes at 120 VAC and 3 amperes at 24 VDC.
   6. Terminals: Screw terminals accessible at rear.
   7. Housing: Fully gasketed, dust and watertight.
   8. Power Input: 120 VAC and 24 VDC as required.

C. Manufacturer and Model:
   1. Automatic Timing and Controls Company, Series 365.
   2. Or equal.

2.7 CURRENT ALARM RELAYS

A. Type: Direct current, electronic setpoint control relay which accepts 4-20 mAdc input signal and provides dry circuit contact output based on trip point setting.

B. Performance Requirements:
   1. Repeatability: Trip point repeats within ±0.1 percent of span.
   2. Trip Adjustment: 0 to 100% of span.
   3. Adjustable Deadband: 1 to 20% of span.

C. Construction Features:
   1. Trip Adjustment: Multiturn front panel adjustment.
   2. Contacts: DPDT relays, rated 5 amps at 117 VAC or 24 VDC non-inductive.
   3. Enclosure: Standard housing designed for internal panel mounting.
   4. Power Supply: 117 Vac, 60 Hz.

D. Manufacturer:
   1. Moore Industries.
   2. AGM.

2.8 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

A. General:
   1. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
   2. Type:
      a. Selector Switches Pushbuttons and Indicating Lights: Heavy duty, oil-tight, round.
      b. Common, push to test circuitry shall be provided for each panel to simultaneously test all indicating lights on the panel using a single pushbutton.
   3. Provide legend plate for indication of switch, pushbutton or light function (i.e. OPEN-CLOSED, HAND-OFF-AUTO).
   4. Mounting: Flush mounted on control panel front, unless otherwise noted.

B. Selector Switches:
   1. Type: Provide selector switches with number of positions as required to perform intended functions specified.
   2. Contacts:
      a. Provide number and arrangement of contacts as required to perform intended functions specified but not less than one single pole, double throw contact.
      b. Type: Double break, silver contacts with movable contact blade providing scrubbing action.
      c. Rating: Compatible with AC or DC throughput current of devices simultaneously operated by the switch contacts but not less than 10 amperes resistive at 120 volts AC or DC continuous.
   3. Switch Operator: Standard knob, black color.

C. Pushbuttons:
   1. Type: Provide momentary type pushbutton required to perform intended functions specified and shown.
   2. Contacts: Comply with the requirements specified for selector switches.

D. Indicating Lights:
   1. Type: Compact, integral transformer type.
   2. Lamps: 6 V, long life (20,000 hours minimum).
   3. Lens Colors:
      a. Red for indication of open, on, running.
      b. Green for indication of closed, off (ready), stopped.
      c. Amber for indication of equipment malfunction process trouble and alarms (i.e. high level, low level, etc.).
      d. Blue for indication of electrical control power on.

E. Manufacturer and Model:
   1. Allen Bradley Types 800T and 800H.
   2. Square D; Types SK and K lights.
   3. Or equal.

2.9 PANEL MOUNTED INSTRUMENTS

A. Indicators:
   1. General: Indicators shall be solid state electronic design and shall be equipped with gas discharge bar graph displays.
   2. The indicators shall meet the following requirements:
      a. Input Signal: 4 to 20 mAdc.
      b. Power Supply: 120 VAC, 60 Hz.
      c. Display: Bargraph, gas discharge display.
      d. Accuracy: 0.5 percent of span.
      e. Size: 4 inch long scale.
   3. Materials of Construction:
      a. Case: Black enamel steel, drawout type.
      b. Chassis: Aluminum with cast aluminum bezel.
      c. Circuit Boards: Glass epoxy with aluminum perimeter strip.
   4. Product Manufacturer: Provide one of the following:
      a. Bristol, Model SLC 3751.
      b. Or equal.

B. Electronic Indicating Single Loop Controller:
   1. General: Separate, Single Station electronic Indicating (Single Loop) Controllers shall be provided for executing stand-alone, automatic regulatory loop control as shown on the Drawings. The controllers shall match the other panel mounted components in general appearance.
   2. Type: Microprocessor-based controller with single loop integrity and user configuration capability.
   3. Required Design and Construction Features:
      a. Modular Construction.
      b. Front panel LED, gas-discharge or vacuum-fluorescent type, user configurable displays as follows:
         1) Two (2) vertical bar graphs with percentage scales; capability to provide direct reading scales, insertable without tools, shall be available.
         2) Digital readout display, 4 digits (minimum) with decimal point and minus sign typically for display of the engineering unit values associated with the two vertical bar graphs.
         3) One (1) horizontal bar graph with 0 to 100% scale or an auxiliary 4 digit (minimum) digital indicator display, typically for output value.
      c. Front panel pushbuttons or membrane type key pad controls for the following:
         1) Digital display selector.
         2) Remote-Ratio/Local Setpoint mode selector.
         3) Automatic/Manual Output Control Selector, permitting bumpless, balanceless transfer.
         4) Raise/Lower Setpoint Adjustments.
         5) Increase/Decrease Manual Output Adjustments.

d. Discrete Status Indicators for the following:
   1) Indication of values displayed on the digital readout display.
   2) Indication of remote or local setpoint mode.
   3) Indication of automatic or manual mode of operation.
   4) Process alarm limit indication of two separate alarm limit settings.

e. Mounting Requirements: Designed for flush panel mounting; suitable for single and multiple case mounting.

f. Power Requirements: Unit shall be designed to operate on nominal 24 VDC power provided by an external panel/instrument power supply. Lithium battery backup shall be provided for controller memory.

g. Input/Output Capabilities:
   1) Analog Inputs:
      a) Type: 4-20 mAdc current signals and 1-5 VDC signals.
      b) Quantity: Three (3), minimum.
      c) Resolution: 12 bit binary (±0.025%).
      d) Accessories: Provide auxiliary input signal isolators when required.
   2) Analog Outputs:
      a) Type: 4-20 mAdc.
      b) Quantity: Two (2) separate outputs, minimum.
      c) Accessories: Provide auxiliary output signal isolators when required.
   3) Digital Inputs:
      a) Type: 0-15 VDC logic level.
      b) Quantity: Two (2), minimum.
      c) Accessories: Provide auxiliary interposing relays when required to interface higher level control/status/alarm input signals.
   4) Digital Outputs:
      a) Type: Solid state, open-collector transistor type, logic level outputs (30 VDC maximum).
      b) Quantity: Two (2), minimum.
      c) Accessories: Provide auxiliary interposing relays when required to provide higher level control/status/ alarm outputs.

h. Microprocessor Sampling and Update Rates:
   1) PID and Control Program Execution Rate: Program executed once per 0.1 seconds.
   2) Input Signal Sampling Rate: 0.1 seconds.
   3) Display Update: 0.1 seconds.
   4) Output Signal Update: 0.1 seconds.

i. Required Operational and Functional Capabilities:
   1) Processing capability for a minimum of one PID control loop with analog input signal conditioning, and remote setpoint and ratio control functions.
   2) Anti-reset windup.
   3) Ramp setpoint capability.
   4) Output limiting.
   5) Alarming (absolute process and deviation).
   6) Calculation Functions:
      a) Addition.
      b) Subtraction.
      c) Multiplication.

d) Division.
e) Square Root.

7) Ratio Control.
8) Lead/Lag.
9) Override Control via remote inputs and/or internal program logic.
10) Totalization capability.
11) Digital Logic Operations.
12) On-Off Digital Output Control.
13) Configurable power fail-auto restart in previous mode at last output or in manual at a preset output.
14) Balanceless and Bumpless control transfer between all operating modes.
15) Internal operating diagnostics to detect hardware malfunctions, memory error, loss of input and low memory battery backup voltage.

j. Communication Capability: Unit shall be designed to permit bi-directional communication with other controllers and a supervisory control system and/or host computer utilizing a RS-422 Serial Communication link.

k. Configuration Capability and Accessories:
1) Controller shall be user-configurable by means of a portable, hand-held configurator terminal or from the controller front key-pad upon entry of a security code password. The hand-held terminal shall plug directly into the front panel of the controller. Configuration firm-ware shall provide access to all configurable parameters and controller set-up functions in addition to providing configuration and operation diagnostics.
2) The controllers shall be completely pre-configured by the instrumentation and control system supplier to perform the control algorithms and functions shown on the Drawings and/or specified in the Schedule.
3) Controller configuration shall be capable of being copied and transported by either of the following methods:
a) Portable, battery-backed RAM memory module or NOVRAM module with copy accessory installed in controller and capable of both copying and loading the controller configuration data base.
b) External, portable programming terminal with tape cassette or disc drive for off-line programming, editing, and copying of configurations and block downloading of configurations to the connected controller.
4) One (1) portable, hand-held configurator terminal shall be supplied with the controllers.

l. PID Control Range Adjustment:
1) Proportional Band: 0% (off) to 1000%.
2) Integral: 0.04 seconds to 100 minutes and off.
3) Derivative: 0.01 minutes to 100 minutes and off.
4) Manual Reset: 0% to 100%.

m. Connections: Provide compression type terminals for power and signal line connections.

n. Nameplates: Provide function identifying nameplates as required in Article 1.5.5 of this Section. Mount on MCP directly beneath controller.

4. Acceptable Products:
   a. Bristol, Model SLC 3740..
   b. Or equal.

C. Recorders:
1. General: The recorders shall be provided for mounting on the local panel specified herein.
2. Type: Recorders shall be miniature, 6-inch by 3-inch electronic, null balance, servo-operated, with rectilinear strip charts, potentiometer type.
3. Required Features:
   a. Each recorder shall be equipped with pens in quantities specified under Recorder Panel. Recording shall be on a 4-inch rectilinear chart.
   b. Recorder input signal circuits shall be electrically isolated. Zero and span adjustments shall be provided.
   c. Input: 4 to 20 mAdc.
4. Manufacturer:
   a. Bristol, Model SLC 3711.
   b. Or equal.

D. Annunciator System:
1. Performance Requirements:
   a. Activate flashing light in module and sound alarm horn(s).
2. Required Features:
   a. Flush panel mounted; NEMA rating to be that of panel in which it mounts.
   b. Solid state integral logic.
   c. Plug-in lamp modules including alarm logic circuit boards and filter module (if required).
   d. Isolated auxiliary contacts for each alarm point.
   e. Front accessible selectors for:
      1) N.O./N.C. dry field contacts.
      2) Lock-in/non-lock-in alarms.
   f. Lamp Test and Acknowledge pushbuttons (located in pushbutton area of respective panels).
   g. Horn with adjustable volume control (mounted within panel).
   h. Alarm sequence to be ISA sequence "A".
   i. Single point alarms with 2 lamps per point.
   j. Total number of alarm points shall include 20 percent minimum as spares for each system.
   k. Hard wired points described.
   l. Windows shall be engraved for all active points as per Annunciator List attached to end of this Section.
   m. Spare points shall be provided complete including windows, but without engraving.
   n. Units shall be powered by 120 VAC, 60 Hz and be provided with individual replaceable non-resettable line fuses sized to protect the system.
   o. Annunciators shall be provided with internal 24 VDC power supply.
3. Product and Manufacturer: Provide one of the following:
   a. Ronan.
   b. Riley Panalarm Division.

E. Totalizer/Integrator:
   1. General: Totalizer displays shall be in groups of four. The 8 digit non-reset mechanical counter shall receive 24 VDC pulses from a integrator.
   2. Construction: The totalizer assembly shall be a draw-out assembly that fits into anyone of the available plug-in slots on the front of the MSP.
   3. Manufacturer:
      a. Bristol, Model SLC 3776.
   4. General: The linear integrator for the above totalizer shall be surface mounted at the rear of the MSP. It shall accept a 4-20 mAdc signal and out a 24 VDC, 35 millisecond pulse scaled for the flowmeter it serves. Power supply to unit shall be 117 VAC 60 Hz.
   5. Manufacturer:
      a. Moore Industries Model Lit.

F. Telemetry Equipment:
   1. General: The telemetry equipment shall consist of a communications processor unit with I/O, power supply with battery backup, enclosure, modem, and telephone line protector. The complete assembly will be referred to as the RTU. The RTU shall be installed in the MSP. Circuits shown on the Drawings and designated as CMP shall connect to the RTU. The RTU shall receive data from the plant equipment and transmit this data to the existing Cholla Water Treatment Plant via an existing 4-wire telephone line.
   2. RTU shall be BIF Accutel Bright System to work with the existing equipment at Cholla.
   3. Line protector shall be BIF Accutel Model 245-23.
   4. Power supply shall consist of a Power-One Linear DePower supply with 15 minute battery backup.
   5. Spares: Provide 20% spare capacity for the RTU.

PART 3 - EXECUTION

3.1 INSTALLATION, TESTING AND ADJUSTMENTS

A. Install equipment in conformance with NEC.

B. Install all interconnecting wiring between equipment and panels as required for proper operation.

C. Perform system testing and make any adjustments necessary for proper operation of the equipment and in accordance with the applicable requirements of Section 13A.

+ + END OF SECTION + +

ANNUNCIATOR SCHEDULE

TAG		1ST LINE	2ND LINE	WINDOW NO.	RETRANSMIT
NA	202A			A1	
NA	203A			A2	
UA	205			A3	
UA	206			A4	
NA	207A			A5	
NA	208A			A6	
LAH	210			A7	
AAH	301A			B1	
AAH	302A			B2	
LAH	309			B3	
XAH	310A			B4	
XAHH	310A			B5	
NA	301A			B6	
LAH	311			C1	
LAL	311			C2	
NA	312			C3	
PAH	312			C4	
NA	313			C5	
PAH	313			C6	
UA	401			D1	
NA	407			D2	
NA	408			D3	
NA	409			D4	
LAH	414A			D5	
LAH	504			E1	
LAH	505A			E2	
NA	506A			E3	
NA	507A			E4	
NA	508A			E5	
NA	509			E6	
AAL	510			F1	
AAH	510			F2	
AAL	511			F3	
AAH	511			F4	
UA	513			F5	
PAL	514			F6	
WAL	601A			G1	
AAH	602A			G2	
NA	603			G3	
NA	604			G4	
NA	703A			H1	
UA	703			H2	
NA	706A			H3	
NA	707A			H4	
NA	708A			H5	
NA	709A			H6	
NA	710A			J1	
NA	711A			J2	
NA	712A			J3	
AAH	713A			J4	

SECTION 13T

AUTOMATIC BACKWASH FILTER

Part 1 - General

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, equipment, and incidentals as shown, specified and required to provide one automatic backwash filter. Anchor bolts are included.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 1H4, Field Tests of Equipment.
3. Section 1H5, Instruction of Operating Personnel.
4. Section 1I3, Operation and Maintenance Data.
5. Section 3D, Cast-In-Place Concrete.
6. Section 3I, Grout.
7. 5E3, Miscellaneous Metal Fabrications.
8. 5E5, Aluminum Grating and Checkered Plate.
9. 5E10, Aluminum Handrails and Railings.
10. Section 5G, Anchor Bolts, Expansion Anchors and Concrete Inserts.
11. Section 9L, Painting.
12. Section 13A, Instrumentation.
13. Division 16, Electrical, unless specified herein.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have experience in fabricating similar type equipment and shall show evidence of at least five installations of automatic backwash filters of the type and approximate size as that specified herein which have been in satisfactory operation for not less than five years.

B. Manufacturer's Responsibility: CONTRACTOR shall obtain all the equipment specified in this Section from the manufacturer of the automatic backwash filter in whom unit responsibility shall be vested for the proper function of the equipment as an integrated and coordinated system. However, the CONTRACTOR shall retain ultimate responsibility for equipment coordination, installation, operation and guarantee.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM A 36, Structural Steel.
2. ASTM A 48, Iron Castings.
3. ASTM B 241, Aluminum Alloy Seamless Pipe and Seamless Extruded Tube.
4. ASTM B 429, Aluminum Alloy Extruded Structural Pipe and Tube.
5. AISC, Code of Standard Practice for Steel Bridges and Buildings.
6. AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.

7. AISC, Manual of Steel Construction.
8. AGMA Standards.
9. ANSI A12.1, Safety Requirements for Floor and Wall Openings, Railings and Toeboards.
10. AWS D1.1, Structural Welding Code.
11. NAAMM, National Association of Architectural Metal Manufacturers.
12. AWWA Designation B100.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Drawings showing dimensions, overall arrangement and assembly of the equipment, and materials of construction.
   2. Fabrication, assembly and installation drawings, and wiring and control diagrams.
   3. Manufacturer's literature, illustrations, specifications and engineering data including total weight of unit, structural loads at supports, connection details and performance data.
   4. Provide setting drawings, and directions for the installation of anchor bolts and other anchorages.

B. Documentation that the manufacturer has produced, supplied, and placed into satisfactory service, equipment similar to that specified herein. Criteria shall be a minimum of five installations in service for not less than five years.

C. The manufacturer shall provide a performance guarantee that the filter provided for this project will produce filter effluents of:
   a. A turbidity of not greater than 5 NTU with an influent to the filter of not greater than 30 mg/l TSS.
   b. A turbidity of not greater than 2 NTU with an influent to the filter of not greater than 10 NTU.

   The performance guarantee shall be subject to the following conditions and limitations:
   a. That the filter is installed and operated in accordance with the written instructions supplied by the manufacturer.
   b. That the filter is operated at an average flow rate of 0.96 and a peak flow rate not exceeding 1.93 gpm /ft^2.
   c. That the turbidity of the influent is composed of suspended solids capable of being removed by filtering, utilizing a test column containing identical media as the filter and at the specified filtration rate. If a substantial portion of the suspended solids are less than 10 micron in size, suitable chemical treatment shall be required prior to filtration.

D. Operation and Maintenance Manuals: Submit six complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

E. Lubricant Specification: The CONTRACTOR shall furnish a lubricant specification of the type and grade necessary to meet the requirements of the equipment.

1.4 PRODUCT INSPECTION, DELIVERY AND STORAGE

A. Prior to shipping, the equipment shall be inspected to assure that all components are complete and in compliance with all requirements. It shall then be boxed or crated as required by the manufacturer to prevent damage during shipment. All machined surfaces, matching connections and flanges shall be suitably protected to prevent damage.

B. All boxes, crates, or packages shall clearly identify their contents by name or tag number using a packing slip affixed to the outside of the container.

C. All boxes, crates and packages shall be inspected by the CONTRACTOR upon delivery to the site. CONTRACTOR shall notify the ENGINEER if damage exists to any equipment of components. CONTRACTOR shall make all necessary arrangements to replace loss or repair such damage, to new condition, in accordance with the manufacturer's instructions.

D. Store materials to permit easy access for inspection and identification. Keep steel members off the ground using pallets, platforms, or other supports. Protect steel members and packaged materials from condensation and corrosion.

PART 2 - PRODUCTS

A. General:
1. Filter shall be designed to filter effluent wastewater from a secondary treatment process, under the following conditions:

Maximum Flow	-	1.0 mgd
Influent Suspended Solids	-	30 mg/l
Maximum Effluent Suspended Solids	-	10 mg/l
Maximum Effluent Turbidity Level	-	5 NTU
Maximum Filtration Rate	-	1.93 gpm/square foot
Media Surface Area	-	360 sq. ft.
Filter Media	-	Sand

2.2 FABRICATION

A. General:
1. Automatic backwash filter mechanism shall include filter bed, cleaning mechanism and controls, floating skimmer, electrical feed cable, bridge rails, wastewater launders and supports.
2. All equipment shall be constructed of corrosion resistant material or protected with shop applied protective coatings.

B. Filter Bed:
1. The filter bed shall consist of a series of self-supporting lateral partitions (cell dividers) which shall divide the filter into a multitude of 8 inch wide compartments. Each compartment shall be arranged for connection to a separate backwash port. The cell dividers shall be at least 20 inches high and shall be fabricated of fiberglass reinforced polyester (FRP).
2. Fiberglass reinforced polyester angles shall be attached to the cell dividers and fastened to non-coated steel leveling angles with

plated steel self drilling and tapping screws. Factory pre-punched leveling angles shall be fastened to the filter floor slab with self drilling and tapping stainless steel anchors.

3. Each filter effluent wall header section shall be a monolithic molding using a polyethylene or other suitable plastic resin. Each effluent wall header section shall be 24 inches long; shall include filtrate cone section, connection slots for cell dividers and backwash wear strip connection surface; and shall be structurally strong enough to support the full weight of the effluent concrete wall without deforming and without additional support during construction. The influent header section shall be structurally self-supporting and similar to the effluent header section except it shall be a face section with connection slots for cell dividers and end flanges only.
4. Formed at the midpoint of each cell divider shall be not less than a 5/8 inch wide support surface upon which shall rest 1 inch thick porous plate blocks. To hold the porous plate blocks down on top of this support surface shall be retaining angles having angle legs no longer than 1 inch. The retaining angles shall be manufactured of fiberglass reinforced polyester and shall be attached to the cell divider with stainless steel fasteners through factory pre-drilled holes.

   The porous plate blocks shall be of fused alumina oxide meeting the following requirements:
   a. Maximum Pore Diameter: 1300 microns.
   b. Porosity: 30 to 40 percent.
   c. Flexural Strength: 1000 psi
   d. Air Permeability: 170 to 190 cfm air/ft^2 per 1 inch thick plate at 2 inch water column pressure.
   e. Thickness1 inch.

   The porous plates shall be completely sealed in place with polyurethane sealant supplied by the equipment manufacturer.
5. The filter media shall minimally consist of high grade silica sand approximately 11 inches deep, complying with specifications for Filtering Material (AWWA Designation B100). The sand shall be well graded, and material showing abnormal grading shall be rejected. The particle size distribution shall be determined by screening through standard U.S. Series sieves. The percent size shall be predetermined from a plot of the percentages by weight of the material passing each sieve, against the rated opening of the sieve. The 10% size or effective size shall be between 0.55 and 0.65 millimeters. The uniformity coefficient (ratio of 60% size to 10% size) shall not exceed 1.50. The CONTRACTOR may supply additional depth and/or different filter media in order to meet the effluent limitations set forth in the performance guarantee.

C. Cleaning Mechanism And Controls:
1. Traveling Bridge:
   a. The traveling bridge shall contain and support the drive mechanism, pumps, backwash support frame and shoe, washwater hood and controls.
   b. The bridge frame shall be of welded steel construction allowing a maximum deflection of 1/360 of the span with a 50 lb/ft^2 live load. Main member shall be braced to assure rigidity.
   c. The traveling bridge walkway shall be not less than 3 feet 6 inches wide, shall have an aluminum grating deck, and shall

have handrails on each side of the walkway. A removable section of floor plate shall be provided directly above the liquid level probes.

d. Gratings shall be designed to support a uniform load of not less than 150 pounds per square foot with a maximum deflection of 1/160 of the span or 1/4 inch, whichever is smaller, and a maximum fiber stress of 12,000 psi.

Gratings shall be of aluminum material, and of I-bar design. Bars shall have a nonslip exposed surface. Spaces between main bars shall not exceed 1/4 inch. Frames shall be structural shapes with suitable anchors.

All edges of gratings, including edges of cutouts for pipe and other items passing through gratings, shall be banded with straight bar size material.

Gratings shall be set with a full and uniform end bearing on the supports to preclude rocking movement.

Wedges or similar shimming devices shall not be used.

Aluminum clamps or clips shall be installed to anchor the grating to the supports.

No field welding of members will be permitted.

All aluminum gratings, and any aluminum support members, shall have a mill finish.

e. The railing system shall conform to OSHA, Part 1910.23, including the 200 pound loading requirement. In addition, the system shall conform to the following requirements of ANSI A12.1:

1) Completed railing shall withstand a load of 25 pounds per linear foot applied in any direction at the top of the railing.
2) The intermediate rails shall withstand a horizontal load of 20 pounds per linear foot.
3) The above loads are not additive.

All material supplied for posts and railings shall be 1-1/2 inch diameter extruded aluminum pipe or tubing conforming to ASTM B 429 or B 241, Alloy 6063-T6, Schedule 40.

All aluminum railings, posts, flanges, and structural shapes shall have a mill finish.

The railings shall be fabricated to shape in the shop.

Fabricated lengths shall be as long as possible commensurate with shipment requirements. A top and two middle rails shall be provided.

For a welded railing system, all joints except field joints shall be welded. All field joints shall be approved slip type with counter-sunk stainless steel fasteners. Field welding of pipe and railing will not be permitted. All joints shall be smoothed by grinding to present a workmanlike appearance when completed.

For a non-welded railing system, the components shall be fabricated in accordance with the manufacturer's design requirements. Posts shall be provided at the beginning and end of a run, at or adjacent to all corners and equally spaced over the length of the run at not greater than 6 feet on centers. Railings shall be 42 inches nominal from upper surfaces of top rail to the floor. The intermediate rails shall be spaced at 13-1/2 inches center to center starting from the top rail. All railings shall have a smooth surface. A toe board shall be provided for all railings. The toe board shall be 4 inches

minimal in vertical height from its top edge to the level of the floor, and securely fastened in place with not more than 1/4 inch clearance above floor level. The toe board shall be a plate or channel suitable supported on the railing posts.

2. Drive Mechanism:
   a. The bridge drive unit shall consist of one drive unit assembly, drive shaft, drive chain and chain guards, and wheels.
   b. Drive Unit Assembly:
      1) The drive unit assembly shall have a speed reducer and electric motor connected by a flexible shaft coupling, mounted on a common cast iron or welded steel base with and OSHA approved coupling guard.
      2) The speed reducer shall conform to AGMA rating and specifications for moderate shock, 24 hour continuous full load operation with a service factor of 1.50.
      3) The motor shall be of adequate size so that there is no overload on the motor above rated nameplate horsepower under normal conditions of service, but not less than 1 horsepower.
      4) The motor shall be TEFC suitable for operation on 480 volt, 60 Hz, 3 phase power, 1800 rpm maximum.
      5) Space heaters 120 volt, single phase, shall be provided in each motor frame.
      6) The motor shall have a 1.15 service factor, 50° C ambient rise and shall comply with the latest ANSI, NEMA, and IEEE Standards as minimum.
      7) The motor shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, Hp, full load current, RPM, centigrade degree rise, manufacturers name and serial no., model, voltage, locked rotor KVA code, bearing numbers and a connection diagram. The motor terminal box shall be oversized to provide adequate space for connections, constructed of cast iron or fabricated steel, and neoprene gasketed and bolted. The motor leads shall be permanently marked in agreement with the connection diagram.
      8) The reducer shall be of the helical or combined helical-worm gear type enclosed in a cast iron or welded steel casing.
      9) Speed reducer moving parts shall be immersed in oil, and bearings shall be anti-friction throughout. The casing shall be provided with inspection covers, oil fill, drain connections and means for inspection of oil flow. Inspection, oil fill and drain covers shall be chained to the casing to prevent loss. An oil lever indicator shall be provided for each unit.
   c. Drive Shaft And Drive Chain:
      (1) The drive shaft shall be fabricated of steel of sufficient size to adequately and safely withstand all bending and torsional loads of starting and operating. The drive shall be supported by multiple self-aligning grease lubricated ball bearings.
      (2) The driving chain shall have a minimum average ultimate strength of 20,000 psi. The chain shall be covered with a guard of sheet steel or fiberglass construction conforming to OSHA. A spring or counterweight device shall be furnished to maintain constant tension in the drive chain.

d. Wheels:
   (1) All wheels shall be double flanged steel construction, locked rigidly to the shaft(s) and shall ride on ASCE rails.

3. Pumps:
   a. The backwash and washwater systems shall be powered by two cast iron submersible pumps.
   b. Each pump shall provide a minimum pumping rate of 25 gallons per minute per square foot of cell area, at a total dynamic head sufficient to properly backwash the filter. The pumps shall be equipped with stainless steel shafts and cast iron impellers.
   c. The pump shall be driven by a totally enclosed fan cooled motor, with a maximum speed of 1,800 rpm. The motor shall be of adequate size so that there is no overload on the motor above rated nameplate horsepower under normal conditions of service. The motor shall have Class B insulation. The motor shall be suitable for operation on 460 volt, 60 Hz, 3 phase power. Space heaters, 120 volt, single phase shall be provided. The motor shall have a 1.15 service factor, 50° C ambient rise and shall comply with the latest ANS, NEMA, and IEEE Standards as minimum. Motors above 5 horsepower shall have a nominal full load power factor of 85 percent or higher or shall be provided with a capacitor for mounting at the motor which shall improve the power factor to 90-95 percent. The motor shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, Hp, full load current, RPM, centigrade degree rise, manufacturers name and serial no., model, voltage, locked rotor KVA code, bearing numbers, and a connection diagram. The motor terminal box shall be of cast iron or fabricated steel, neoprene gasketed and bolted, and oversized to provide adequate space for connections. The motor lead shall be permanently marked in agreement with the connection diagram.
   d. Motors 3 horsepower and larger shall be high efficiency design, Westinghouse Electric Corporation TEEII, Reliance Electric XE, General Electric Energy Saver, or equal. Efficiencies shall be determined in accordance with NEMA Standard MG1-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MG1-12.53b.

4. Backwash Frame and Shoe:
   a. A fabricated backwash support frame shall be attached to the traveling bridge at the effluent channel side. The backwash shoe shall be mounted on the backwash frame such that it can independently follow any irregularities of the matching backwash wear strip. This flexible movement shall be controlled by 300 series stainless steel springs and fittings. The shoe shall attach to Schedule 80 PVC piping by means of a flexible hose.
   b. A FRP backwash strip shall be provided against which the backwash shoe will slide. The strip shall be fastened to the effluent header by means of countersunk Type 304 stainless steel fasteners.

5. Washwater Hood:
   a. The washwater hood shall be fabricated of fiberglass reinforced polyester. It shall be designed to permit the uniform expansion of the filter media. The hood width shall be at least 1.5 times the cell width. The PVC manifold shall be installed in the

upper portion of the washwater hood and shall connect to the washwater pumps. The washwater hood shall contain two full length Type 304 stainless steel drag components.

6. Piping and Valves:
   a. All piping and valves shall be of PVC or other non-metallic material.
7. Controls:
   a. The automatic controls for filter operation shall be furnished as an integral part of the backwash mechanism. The controls shall consist of electrical apparatus suitable for controlling the operation of the cleaning and backwashing mechanism, operation of the floating skimmer, and providing alarm signals for failure of the equipment to operate properly.
   b. Control Panel: Each travelling bridge shall be furnished with a bridge mounted control panel suitable for outdoor installation. The panel shall be free standing and completely enclosed. Width dimensions of the panel shall be as required. Height shall be approximately 84 inches. It shall be the responsibility of the manufacturer to design the internal circuitry to meet the functional requirements of this Section.

      All electrical work in the panel shall conform to the applicable requirements of the National Electric Code. Each travelling bridge sludge collector mechanism shall be arranged for local start-stop only, with provisions for both automatic and manual operation. Provisions shall be made for remote monitoring of status and alarm when in the automatic mode.

      Each panel shall be construction of 12 gage (minimum) stainless steel panels with 10 gage (minimum) access doors, or of 1/4-inch fiberglass reinforced panels and access doors. The fiberglass shall contain an ultraviolet blocking agent. Panels and access doors shall be reinforced where required, and free from flaws. The structural components shall be sufficiently strong to withstand the load of all instruments and appurtenances to be mounted thereon. The panel shall be NEMA 4X suitable for outdoor construction. All hardware, including hinge and latching mechanism shall be stainless steel. The color of the fiberglass, if provided, shall be selected by the ENGINEER from color charts furnished by the CONTRACTOR. Color pigments shall be molded into the resin. Exterior surfaces of the fiberglass shall be gel-coated to provide a maintenance-free satin finish.

      Each panel shall be furnished completely factory-wired with all appurtenances mounted therein as required for a complete installation, and to function as indicated herein. All instruments and devices including the annunciator panel individual alarm points shall be factory wired to terminal blocks. All wiring shall be factory wired to terminal blocks. All wiring shall be in horizontal or vertical runs and groups of wires to and from common points shall be neatly harnessed and adequately supported. Wiring shall be run to numbered terminal blocks mounted on the inside of the enclosure for connection to power, and external equipment. Wiring shall be color coded and shall consist of thermoplastic insulated conductors. Instrumentation wiring shall be grouped separately and kept segregated from power leads. All ground terminals of receptacles shall be solidly grounded. One ground terminal shall be installed in the

panel. A complete wiring diagram for the panel shall be provided. The diagram shall be enclosed in transparent plastic or plexiglass. The diagram shall represent the "as-built" circuitry, shall include all equipment and shall show connections from numbered terminal blocks to external contacts. The transparent plastic or plexiglass enclosed wiring diagram shall be affixed to the panel at a convenient location and shipped with the panel.

All relays used in the panel shall be of the plug-in type with transparent dust covers and shall be designed for long life. Time delay relays shall be adjustable with dials indicating the actual time setting.

A service light with switch and a duplex 120 volt single phase outlet shall be provided inside the panel.

Engraved laminated phenolic nameplates shall be mounted on the panel below each instrument and accessory. The location and designation of the nameplates is subject to the approval of the ENGINEER. Nameplates shall have white letters on a black background.

Each panel shall include but not be limited to the following:

(1) Main disconnect switch.
(2) A control power transformer suitably sized for all 120 volt requirements.
(3) Reversing starter for bridge drive.
(4) Starters for washwater pump and skimmer trash pump.
(5) Manual and automatic controls for the bridge program including hand-off-automatic switch.
(6) Manual and automatic controls for the skimmer system.
(7) Forward/Reverse/Stop selector switch for bridge drive.
(8) Hand-off-automatic selector switches and indicating lights for each motor, red-running; green-ready.
(9) Annunciator with acknowledge and test buttons.
(10) All switches, timers, time delay devices, relays and contacts required for a complete and workable installation.

NOTE: All selector switches shall be wired for alarm by-pass when in the Stop position.

All equipment shall be installed in accordance with the manufacturer's requirements and instructions. All panel mounted equipment shall be selected to match each other and present a pleasing appearance.

Instruments and controls shall be mounted on the panel in functional groups. Pushbuttons shall be oil-tight.

Indicating lights shall be 120 volts, transformer type.

The automatic control system shall have the following features:

1) The washwater pump motors and carriage, at the option of the operator, may be actuated automatically by a predetermined increase in hydraulic head actuated by a high water sensing electrode, or by a timing device to control the interval between each cleaning cycle automatically. The washing cycle when actuated, shall continue for not less than one complete pass of the filter bed. The cleaning cycle shall be terminated by a signal from a low water sensing electrode. The "off-time" of the cleaning cycle shall be controlled by a reset timer with a range of three minutes to twenty hours. When the timer times out, the washwater pump motors shall be actuated. During the"on-time" the timer

shall be de-energized and reset for starting off-time at the end of the cycle. Should high water occur during off-time, the washwater pump motors shall be started by a relay actuated from the high water electrode signal, with a corresponding resetting of the timer. A separate electrode shall be provided to actuate a high-high water alarm should the water level continue to rise after the high water signal is actuated.

2) The control sequence for the backwash mechanism shall be wired so that the backwash mechanism stops randomly along the length of the filter basin upon termination of the backwash cycle, or at either end of the basin.
3) Bridge motions shall be protected against overtravel in either direction. Backup limit switches or other approved devices may be used to accomplish this purpose. Alarm points shall be provided on the local control panel to indicate the failure of the primary control and he activation of the backup device. Limit switches shall be mounted on bridge.
4) Controls for the skimmer trash pump shall function to delay starting the pump until sufficient waste is accumulated, and to delay stopping the pump until the material gathered is removed. A counter shall be furnished to permit operation during each backwash cycle or after a preset number of cycles have occurred.

The annunciator panel shall be of the relay type having the number of units required. The annunciators shall be furnished with a common lamp test pushbutton. The lamp test pushbutton shall be wired to operate all lamps on the annunciators, without activating the audible or remote alarm during the test procedure.

The annunciator sequence shall follow ISA Sequence "A". Each annunciator shall be provided with a sufficient number of flasher units and plug-in relays. Each annunciator shall be furnished with all necessary active and spare plug-in relays. All spare or unused circuits shall be furnished complete and ready for future use.

The annunciator cabinets shall be suitable for flush panel mounting, of NEMA 4X construction. Annunciator windows shall be white plastic with dimensions of approximately 2 inches by 3 inches. Windows shall be engraved in black lettering. The size of lettering shall be the maximum size available that can be engraved with the required legend of a particular window. Each window shall be illuminated by two 6-watt lamps connected in parallel.

Annunciator points shall include, but are not limited to those specified below:

1) Failure of bridge drive motor.
2) Failure of bridge overtravel limit device and activation of backup device.
3) Failure of washwater pump motor.
4) Interruption of bridge program for any reason.
5) High-high water alarm.
6) Failure of skimmer trash pump.

A minimum of four spare annunciator units shall be provided. The annunciator cabinet shall be complete with illuminated nameplates and plug-in relays. The cabinet shall be designed to incorporate all of the alarm functions specified herein. The plug-in type

relays shall be accessible from the front of the panel. The system in the event of alarm signal, shall simultaneously light the individual nameplate. In addition all alarms shall be brought to a common remote alarm annunciator point for transmission of a common alarm to a main status panel provided by others. The alarm shall remain in operation until the common acknowledgement button is depressed at which time the horn shall be silenced, but the alarm system shall remain in service for possible receipt of other alarms. An audible device shall be furnished and mounted on the panel. The audible device shall be a 4-inch vibrating horn suitable for operation of 120 volts AC. The horn shall be a heavy duty, flash type and shall be furnished with a volume control. A "Test" switch shall be provided to perform a full functional test of all components, except auxiliary relays which will be operable only when the field contacts are in an alarm condition. An "acknowledge" switch shall be provided to silence the audible device and turn the visual indication from flashing to steady without affecting a subsequent alarm.

D. Floating Skimmer

1. A floating skimmer shall be furnished to provide for automatic removal of floating debris, grease, and oil, which may accumulate on the liquid surface of the filter.
   The skimmer shall consist of plastic floating guides, stainless steel connecting members, collection pockets with adjustable weirs, plastic suction and discharge tubing with stainless steel fittings, and a submersible 1/2 HP pump.
2. The skimmer shall be free floating, operate without adjustment with varying liquid levels, and shall skim in each direction.
   The plastic blades shall serve to support the skimmer and to direct floating material or oil to two collection pockets, from which it shall be pumped to waste. Each collection box shall be provided with adjustable weirs which permit varying the cut (the thickness of the film of material to be removed) without handling large quantities of liquid.
   The skimmer shall be supported from, and guided by the traveling bridge of the filter. Stops which can limit the high and low position of the unit shall be included.
   The controls, providing for manual or automatic operation, shall be incorporated in the filter control panel.
3. Materials of Construction:
   a. Blades: Fiberglass reinforced plastic.
   b. Structural Members and Weirs: Type 316 stainless steel.
   c. Pump: Submersible 50 gpm at 10 feet tdh.
   d. Piping: Schedule 80 PVC.

E. Electrical Feed Cable:

1. A stretch cable electrification system shall be provided. The cable shall be stretched between two galvanized eyebolts and stainless steel hardware. The cable shall be not less than 3/8-inch diameter aircraft type composed of seven strains of nineteen wires per strain. A galvanized turnbuckle shall be provided at one end for cable tension adjustment.
2. This cable shall be equipped with a number of non-friction pulleys which shall support the electrical cable used to power the bridge.
3. The cable shall be looped in coils with each coil being attached to a separate pulley.

4. Upon traveling to the end of the basin, the coils shall be extended to form a draped cable supported by each pulley, and as the cable returns, the loops shall be retracted by the action of the bridge.

F. Bridge Rails:
1. Rails shall be 30 pound ASCE with splice plates and steel anchor bolts. Rail stops shall be included.
2. A sufficient quantity of anchor plate assemblies shall be furnished to allow clamping the rail at least once every five feet along its length.
3. Each anchor plate assembly shall consist of two stainless steel anchor bolts held in the vertical position by a horizontal steel plate, two stainless steel leveling nuts, one on each anchor bolt, and a floating leveling plate over the top of the leveling nuts.

G. Washwater Launders And Supports:
1. The washwater launders shall be constructed of pultruded fiberglass supported by aluminum mounting brackets and stainless steel hardware. The fiberglass shall contain an ultraviolet blocking agent.
2. The trough shall be blue-green in color, not less than 1/4-inch thick and reinforced with integrally shaped longitudinal stiffener sections or with members cemented or bolted to the troughs. Additional horizontal stiffness and rigidity shall be provided through the use of plastic spreaders placed in strategic points and fastened to the troughs with stainless steel hardware. All matched edges of the troughs shall be resin sealed.
3. Maximum deflection of the troughs shall not exceed 1/360 of the span under full load.

H. Surface Preparation And Shop Painting:
1. Surface preparation and shop painting is required for all ferrous metals, equipment and accessories. Stainless steel shall not be painted.
2. All ferrous metal surfaces shall be cleaned and provided with two coats of priming paint. All paint materials shall be products of the Koppers Company Inc,. or the Tnemec Company Inc.
   All ferrous surfaces of the equipment constantly above normal water surfaces shall be cleaned with a Commercial Sandblast (SSPC-SP6) and shall receive two coats of Koppers Epoxy Primer 654, with a minimum dry thickness of 1.5 to 2.0 mils per coat, or two coats of Tnemec 66-1211 Epoxy Primer, with a minimum dry thickness of 1.5 to 2.5 mils per coat. Ferrous metal surfaces constantly above the water surface may be given two coats of the manufacturer's standard paint system in lieu of the priming paint, provided that the total mil thickness of paint is equal to that specified above.
   Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6) except that motors and like items that may be damaged by sandblasting may be prepared by other approved means.
   All castings and carbon steel parts constantly or intermittently below the normal water surface shall be cleaned with a Near White metal Sandblast (SSPC-SP10) and shall receive two coats of Koppers Epoxy Primer 294, with a minimum dry thickness of 1.5 to 2.0 mils per coat, and two coats of Koppers Hi-Gard with a minimum dry

thickness of 2.0 to 3.0 mils per coat or shall receive two coats of Tnemec 20-1255 Epoxy Primer with a minimum dry mil thickness of 1.5 to 2.5 mils per coat and two coats of Tnemec 20-2000 with a minimum dry mil thickness of 2.0 to 3.0 mils per coat.

I. Bolts, Nuts, And Anchors
   1. All anchor bolts and nuts and other fasteners furnished for connection of the equipment and other miscellaneous items to the concrete structure or concrete base pads shall be of Type 304 stainless steel, furnished by the CONTRACTOR, and shall be a ample size and strength for the purpose intended.

J. Product And Manufacturers:
   1. Environmental Elements Corporation.
   2. Aqua-Aerobic Systems.
   3. Or equal.

Part 3 - EXECUTION

3.1 INSTALLATION

A. Installation of all equipment shall be in complete accordance with manufacturer's recommendations and instructions and the approved Shop Drawings.

B. The automatic backwash filter shall be installed on concrete foundations as shown on the Contract Drawings.

C. Installation shall include furnishing an applying an initial supply of lubricants recommended by the manufacturer.

3.2 TESTING AND START-UP

A. Make adjustments required to place the system in proper operating condition.

B. After the filter has been installed tests shall be run in the field by the CONTRACTOR, at his expense, and witnessed by the ENGINEER and a representative of the filter manufacturer. The object of these tests shall be to demonstrate that the unit will perform as specified and meet the performance guarantee as specified under Section 1.3.C. Equipment that does not meet the specified requirements shall be modified and retested until full compliance with these requirements can be demonstrated.

3.3 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall provide the services of a qualified, factory-trained representative of the manufacturer to check and approve the installation before it is placed in service, supervise initial operation and testing in the presence of the ENGINEER and instruct the OWNER'S personnel in operation and maintenance of the equipment. A Minimum of

three, 8-hour days, which may not necessarily be consecutive, shall be provided for these services. In the event of trouble with the equipment, the manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

+ + END OF SECTION + +

SECTION 15A1

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, tools, equipment and incidentals as shown, specified and required to install, disinfect as required and test and clean all buried piping, fittings, and specials and appurtenances as shown, specified and required to complete the Work. The Work includes, but is not limited to, the following:
   a. All types and sizes of buried piping unless specifically included under other Sections. These include, but are not limited to: ductile iron, copper, thermoplastic, vitrified clay, and reinforced concrete drainage pipe.
   b. Pipe beneath structures.
   c. Supports, restraint, and thrust blocks.
   d. Testing.
   e. Cleaning and disinfecting, where applicable.
   f. Installation of all joints, jointing and gasketing materials, specials, couplings, flexible couplings, mechanical couplings, adaptors, harnessed and flanged adapters, sleeves, tie rods, closures, end caps, bulkheads, plugs, bolts, nuts and all other Work required to complete the piping installation.
2. All valves, gates and specials shown or specified shall be incorporated into the piping systems as required and as specified in these Specifications.
3. Unless otherwise shown or specified, buried piping installation includes all piping Work required and shown on the Drawings, beginning at the outside face of structures or building foundations.
4. All piping shall be plugged with a suitable bulkhead securely fastened to the end of the piping at the end of each work day.

B. Coordination:
1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.
2. Section 15A1 specifies the installation of all buried piping materials specified in Sections 2G2 and 15A3 through 15A14, unless otherwise specified. Coordinate with these Sections.

C. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 2D1, Excavation and Backfill.
3. Section 2D5, Crushed Stone and Gravel.
4. Section 2G1, Drainage Structures.
5. Section 2G2, Drainage Pipe.
6. Section 2H6, Manholes.
7. Section 3D, Cast-In-Place Concrete.
8. Section 9L, Painting.
9. Division 15 Sections for Piping, Valves, Appurtenances and Specials.
10. Division 15 Sections on Plumbing and HVAC Piping.
11. All piping specifically included with equipment.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Comply with applicable provisions of the following regulatory agencies:
      a. Applicable local building codes.
         1) CONTRACTOR shall conform to all applicable requirements of the Lapaz County Standard Specifications. If there is a conflict between Lapaz County Standard Specifications and these Specifications, the provisions of these Specifications shall govern.
      b. Underwriters' Laboratories, Incorporated.
      c. NFPA Standard No. 24 where applicable to water pipe systems which are used for fire protection.
      d. Other authorities having jurisdiction.
   2. Refer to the General and Supplementary Conditions for the permit requirements for this Project.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C 12, Recommended Practice for Installing Vitrified Clay Sewer Pipe.
   2. ASTM D 2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
   3. ASTM D 2774, Underground Installation of Thermoplastic Pressure Piping.
   4. ASTM F 493, Solvent Cements for Chlorinated Poly (Vinly Chloride) (CPVC) Plastic Pipe and Fittings.
   5. ASCE MOP No. 37, Design and Construction of Sanitary and Storm Sewers.
   6. AWWA C111 (ANSI A21.11), Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
   7. AWWA C206, Field Welding of Steel Water Piping.
   8. AWWA C600, Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances.
   9. AWWA C601, Disinfecting Water Mains.
   10. AWWA C606, Grooved and Shouldered Type Joints.
   11. AWWA M9, Installation of Concrete Pipe.
   12. AWWA M23, PVC Piping.
   13. AWWA M11, Steel Pipe - Design and Installation.
   14. NFPA No. 24, Outside Protection.
   15. Concrete Pipe Handbook, American Concrete Pipe Association.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Laying schedules and detailed layout drawings for all piping reflecting the CONTRACTOR'S construction schedule and installation methods, except as noted in Paragraph A.6 below. The laying schedules and layout drawings shall be referenced to the stationing and elevations shown on the Drawings, and all layout drawings shall be prepared to scale. Each pipe, fitting or special shall be designated on the layout drawings and in the laying schedules. Pipe, fittings and specials delivered to the job site shall be marked with the same letter or number designation appearing on the layout drawings and in the laying schedules.

2. Full details of pipe, fittings, specials, supports, and connections to existing pipes and structures, including dimensions, sizes, classes, etc.
3. Typical joint and harnessing details.
4. Detailed description of the proposed pipe handling and installation methods. Copies of these descriptions shall be furnished to the pipe manufacturer for use in pipe design.
5. Detailed descriptions of proposed field testing including information and data pertaining to procedures and apparatus.
6. Laying schedules and layout drawings for buried piping 4 inches in diameter and smaller will not be required unless specifically requested by the ENGINEER.

B. Tests: Submit description of proposed testing methods, procedures and apparatus. Submit copies of all test reports.

C. Certificates: Submit certificates of compliance with referenced standards.

D. Record Drawings: During progress of the Work, keep an up-to-date set of drawings showing field and Shop Drawing modifications. The drawings shall show all piping on plans and in sections, with all reference dimensions and elevations required for complete record drawings of the piping systems. All piping shall be shown on the record drawings irregardless whether the piping was shown on the Contract Drawings.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 1G17 and Section 1H1 as applicable.

B. Delivery and Storage:
1. Pipe, fittings, specials, appurtenances and accessories shall be delivered to and stored within the CONTRACTOR'S work limits as shown on the Drawings.
2. CONTRACTOR shall provide suitable temporary roadways and equipment for delivery of the products.
3. Special care shall be exercised during delivery and storage to avoid damage to the products.
4. Products shall be stored on heavy wood blocking or platforms in strict conformance with the manufacturer's recommendations, so they are not in contact with the ground, and in such a manner so as to maintain their interiors free from dirt and foreign matter.
5. Products shall be stored so as to avoid unnecessary handling and in locations where they will not interfere with the OWNER'S operations, construction operations or public travel.
6. Thermoplastic pipe shall be stored so as to prevent sagging or bending.
7. Thermoplastic pipe, fittings and specials shall not be stored in direct sunlight.

C. Handling:
1. Pipe, fittings, specials, appurtenances and accessories shall be handled carefully with approved handling devices in strict conformance with the manufacturer's recommendations.
2. Products shall not be dropped or rolled off trucks, nor shall products be otherwise dragged, rolled or skidded.

D. Products cracked, gouged, chipped, dented or otherwise damaged will not be approved and shall be removed and replaced at the CONTRACTOR'S expense, unless the product can be repaired in a manner acceptable to the manufacturer and ENGINEER. All repairs shall be at the CONTRACTOR'S expense.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The extent and size of piping is shown on the Drawings and in the schedule included at the end of this Section. Refer to applicable Sections of these Specifications for detailed materials specifications.

B. Pipe Marking:
   1. Each piece of pipe, fitting or special, except straight pipe with no outlets, shall be clearly marked with a designation which shall conform with designations shown on the Shop Drawings.
   2. Class, size, manufacturer's name or trademark, date of manufacture and material designation shall be cast or painted on each piece of pipe, fitting or special 4 inches in diameter and larger.
   3. Piping less than 4 inches in diameter shall be clearly marked by manufacturer as to material, size and rating.
   4. Special markings designating thrust restraint or abnormal loading conditions shall be placed on pipe, fittings and specials as applicable.
   5. Marking shall take place after installation of shop applied linings and coatings.

2.2 BURIED PIPING SCHEDULE

A. Attached at the end of this Section is the "Buried Piping Schedule." Conform to requirements of the schedule, unless otherwise approved by the ENGINEER.

2.3 RESTRAINED JOINT SCHEDULE

A. Use restrained joints for thrust protection for the following piping systems and where shown on the Drawings:
   1. Potable water piping.
   2. Pump discharge piping.
   3. Air piping.
   4. Chemical piping.
   5. All other pressure piping. (Test pressure greater than 20 psig as indicated in the Buried Piping Schedule.)
   6. All ductile iron piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Installation of all pipe, fittings, valves, specials and appurtenances shall be subject to the review and/or approval of the ENGINEER.

2. Install piping as shown, specified and as recommended by the manufacturer and in conformance with referenced standards, and approved Shop Drawings.
3. Request instructions from ENGINEER before proceeding if there is a conflict between the manufacturer's recommendations and the Drawings or Specifications.
4. All piping shall be inspected by the ENGINEER prior to installation. ENGINEER'S inspection will not relieve CONTRACTOR or manufacturer from responsibility for damaged products.
5. All piping shall be carefully examined for cracks, damage or other defects before installation. Any piping that is defective, including but not limited to, cracked, damaged, in poor condition, or with damaged linings or improperly marked will be rejected unless the product can be repaired in a manner acceptable to the Manufacturer and ENGINEER. Any piping found to be broken or defective after it has been installed shall be removed, replaced or repaired at the CONTRACTOR'S expense.
6. Minimum earth cover over the piping shall be as shown on the Drawings, specified or directed by the ENGINEER, but in no case shall the earth cover be less than 3 feet-6 inches for all piping except drains.
7. Required earthwork shall be as specified in the 2D Sections of these Specifications.
8. Present all conflicts between piping systems and equipment, structures or facilities to ENGINEER for determination of corrective measures before proceeding.
9. Take field measurements where required prior to installation to ensure proper fitting of Work. The CONTRACTOR shall uncover the existing pipelines sufficiently in advance of the proposed Work in order that the type and location of the existing pipes and joints and other information required to fabricate the proposed piping can be determined. It shall be the responsibility of the CONTRACTOR to obtain whatever information is required to complete the connections of the proposed pipelines to the existing pipelines. Refer to Article 3.2 of this Section as applicable.
10. Interior of all piping and mating surfaces shall be inspected and all dirt, gravel, sand, debris or other foreign material shall be completely removed from the interior and mating surfaces before installation. Measures shall be taken to maintain the interior of all piping clean until acceptance of the completed Work. Care shall be taken to prevent foreign matter from entering joint space. Bell and spigot mating surfaces shall be wiped clean immediately before piping is laid. For ductile iron pipe, the bell and spigot mating surfaces shall be thoroughly cleaned with a wire brush.
11. Install piping accurately to line and grade shown, specified or directed, unless otherwise approved by the ENGINEER. Accurate means of determining and checking the alignment and grade shall be used, which shall be subject to the approval of the ENGINEER. Any modifications to the Drawings or these Specifications to suit the pipe manufacturer's standard must be approved by the ENGINEER. Remove and relay piping that is incorrectly installed at CONTRACTOR'S expense.
12. Do not lay piping in water, unless otherwise specified in these Specifications or approved by the ENGINEER. Ensure that the water level in the trench is at least 6 inches below the bottom of piping. Maintain a dry trench until jointing and backfilling are complete,

unless otherwise specified in these Specifications or approved by the ENGINEER.

13. Where unforeseen conditions will not permit the installation of piping as shown or specified, no piping shall be installed without approval of the ENGINEER. Do not modify structures or facilities without approval of the ENGINEER.
14. Start laying piping at lowest point and proceed toward the higher elevations, unless otherwise approved by the ENGINEER. Slope piping uniformly between elevations shown on the Drawings or as otherwise provided by the ENGINEER.
15. Place bell and spigot piping so that the bells face the direction of laying, unless otherwise approved by the ENGINEER.
16. Piping shall be installed so that the barrel of the piping and not the joints, receives the bearing pressure from the trench bottom, or other bedding condition.
17. No piping shall be brought into position until the preceding length, valve, fitting, or special has been bedded and secured in place.
18. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil, water and other foreign matter from entering the piping.
19. Field cutting of metallic piping, where required for inserting valves, fittings, specials, and closures, shall be made with a machine specially designed for cutting piping and in accordance with the manufacturer's instructions. Cuts shall be carefully done, without damage to piping, so as to leave a smooth end at right angles to the axis of the piping. Cut ends shall be tapered and sharp edges filed off smooth. Flame cutting will not be permitted. Piping damaged by the CONTRACTOR by improper or careless methods of cutting shall be replaced or repaired at his expense.
20. Blocking under piping will not be permitted unless specifically approved by ENGINEER for special conditions.
21. Protective linings and coatings shall be touched up prior to installation, where required.
22. Except where bends, wyes or similar fittings are used, changes in alignment and grade of the piping shall be made by deflecting joints or with beveled pipe. Permissible joint deflection shall not exceed 75 percent of the amount allowed by the manufacturer.
23. All joints shall be made in the presence of the ENGINEER or his duly authorized representative, except as otherwise approved.
24. Special care shall be taken to ensure that each section of piping abuts against the next in such a manner that there will be no shoulder or uneveness of any kind along the piping invert.
25. Piping shall be rotated as required to place outlets in proper position.
26. Blind flanges and cleanouts shall be provided at locations shown on the Drawings, specified or required. Cleanouts on buried piping shall include all pipe, fittings and appurtenances required to bring cleanout to finished grade and terminate in a flange and blind flange or suitably capped piping as shown. Cleanout piping shall be same as that specified for the main run.
27. All gravity lines shall pitch uniformly at the grade shown or as specified or approved.
28. Short pipe stubs, maximum 4 feet-0 inch in length, shall be used at all manholes and other wall faces, except as otherwise specified.
29. Field painting shall be accomplished after joints are made.
30. All piping shall be plugged watertight with a suitable cap or plug

securely fastened to the end of the piping at all contract interfaces.

B. Manufacturer's Installation Specialist:
   1. CONTRACTOR shall provide the services of a competent manufacturer's installation specialist when pipe laying begins, if the CONTRACTOR is not experienced in laying and jointing a particular type of pipe.
   2. Retain specialist on the job for a minimum of 2 days and until competency of the pipe laying crew has been demonstrated to the satisfaction of the ENGINEER.

C. Bedding Pipe:
   1. Piping shall be bedded in conformance with Sections 2D1 and 2D5, and as shown, except as otherwise specified.
   2. No piping shall be laid until ENGINEER approves the bedding condition.
   3. Excavation in excess of that required as shown on the Drawings or specified, which is not authorized by the ENGINEER, shall be at the CONTRACTOR'S expense. Backfilling and compaction of the overexcavated areas shall be at the CONTRACTOR'S expense. Select granular fill shall be used to refill the overexcavated areas.
   4. Backfilling and compaction of pipe bedding and cover shall be as shown on the Drawings and specified in Sections 2D1 and 2D5.
   5. Carefully and thoroughly compact all pipe bedding and fill up to the pipe centerline with hand-held pneumatic compactors.

D. Ductile Iron Pipe Installation - Supplementary Requirements:
   1. Conform to AWWA C111, AWWA C600 and to applicable manufacturer's recommendations.
   2. Prior to assembling mechanical joints and mechanical restrained joints, the outside of the spigot and the inside of the bell shall be cleaned thoroughly with a wire brush to remove foreign matter and then coated with a soap solution. The rubber gasket shall be wiped clean, flexed and then coated with a soap solution. Immediately after the soap solution is applied, the cast iron or ductile iron gland and soaped rubber gasket shall be slipped on the spigot end of the pipe. For assembly, the spigot shall be centrally located in the bell and the pipe shall be pushed forward to seat the spigot in the bell. The gasket shall be pressed into place evenly within the bell and the gland shall be moved along the pipe into position for bolting. After the gasket is compressed and before the pipe is pushed or pulled all the way home, the gasket shall be carefully checked for proper position around the full circumference of the joint. Final assembly shall be made by forcing the spigot all the way home, and all tee head bolts shall be inserted and all nuts screwed up tightly. Nuts spaced 180 degrees apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland and seat the gasket evenly. All nuts shall be tightened with a torque-limiting wrench. Gaskets which have been scoured or otherwise damaged shall not be used. The allowable torque shall be as follows:

Bolt Size (inches)	Applied Torque (ft.-lbs.)
5/8	50
3/4	80
1	90
1-1/4	110

3. Restrained mechanical joints shall be in accordance with Section 15A3.
4. Prior to assembling push-on type joints, the outside of the spigot and the inside of the bell shall be cleaned thoroughly with a wire brush to remove foreign matter. The rubber gasket shall be wiped clean, flexed and then placed in the bell in accordance with the instructions of the manufacturer. The gasket shall be smoothed out around the entire circumference of the bell to remove bulges and to prevent interference with the proper entry of the spigot of the entering pipe. Immediately prior to assembly, a thin film of approved lubricant shall be applied to the surface of the gasket which will come in contact with the entering spigot end of pipe. The CONTRACTOR may, if he desires, apply a thin film of lubricant to the outside of the spigot of the entering pipe. For assembly, the spigot shall be centrally located in the bell and the pipe shall be pushed forward until it just makes contact with the rubber gasket. After gasket is compressed and before pipe is pushed or pulled all the way home, the gasket shall be carefully checked for proper position around the full circumference of the joint. Final assembly shall be made by forcing the spigot end of the entering pipe past the rubber gasket until it makes contact with the base of the bell. Where more than a reasonable amount of force is required to assemble the joint, the spigot end of the pipe shall be removed to verify the proper positioning of the rubber gasket. Gaskets which have been scoured or otherwise damaged shall not be used.
5. A sufficient quantity of joint lubricant and rubber gaskets shall be kept on hand at all times.
6. Prior to the installation and assembly of mechanical couplings, the joint ends shall be cleaned thoroughly with a wire brush to remove foreign matter. Following this cleaning, lubricant shall be applied to the rubber gasket or inside of the coupling housing and to the joint ends. After lubrication, the gasket shall be installed around the joint end of the previously installed piece and the joint end of the subsequent piece shall be mated to the installed piece. The gasket shall be positioned and the coupling housing placed around the gasket and over the grooved or shouldered joint ends. The bolts shall be inserted and the nuts screwed up tightly by hand. The bolts shall then be tightened uniformly in order to produce an equal pressure on all parts of the housing. When the housing clamps meet metal to metal, the joint is complete and further tightening is not required.
7. Flanged joints shall be drawn together until the joint is perfectly tight using approved full-faced gaskets and gasket compounds. Gaskets shall be suitable for service intended in accordance with manufacturer's ratings and instructions. The length of bolts shall be uniform and they shall not project from the nut more than 1/4 inch or fall short of the end of the nut when fully taken up. The ends of bolts shall be cut off in a lathe so as to be neatly rounded. Threads on both nuts and bolts shall be sharply cut and accurately sized so as to turn freely without undue play. No washers shall be used. Bolt threads and gasket faces for flanged joints shall be cleaned and lubricated.

E. PVC Pipe Installation - Supplementary Requirements:
1. Install in accordance with ASTM D 2774 and ASTM D2321.

2. If ground water is encountered, stabilize by overexcavating to about 12 inches and fill to grade with gravel having a maximum particle size of 1/2 inch. Keep trench free of ground water during laying and jointing and until backfilled sufficiently to prevent pipe flotation.
3. Completely clean all jointing surfaces and adjacent areas prior to making joint.
4. Welded joints for PVC piping shall be made in conformance with manufacturer's recommendations. For PVC piping, solvent welded joints shall conform to ASTM D 2564 and ASTM D 2855 with strict accordance to required setting times at minimum temperatures.
5. Threaded joints for PVC piping shall be made in conformance with manufacturer's recommendations using teflon tape.
6. Snake line in trench from side to side to compensate for thermal expansion.
7. All buried PVC piping shall be encased from 12 inches below the pipe to 12 inches above the pipe in granular fill. The granular fill material shall be a clean, well-graded sand. The material shall be loosely placed and then compacted with a sled-type vibrator.

F. Restraints, Supports and Thrust Blocks:
1. Install restrained joints as shown, specified, required, and as recommended by manufacturer. Assembly of restrained joints shall be in strict accordance with manufacturer's recommendations.
2. All valves in restrained piping shall be installed with mechanical couplings.
3. All joints on pressure piping systems shall be restrained to provide thrust protection to the limits shown or specified.
4. No joints on culvert, storm drain or gravity sewer piping will require harnessing.

G. Transitions from One Type of Pipe to Another:
1. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.
2. Encase all such connecting joints with 6 inches minimum of Class "B" concrete unless otherwise shown, specified or recommended by manufacturer.
3. Whenever changes in sizes of piping occur, changes shall be made with reducing fittings. The use of bushings will not be permitted unless otherwise shown or specified.

H. Closures:
1. Provide all closure pieces shown or required to complete the Work.
2. Locate closures in straight runs of pipe.
3. Closure pieces shall be complete with gaskets, follower rings, long bells, wire mesh and any other items necessary for a complete installation.

I. Backfilling:
1. Conform to applicable requirements of Section 2D1 and as specified in this Section.

J. Copper Pipe Installation - Supplementary Requirements:
1. Trench bottom shall be tamped to line and grade. Remove all sharp stones and rocks in trench bottom; replace and tamp with clean earth.

2. For long lines use annealed temper to permit long runs with a minimum of joints. Snake piping to absorb line expansion.
3. Use proper jointing methods as recommended by the Copper Development Association, Inc., Copper Brass Bronze Product Handbook, to prevent joint corrosion.
4. Backfill with tamped, clean earth free from stones, cinders, or other materials which could cause damage or corrosion to piping.
5. For installation in soils or fill materials a wrapping of insulating tape, a coating of asphaltum paint or an inert moisture barrier shall be applied to pipe.
6. Connections between copper and ferrous iron pipelines shall be joined by a dielectric (insulated) pipe union. The gasket, when the joint is made, shall not project into the internal opening. The pipelines shall be connected so that the electrical current is below 1 percent of the galvanic current. The union shall be suitable for the working pressure of the line on which installed.

3.2 WORK AFFECTING EXISTING PIPING

A. Conform to applicable requirements of Division 1.

B. Location of Existing Piping:
1. Locations of existing piping shown shall be considered approximate.
2. CONTRACTOR is responsible for determining exact location of existing piping to which he must make connections, relocate, replace or which he may disturb during earth moving operations, or which may be affected by his Work in anyway.
3. Coordinate all excavations with utility companies, OWNER and ENGINEER, as applicable.

C. Taking Existing Pipelines Out of Service:
1. Do not take pipelines out of service unless specifically approved by ENGINEER.
2. Notify ENGINEER at least 48 hours prior to taking any pipeline out of service.
3. Descriptions of tie-in work to existing pipelines are specified in Division 1.

D. Work on Existing Pipelines:
1. Cut or tap pipes as shown or required with machines specifically designed for this Work.
2. Install temporary plugs to keep out all mud, dirt, water and other foreign materials.
3. Provide all necessary adapters, fittings, tapping sleeves, valves, specials, pipe and appurtenances required.
4. Dewater any existing piping as necessary to perform the Work and remove any leakage or infiltration to the extent that water does not interfere with the connection work and making of joints.
5. Provide all temporary pumping and temporary services as specified and required.

3.3 TESTING OF PIPING

A. General:
1. Notify ENGINEER 48 hours in advance of testing:

2. Provide all testing apparatus including pumps, hoses, gages, fittings, temporary bulkheads, plugs, compressors and miscellaneous other required items.
3. Provide temporary blocking and bracing or approved thrust and joint restraint to prevent joint separation and pipe movement during testing.
4. All blind flanges, bulkheads, plugs and end caps shall be in place during testing.
5. Pipelines shall hold the specified test pressure for a period of 2 hours or as specified herein.
6. Pipelines which fail to hold specified test pressure or which exceed the allowable leakage rate shall be repaired and retested.
7. Test pressures required are at the lowest elevation of the pipeline section being tested, unless otherwise specified.
8. Unless otherwise approved, conduct all tests in the presence of the ENGINEER. Repeat tests in the presence of local authorities having jurisdiction, if required by them.
9. All tests shall be repeated until the test conditions are satisfied.
10. Water Source:
    a. CONTRACTOR shall make all arrangements for and bear all expenses for providing all water for testing. The source of the water shall be subject to the approval of the ENGINEER.
    b. The point of introduction of water for conducting tests shall be subject to the approval of the ENGINEER.
11. All costs for tests shall be included in the prices bid.

B. Schedule of Pipeline Tests:
1. Refer to "Buried Piping Schedule" at the end of this Section for pressure test values for water testing.
2. All piping shall be water tested after installation except as otherwise specified or directed.
3. Piping not in schedule shall be tested at 10 psig greater than its maximum operating pressure.

C. Required Tests for Force Mains and Pressure Pipes:
1. Backfill and compaction shall be completed as required to assure restraint by harnessed joints before testing, unless otherwise required or approved by ENGINEER.
2. Fill section to be tested slowly with water and expel all air. Install corporation cocks, if necessary, to remove all air.
3. Test only one section of pipe at a time, between valves or bulkheads.
4. Apply required test pressure for 2 hours and observe gage. Check carefully for leaks while test pressure is being maintained. If no test pressure is given, test shall be at the normal operating pressures plus 20 PSI in each particular section of piping.
5. Maintain test pressure constantly for a 2-hour period and accurately measure the amount of water which must be added to maintain the test pressure.
6. Allowable Leakage Rates (in gallons per hour per 1,000 feet per inch diameter):
    a. Ductile Iron Pipe: 0.1.
    b. Thermoplastic and Copper Pipe: 0.

D. Required Tests for Gravity Sewer Piping:

1. CONTRACTOR may elect to test piping, using either air or water test procedures. He must, however, notify ENGINEER in advance of all testing, which method he plans to utilize and must follow through with the same method on all pipeline testing.
   a. Gravity sewers may be tested with either air or water testing.
   b. Tests to be performed after backfilling is completed but may be performed before final cleanup and acceptance of Work.
   c. Tests to be performed prior to final acceptance.
      1) Test all piping and manholes for leakage by means of the tests described below.
      2) Test to be performed between adjacent manholes or as approved by the ENGINEER.
   d. Prior to making tests, the CONTRACTOR shall submit details of his testing procedures with a description of methods and equipment he proposes to use to the ENGINEER for approval. The CONTRACTOR shall furnish all necessary labor, equipment, water, watertight bulkheads, rodding machine, generator, pumps and all else necessary to carry out the required tests.
2. Air Test:
   a. Thoroughly clean the inside of the pipe before test is performed.
   b. Insert test plugs in ends of pipe to be tested.
   c. Securely brace test plugs.
   d. Measure and record groundwater height above the pipe invert. All gage pressures in the test shall be increased by the amount of the back pressure due to groundwater submergence.
   e. Slowly fill the pipe with air to a pressure of 4 psig. Maintain pressure between 4 and 3.5 psig for at least two minutes for temperature stabilization.
   f. Check all plugs for tightness.
   g. With a pressure of approximately 4 psig in pipe, disconnect air supply.
   h. Allow pressure to decrease to 3.5 psig.
   i. When the pressure reaches 3.5 psig, record the time required to decrease to 2.5 psig using a stopwatch.
   j. The line is considered acceptable if the time for the pressure to decrease from 3.5 psig to 2.5 psig is not less than the amount shown on the following table for the respective pipe diameters:

Minimum Acceptance Times

Pipe Diameter	Time
6"	2 min. 50 sec.
8"	3 min. 50 sec.
10"	4 min. 45 sec.
12"	5 min. 40 sec.
14"	6 min. 40 sec.
16"	7 min. 5 sec.
18"	7 min. 35 sec.
20"	9 min. 30 sec.
21"	9 min. 55 sec.
24"	11 min. 20 sec.
27"	12 min. 45 sec.

k. If the leakage in the section tested exceeds the specified amount, the CONTRACTOR shall make the necessary repairs or replacements required to reduce the leakage to within the specified limits and the test shall be repeated until the leakage requirement is met.
l. No one shall be allowed in the manhole during air testing.

3. Water Test:
   a. When water test is performed, the test section shall be filled with water and allowed to stand for 24 hours. The water shall then be replenished and the test performed.
   b. Insert test plugs and securely brace.
   c. Fill the pipe and manhole with water to provide a positive differential head on the top of the pipe at the highest point of the pipeline under test of at least the test pressure specified in the buried piping schedule.
   d. The amount of water added to maintain this head shall be the leakage.
   e. Test for a period of at least four hours.
   f. Total leakage of any section tested shall not exceed the following rates:
      1) Gravity Sewer: 0.5 gallons per hour per 100 feet of pipe per inch diameter of pipe.
   g. If the leakage in the section tested exceeds the specified amount, the CONTRACTOR shall make the necessary repairs or replacements required to reduce the leakage to within the specified limits and the test shall be repeated until the leakage requirements is met.
   h. On steep grades it may be necessary to place plugs in the pipe between manholes to avoid excessive pressures in the pipe.
4. Visual Inspection:
   a. Prior to final acceptance, a visual inspection of all appurtenance structures, i.e. manholes, chambers, etc., will be required. Any visual leaks, regardless of their magnitude shall be repaired by the CONTRACTOR.
5. Watertight Sewers:
   a. It is imperative that all sewers and appurtenant structures be constructed as watertight as practicable. The CONTRACTOR shall adhere rigidly to all requirements of the Plans and Specifications and follow all directions of the ENGINEER to secure a watertight sewer. If, during the work or after its completion, any leaks, are discovered, they shall be repaired in a satisfactory manner at the expense of the CONTRACTOR notwithstanding the pipe and appurtenant structures may have already successfully passed the leakage tests.

E. Deflection Testing for PVC Pipe:
1. Deflection testing shall be performed for all PVC pipe 6-inches in diameter and larger as directed by the ENGINEER. Testing shall be performed after backfill is complete and compacted. Deflection shall be limited to a maximum Mandrels for testing 5% reduction in base inside diameter. Shall have outside diameter to match the 5% deflection. The number of tests are as follows: one test for each 1,000 linear feet of each pipe size, 6-inches in diameter and larger.

3.4 CLEANING AND DISINFECTION

A. Cleaning:
   1. All piping shall be thoroughly cleaned and flushed prior to placing in service in a manner approved by ENGINEER.

B. Disinfection:
   1. Disinfect all water mains and other potable water piping.
   2. Flush piping prior to disinfection with water at a minimum velocity of 2-1/2 feet per second.
   3. Conform to procedures described in AWWA C601 unless otherwise approved by ENGINEER.
   4. Chlorine shall be supplied by CONTRACTOR.
   5. Bacteriologic tests will be performed by OWNER. A certified test laboratory report will be available to CONTRACTOR, if requested.
   6. Chlorine concentration in the water entering the piping shall be between 50 and 100 parts per million, such that a minimum residual concentration of 25 mg/l will be left after a 24-hour retention period. The operation shall be repeated as necessary to provide complete disinfection.

C. Water Source and Appurtenances:
   1. Water for flushing, testing and chlorination shall be furnished and paid for by the CONTRACTOR. CONTRACTOR shall provide all temporary piping, hose, valves, appurtenances and services required.

3.5 DISPOSAL OF WATER

A. CONTRACTOR shall provide suitable means for disposal of test and flushing water so that no damage results to facilities or waterways.

B. Means of disposal of test and flushing water shall be subject to the approval of ENGINEER, local governing authorities and regulatory agencies.

C. CONTRACTOR shall be responsible for any damage caused by his water disposal operations.

BURIED PIPING SCHEDULE

Service	Material(3)	Interior Linings	Exterior Coating	Thickness Class	Joint	Pressure Test (psig)
Wastewater Treatment Plant						
Sludge Lines:						
A. Suction	DI	CL	BC	53	MJ	15
B. Discharge	DI	CL	BC	53	MJ	50
Drains	DI	CL	BC	53	MJ	15
Chlorine Solution	CPVC	-	-	Sch. 80	SW	100
Influent Sewer	VC	-	-	Extra Strength C		20 feet
Plant Potable Water Supply:						
A. 3" or greater	DI	CL	BC	53	MJ	100
B. Less than 3"	PVC	-	-	Sch.80	SW	100
Sludge Drying Bed Filtrate Lines	DI	CL	BC	53	MJ	15
Sample Piping	PVC	-	-	Sch. 80	SW	75
Other Piping Not Listed Above:						
A. 3" or greater and less than 24"	DI	CL	BC	53	MJ	100
B. Less than 3":	PVC	-	-	SDR-21	B&S	100
Collection and Transmission System						
Gravity Sewer	PVC	-	-	SDR-35	B&S	100
Low Pressure Sewer	PVC	-	-	SDR-21	B&S	(1)
Force Main	PVC	-	-	SDR-21	B&S	100

Notes:

1. Actual test pressure to be determined by ENGINEER based on location.

The following abbreviations are used.

A. Material Abbreviations

Ductile Iron	DI
Chlorinated Polyvinyl Chloride	PVC
Vitrified Clay	VC

B. Lining Abbreviations

Bituminous Coated	BC
Cement Lined	CL

C. Joint Abbreviations

Bell and Spigot	B&S
Mechanical Joint	MJ
Solvent Welded	SW
Compression	C

+ + END OF SECTION + +

SECTION 15A2

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, tools, equipment and incidentals as shown, specified and required to install, test, disinfect as required and clean all exposed piping, fittings, specials, and appurtenances as shown, specified and required to complete the Work. The Work includes but is not limited to the following:
   a. All types and sizes of exposed piping, unless specifically included under other Sections. These include but are not limited to ductile iron, thermoplastic, stainless steel, carbon steel and copper.
   b. Piping embedded in concrete within a structure or foundation will be considered as exposed and included herein.
   c. Restraints, supports, and kickers.
   d. Testing, cleaning and disinfection.
   e. Disposal of water.
   f. Also included are installation of all joints, specials, couplings, flexible couplings, mechanical couplings, adaptors, harnessed and flanged adapters, sleeves, tie rods, closures, end caps, bulkheads, plugs, bolts, nuts, jointing and gasketing materials and all other Work required to complete installation of exposed piping.
2. Provide all exposed valves, gates, specials, sleeves, wall pipes and floor pipes shown, specified or required and incorporate them into the piping systems. Valves, gates, specials, sleeves, wall pipes, floor pipes shall be as specified under the appropriate Sections of Division 15.
3. Schematic diagrams for some of the small diameter piping systems are shown on the Drawings. It is the intention of the Drawings and of these Specifications to provide complete and workable piping systems, and any miscellaneous fittings, valves and specials required for proper completion of the Work shall be considered as having been included under this Section.

B. Coordination:
1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section.
2. This Section specifies the installation of all exposed piping materials specified in Sections 15A3 through 15A9, 15C3 and 15C4, unless otherwise specified. Coordinate with these Sections.

C. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 3D, Cast-In-Place Concrete.
3. Section 9L, Painting.
4. Division 15 Sections for Piping, Valves, Appurtenances and Specials.

5. Division 15 Sections on Plumbing and HVAC Piping.
6. All piping specifically included with equipment.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Comply with applicable provisions of the following regulatory agencies:
      a. Applicable local building codes.
      b. Underwriters' Laboratories, Incorporated.
      c. Other authorities having jurisdiction.
   2. Refer to the General and Supplementary Conditions for the permit requirements for this Project.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. AWWA C111 (ANSI A21.11), Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
   2. AWWA C206, Field Welding of Steel Water Pipe Joints.
   3. AWWA C600, Installation of Gray and Ductile Iron Water Mains and Appurtenances.
   4. AWWA C 601, Disinfecting Water Mains.
   5. AWWA M11, Steel Pipe - Design and Installation.
   6. AWWA M23, PVC Piping.
   7. AWS, D1.1, Structural Welding Code.
   8. AWS, D10.4, Welding of Austenitic Chromium-Nickel Steel Piping and Tubing.
   9. AWS, D10.9, Standard for Qualification of Welding Procedures and Welders for Piping and Tubing.
   10. Chlorine Manual, Chlorine Institute, Inc.
   11. ANSI B16.3, Malleable Iron Screwed Fittings.
   12. ANSI B16.4, Cast Iron Screwed Fittings.
   13. ANSI B16.5, Steel Pipe Flanges, Flanged Valves and Fittings.
   14. ANSI B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
   15. ANSI B16.11, Forged Steel Fittings, Socket-Welding and Threading.
   16. ANSI B36.19, Stainless Steel Pipe.
   17. MSS Sp-43, Wrought Stainless Steel Butt-Welded Fittings.
   18. NFPA No. 26, Supervision of Valves Controlling Water Supplies for Fire Protection.
   19. ASME, Boiler and Pressure Vessel Code.
   20. ASTM A312, Seamless and Welded Austenitic Stainless Steel Pipe.
   21. ASTM A403, Wrought Austenitic Stainless Steel Piping Fittings.
   22. ASTM D2464, Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   23. ASTM D2467, Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   24. ASTM D2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
   25. ASTM D2855, Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
   26. ASTM F493, Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
   27. ASTM A 312, Seamless and Welded Austenitic Stainless Steel Pipe.
   28. ASTM A 403, Wrought Austenitic Stainless Steel Pipe Fittings.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Laying schedules and detailed layout drawings for all piping reflecting the CONTRACTOR'S construction schedule and installation methods. The laying schedules and layout drawings shall be referenced to the stationing and elevations shown on the Drawings, and all layout drawings shall be prepared to scale. Each pipe, fitting or special shall be designated on the layout drawings and in the laying schedules. Pipe, fittings and specials delivered to the job site shall be marked with the same letter or number designation appearing on the layout drawings and in the laying schedules.
   2. Full details of pipe, fittings, specials, supports, and connections to existing pipes and structures, including dimensions, sizes, classes, etc.
   3. Typical joint and harnessing details.
   4. Detailed description of pipe handling and installation methods. Copies of these descriptions shall be furnished to the pipe manufacturer for use in pipe design.
   5. Detailed descriptions of proposed field testing and disinfection including information and data pertaining to procedures and apparatus for testing and disinfection.

B. Tests: Submit description of proposed testing methods, procedures and apparatus. Submit copies of all test reports.

C. Certificates: Submit certificates of compliance with referenced standards.

D. Record Drawings: Conform to Division 1 Requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Conform to the requirements of Article 1.4 of Section 15A1.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The extent and size of piping is shown on the Drawings and in the schedule included at the end of this Section. Refer to applicable sections of these Specifications for detailed materials specifications.

B. Pipe Marking:
   1. Each piece of pipe, fitting or special, except straight pipe with no outlets, shall be clearly marked with a designation which shall conform with designations shown on the Shop Drawings.
   2. Class, size, manufacturer's name or trademark, date of manufacture and material designation shall be marked or stenciled on each pipe, fitting or special 4 inches in diameter and larger.
   3. Pipe less than 4 inches in diameter shall be clearly marked by manufacturer as to material, size and rating.

4. Special markings designating thrust restraint or abnormal loading conditions shall be placed on pipe, fittings and specials as applicable.
5. Markings shall take place after installation of shop applied linings and coatings.

C. Pipe Identification Markers and Arrows:
1. See Section 9L, Painting.

2.2 EXPOSED PIPING SCHEDULE

A. Attached to the end of this Section is the "Exposed Piping Schedule". Conform to the requirements of the schedule, unless otherwise specified or approved by ENGINEER.

2.3 RESTRAINED JOINT SCHEDULE

A. Use restrained joints and thrust protection for all exposed piping systems.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Installation of all pipe, fittings, valves, specials and appurtenances shall be subject to the review and/or approval of the ENGINEER.
2. Install piping as shown, specified and as recommended by the manufacturer, and in conformance with referenced standards and approved Shop Drawings.
3. Request instructions from ENGINEER before proceeding if there is a conflict between the manufacturer's recommendations and the Drawings or Specifications.
4. Any piping that is cracked, damaged, in poor condition or with damaged linings, or improperly marked will be rejected, unless the product can be repaired in a manner acceptable to the manufacturer and the ENGINEER.
5. Present all conflicts between piping systems and equipment, structures or facilities to ENGINEER for determination of corrective measures before proceeding.
6. All piping shall be inspected by the ENGINEER prior to installation. ENGINEER'S inspection will not relieve CONTRACTOR or manufacturer from responsibility for damaged products.
7. Take field measurements where required prior to installation to ensure proper fitting of Work.
8. All piping shall be carefully examined for cracks, damage or other defects before installation. Defective materials shall be immediately removed from the site, unless the defective product can be repaired in a manner acceptable to the manufacturer and the ENGINEER. Any piping found to be broken or defective after it has been installed shall be removed, replaced or repaired at the CONTRACTOR'S expense.

9. Interior of all piping and mating surfaces shall be inspected and all dirt, gravel, sand, debris or other foreign material shall be completely removed from the interior and mating surfaces before installation. Measures shall be taken to maintain the interior of all piping clean until acceptance of the completed Work. Care shall be taken to prevent foreign matter from getting on mating surfaces. Mating surfaces shall be wiped clean immediately before piping is installed.
10. All joints shall be made in the presence of the ENGINEER or his duly authorized representative, except as otherwise approved.
11. Protective linings and coatings shall be touched up prior to installation, where required.
12. Install piping accurately to line and elevation shown, specified or directed, except as otherwise approved by the ENGINEER. Accurate means of determining and checking the line and elevation shall be used, which shall be subject to the approval of the ENGINEER. Any modifications to the Drawings or these Specifications to suit the pipe manufacturer's standard must be approved by the ENGINEER. Remove and reinstall piping that is incorrectly installed at CONTRACTOR'S expense.
13. Where unforeseen conditions will not permit the installation of piping as shown or specified, no piping shall be installed without approval of the ENGINEER. Do not modify structures or facilities without approval of the ENGINEER.
14. Field painting shall be accomplished after the joints are made.
15. All gravity lines shall pitch uniformly at a minimum of 1/4 inch per foot grade, unless otherwise shown, specified or approved.
16. Piping shall be rotated as required to place outlets in proper position.
17. Blind flanges and cleanouts shall be provided at locations shown on the Drawings, specified or required.
18. Install straight runs true to line and elevation.
19. Install vertical piping truly plumb in all directions.
20. Install piping parallel or perpendicular to structure or building walls, floors and ceilings and supported therefrom. Piping at odd angles and 45-degree runs across corners will not be accepted, unless specifically shown or approved.
21. Install small diameter piping generally as shown on the Drawings when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, etc.
22. Install piping so as to leave all corridors, walkways, work areas, and like spaces unobstructed. Unless otherwise approved, provide a minimum headroom clearance under all piping of 7 feet-6 inches.
23. Whenever piping installation is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent foreign matter from entering the piping.
24. Cutting: Cut pipe from measurements taken at site, not from Drawings.
25. Provide provisions to permit bleeding air at high points and draining condensate at low points in air lines.
26. Nonmetallic insect screens shall be furnished and installed on vent pipes.
27. Conform to Section 15C3 for maximum support spacing for piping.
28. Install piping through walls, floors, partitions and roofs using wall pipes, floor pipes and pipe sleeves, unless otherwise shown on the Drawings or directed by the ENGINEER.

29. Where small diameter piping is to be connected to large diameter piping, provide taps in accordance with the pipe manufacturer's recommendations and requirements, unless otherwise shown specified, or directed.
30. Allow clearances for expansion and contraction of piping.
31. Make up all piping to meet the requirements of equipment supplied.
32. Except for copper pipe, flanged or threaded joints shall be used at all equipment and valve connections, except as otherwise shown, specified or directed by the ENGINEER.
33. Where shown, specified or required, flexible piping shall be provided where piping systems connect to equipment. Flexible piping shall be of the same nominal size and strength as the piping system. All flexible piping shall have a minimum line length of 18 inches.
34. Unless otherwise shown or specified, install a shutoff valve constructed of materials suitable for the intended service on every lateral and pipe connection to equipment, except drain and vent lines.
35. Use mechanical link-type seals suitable for 20 psig working pressure as specified in Section 15C4 to seal annular space between pipe sleeve and pipe where shown or required.
36. Provide and install escutcheon plates as specified in Section 15C4 at all pipe penetrations in exposed interior areas, unless otherwise shown, specified or approved.
37. Care shall be taken not to leave tool marks or abrasions on plated, polished or soft metal piping.
38. Concrete or metallic pipe supports conforming to the requirements of Division 3 and Section 15C3, respectively, shall be provided under piping where shown on the Drawings or as otherwise required.
39. All piping shall be plugged watertight with a suitable cap or plug securely fastened to the end of the piping at all contract interfaces.

B. Manufacturer's Installation Specialist:
   1. CONTRACTOR shall provide the services of a competent manufacturer's installation specialist when pipe installation begins, if the CONTRACTOR is not experienced in installing and jointing a particular type of pipe.
   2. Retain specialist on the job for a minimum of 2 days and until competency of the pipe installation crew has been demonstrated to the satisfaction of the ENGINEER.

C. Joints:
   1. General:
      a. Make joints in accordance with the pipe manufacturer's recommendations and the specifications herein.
      b. Cutting: Cut pipe from measurements taken at site, not from Drawings.
         1) Field cut metallic pipe, where required for inserting valves, fittings, specials and closures with a machine specially designed for cutting pipe and in accordance with the manufacturer's instructions.
         2) Cut pipe accurately and squarely without damage to piping so as to leave a smooth end at right angles to pipe axis. Install without forcing or springing.

3) Ream out all pipes and tubing to full inside diameter after cutting. Taper cut ends and remove all sharp edges on end cuts.
4) Remove all cuttings and foreign matter from the inside of pipes and tubing before installation.
5) Flame cutting will not be allowed.
6) Pipe damaged by the CONTRACTOR by improper or careless methods of cutting shall be replaced or repaired at his expense.

2. Threaded Joints: Use standard, righthand tapered full depth threads on steel piping and apply an approved joint compound to the male threads only, before installation. Leave not more than three pipe threads exposed at each connection.
3. Solder Joints:
   a. Ream or file pipe to remove burrs.
   b. Clean and polish contact surfaces of joints.
   c. Apply flux to both male and female ends.
   d. Insert end of tube into fittings full depth of socket.
   e. Heat joint evenly.
   f. Form continuous solder bead around entire circumference of joint.
4. Flanged Joints:
   a. Flanged joints shall be drawn together evenly until the joint is perfectly tight using approved full-faced gaskets and gasket compounds. Gaskets shall be suitable for service intended in accordance with manufacturer's ratings and instructions.
   b. The length of bolts shall be uniform, and they shall not project from the nut more than 1/4 inch or fall short of the end of the nut when fully taken up.
   c. The ends of bolts shall be cut off in a lathe so as to be neatly rounded. Threads on both nuts and bolts shall be sharply cut and accurately sized so as to turn freely without undue play. No washers shall be used.
   d. Bolt threads and gasket faces for flanged joints shall be cleaned and lubricated.
5. Thermoplastic Pipe Joints:
   a. Make joints in conformance with manufacturer's recommendations.
   b. For socket welded joints, conform to ASTM D 2564.
   c. Use teflon tape for threaded joints.
6. Welded Joints:
   a. Welding of steel pipe and fittings shall conform with all applicable requiremens of Code for Pressure Piping, ANSI B 13.1 Section 6.
   b. All welders shall qualify for AR-2 class welding in accordance with ANSI B 13.1, and shall have current certificate available for ENGINEER'S inspection.
7. Flexible Coupling Joints:
   a. Installation and assembly of couplings shall conform to the coupling manufacturer's recommendations.
   b. Prior to assembly, the last 8 inches of the outside of each pipe end shall be cleaned thoroughly with a wire brush to remove foreign matter.
   c. Following cleaning, lubricant shall be applied to each joint end.

d. Immediately after application of the lubricant, the coupling shall be slipped over each pipe end.
e. All bolts shall be inserted and all nuts screwed up tightly with a wrench in accordance with the coupling manufacturer's recommendations.
f. Nuts spaced 180 degrees apart shall be tightened alternately in order to produce an equal pressure on all parts of the coupling.

D. Mechanical Couplings:
1. Prior to the installation and assembly of mechanical couplings, the joint ends shall be cleaned thoroughly with a wire brush to remove foreign matter.
2. Following this cleaning, lubricant shall be applied to the rubber gasket or inside of the coupling housing and to the joint ends.
3. After lubrication, the gasket shall be installed around the joint end of the previously installed piece and the joint end of the subsequent piece shall be mated to the installed piece. The gasket shall be positioned and the coupling housing placed around the gasket and over the grooved joint ends.
4. The bolts shall be inserted and the nuts screwed up tightly by hand. The bolts shall then be tightened uniformly in order to produce an equal pressure on all parts of the housing. When the housing clamps meet metal to metal, the joint is complete and further tightening is not required.

E. Unions:
1. Install all pipelines with frequently placed unions to permit easy disassembly where applicable.
2. Install dielectric unions wherever dissimilar metals are connected except for bronze or brass valves in ferrous piping. When the joint is made the gasket shall not project into the internal opening. The pipeline shall be connected so that electric current is below 1 percent of the galvanic current.
3. Provide a union downstream of each valve with screwed connections.
4. Provide screwed or flanged unions at each piece of equipment where shown, and where necessary to install or dismantle piping.

F. Eccentric Reducers: Use eccentric reducers where shown and where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

G. Valves and Accessories:
1. Provide supports for large valves, meters and other heavy items.
2. Install floor stands as shown and as recommended by the manufacturer.
3. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by the manufacturer.
4. Provide sleeves wherever pipes pass through walls, partitions, floors and roofs unless otherwise shown. Sleeves through wall shall be flush with wall face.
5. Anchor sleeves to concrete and masonry walls as shown or otherwise approved.
6. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.

7. Do not install sleeves and pipes through structural members unless specifically shown and approved by ENGINEER.
8. Position valve operators as shown. When the position is not shown, install the valve so that it can be conveniently operated and as approved by ENGINEER. Avoid placing operators at angles to the floors or walls.
9. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and down stream runs recommended by the manufacturer, unless specific location dimensions are shown. Position flow measuring devices so that they do not conflict with the discs of butterfly control valves.

H. Transitions from One Type of Pipe to Another:
1. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.
2. Whenever changes in piping occur, changes shall be made with reducing fittings. The use of bushings is not permitted unless otherwise shown.

I. Additional Requirements for Copper Tubing:
1. Joints shall be made with clean bright ends, properly fluxed, using 95 percent tin, 5 percent antimony solder.
2. Runs shall contain unions at connections to equipment and at reasonable distances along the lengths of runs to permit convenient disassembly of piping and removal of equipment.
3. All horizontal lines shall be properly pitched to facilitate draining and all low points shall be provided with 3/4-inch hose bibbs properly located so that the entire system may be drained.

J. Additional Requirements for Thermoplastic Piping:
1. All valves shall be supported independently of the piping system.
2. Wide band supports as recommended by manufacturer and approved by ENGINEER shall be used to minimize localized stresses.
3. Piping passing through walls shall be provided with a sleeve of wearing material to prevent abrasion damage to piping.
4. When anchors are required at locations other than equipment or tanks they shall be placed at elbows, valve locations and at bends in pipe line.
5. Spacing of supports shall be in accordance with the manufacturers published values at the maximum design operating temperature of the pipe unless otherwise specified, shown or approved by ENGINEER.
6. Use "U" clamps with wide bank circumferential contact. Avoid all pressure contact with piping.
7. On long runs of piping use guides to maintain alignment and reduce chance of elastic failure of pipe. Space guides as recommended by manufacturer.
8. Use expansion joints to take up pipe expansion. Provide anchors to restrain the expansion joint. Use of expansion joints shall be kept to a minimum. Flexible connectors may be used to absorb thermal movement when approved by ENGINEER.
9. Do not install pipe when temperature is less than 60 F except as otherwise recommended by manufacturer and approved by ENGINEER.

K. Restrained Joint Requirements:
1. Install restrained joints as shown, specified, or required and as recommended by manufacturer. Assembly shall be in strict accordance with manufacturers recommendations.
2. Provide concrete and metal cradles, collars, kickers, and blocks as shown or otherwise approved by ENGINEER.
3. Provide restraints, supports, collars and blocks of sufficient size and weight to prevent expansion and contraction forces from reaching valves, pumps or equipment.
4. All joints on ductile iron pipe, steel pipe, copper pipe and thermoplastic pipe shall be restrained to provide for thrust protection along the entire length of each pipe, fitting or special including connections to valves, equipment and wall fittings.

L. Closures:
1. Provide all closure pieces shown or required to complete the Work.
2. Locate closures in straight runs of pipe.
3. Closure pieces shall be complete with gaskets, glands, follwer rings, wire mesh and any other items necessary for a complete installation.

3.3 TESTING OF PRESSURE PIPING

A. General:
1. Test all piping as specified below unless otherwise authorized by ENGINEER.
2. Notify ENGINEER 48 hours in advance of testing.
3. Provide all testing apparatus including pumps, hoses, gages, fittings, temporary bulkheads, thrust protection and plugs, and miscellaneous other items.
4. Pipelines shall hold the specified test pressure for a period of two hours.
5. Pipelines which fail to hold specified test pressures or which exceed the allowable leakage rate shall be repaired and retested.
6. Test pressures required are at the lowest elevation of the pipeline section being tested, unless otherwise specified.
7. Unless otherwise approved, conduct all tests in the presence of the ENGINEER. Repeat tests in the presence of local authorities having jurisdiction if required by them.
8. Provide temporary blocking and bracing or approved joint restraint to prevent joint separation and pipe movement during testing.
9. All blind flanges and end caps shall be in place during testing.
10. Conduct all tests prior to piping being enclosed in walls, floors and ceilings.
11. Pressure gages, switches, meters and control equipment shall be protected or removed during the tests.
12. CONTRACTOR shall make all arrangements for and bear all expenses for providing all water for testing. The source of the water and point of introduction of water, required for the making of tests, shall be subject to the approval of the ENGINEER.
13. All costs for tests shall be included in the prices bid.

B. Schedule of Pipeline Tests:
1. For pressure test values see "Piping Schedule".

2. All piping shall be water tested after installation except as specified otherwise.
3. Piping not in Schedule shall be tested at 1.5 times the maximum working pressure or 10 psi, whichever is greater.
4. Air lines shall be air tested at 10 psi greater than the anticipated working pressure of the system.

C. Pressure Test Procedure:
1. Insure that all supports and restraint protection are securely in place.
2. Allow concrete for blocking to reach design strength before testing.
3. Fill section to be tested slowly with water and expel all air. Install cocks, if necessary, to ensure removal of air.
4. Test only one section of pipe at a time.
5. Apply test pressure required for two hours and observe pressure gage. Check carefully for leaks while test pressure is being maintained.
6. Thermoplastic piping may be tested with air.
7. Concrete pressure pipe shall be allowed to remain full for a sufficient period to allow voids in concrete pipe to fill. Additional water shall then be added to replace water which filled the voids.

D. Leakage Test Procedure:
1. Conduct leakage test for all liquid piping after satisfactory completion of pressure test.
2. Maintain test pressure constantly for a 2 hour period and accurately measure the amount of water which must be added to maintain the test pressure.
3. Allowable Leakage Rates (in gallons per hour per 1,000 feet per inch diameter):
   a. Ductile Iron Pipe: 0.075.
   b. Copper, Stainless Steel, Carbon Steel, Thermoplastic, and All Other Piping: No leakage permitted.
4. All visible leaks shall be made tight regardless of the amount of leakage or results of the leakage tests. If the pipes tested do not meet the leakage requirements of the leakage tests, they shall be repaired and retested as necessary until the leakage requirement is met.
5. All Work found defective shall be repaired or replaced.

3.4 CLEANING AND DISINFECTION

A. All piping shall be thoroughly cleaned and flushed prior to placing in service in a manner approved by ENGINEER.
1. Piping shall be inspected from and all debris, dirt and foreign matter removed.
2. Remove dirt, dust, rust, etc., from piping in preparation for painting and insulating.
3. Clean lenses on all thermometers, gages, etc., where required.

B. Disinfection:
1. Disinfect all potable water piping.

2. Completely clean interior of all piping and flush piping prior to disinfection with water at a minimum velocity of 2-1/2 feet per second.
3. Conform to procedures described in AWWA C601. Use continuous feed method of disinfection unless alternative method is acceptable to OWNER and ENGINEER.
4. Water for flushing, cleaning and disinfection shall be furnished and paid for by the CONTRACTOR. CONTRACTOR shall provide all temporary piping, hose, valves, appurtenances and services required.
5. Chlorine shall be supplied by CONTRACTOR.
6. Bacteriologic tests will be performed by OWNER. A certified test laboratory report shall be available to CONTRACTOR, if requested.
7. Chlorine concentration in the water entering the piping shall be between 50 and 100 parts per million, such that a minimum residual concentration of 25 mg/l will be left after a 24-hour retention period. The operation shall be repeated as necessary to provide complete disinfection.
8. All costs for disinfection except for bacteriological testing shall be included in the prices bid.

C. CONTRACTOR shall make all arrangements for and bear all expenses for providing all potable water for flushing and disinfection. The source of the water and point of introduction of water required for flushing shall be subject to the approval of the ENGINEER.

3.6 DISPOSAL OF WATER

A. CONTRACTOR shall provide suitable means for disposal of test, disinfection and flushing water so that no damage results to facilities or waterways.

B. Means for disposal of test, disinfection and flushing water shall be subject to the approval of ENGINEER, local governing authorities and regulatory agencies.

C. CONTRACTOR shall be responsible for any damage caused by his water disposal operations.

3.7 IDENTIFICATION OF PIPING

A. Paint and color code piping in conformance with Section 9L.

B. Identify piping and direction of flow with markers as specified in Section 9L.

EXPOSED PIPING SCHEDULE

Service	Material	Interior Linings	Exterior Coating	Thickness Class	Joint	Pressure Test (psig)
Sludge:						
A. Suction	DI	CL	P	53	Flg	15
B. Discharge	DI	CL	P	53	Flg	50
Recycle Pump:						
A. Suction	DI	CL	P	53	Flg	15
B. Discharge	DI	CL	P	53	Flg	50
Chemical Feed:						
A. Chlorine Solution	CPVC	-	-	Sch. 80	Flg/SW	100
Plant Potable Water Supply:						
A. 3" or greater	DI	CL	P	53	Flg	100
B. Less than 3"	CPVC	-	-	Sch. 80	SW	100
Plant Potable Water Supply:	DI	CL	P	53	Flg	100
Other Piping Not Listed Above:						
A. Exposed Pipe:						
3" or greater	DI	CL	P	53	Flg	100
less than 3"	CPVC	-	-	Sch. 80	Sd	100

The following abbreviations are used.

A. Material Abbreviations

Ductile Iron	DI
Polyvinyl Chloride	PVC
Chlorinated Polyvinyl Chloride	CPVC

B. Lining Abbreviations

Bituminous Coated	BC
Cement Lined	CL
Painted	P

C. Joint Abbreviations

Bell and Spigot	B&S
Flanged	Flg
Mechanical Joint	MJ
Solvent Welded	SW

+ + END OF SECTION + +

SECTION 15A3

DUCTILE-IRON PIPE, FITTINGS, SPECIALS AND COUPLINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish all ductile-iron pipe, fittings and specials necessary to complete the Work.
2. The extent of the piping Work is shown on the Drawings and in schedules included in Sections 15A1 and 15A2.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 2D1, Earthwork.
3. Section 9L, Painting. (Surface preparation and shop painting are under Section 15A3).
4. Section 15A1, Buried Piping Installation.
5. Section 15A2, Exposed Piping Installation.
6. Section 15C3, Pipe Hangers and Supports.
7. Section 15D, Valves and Appurtenances.
8. Section 15H Sections, Heating, Ventilating and Air Conditioning.
9. Section 15I Sections, Plumbing.

1.2 QUALITY ASSURANCE

A. Source Quality Control: Obtain ductile iron pipe and fittings from no more than one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. AWWA C100, Cast-Iron Pressure Fittings.
2. AWWA C104 (ANSI A21.4), Cement-Mortar Lining for Cast-Iron and Ductile-Iron Pipe and Fittings for Water.
3. AWWA C110 (ANSI A21.10), Gray-Iron and Ductile-Iron Fittings, 2 in. through 48 in., for Water and Other Liquids.
4. AWWA C111 (ANSI A21.11), Rubber Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C115 (ANSI A21.15), Flanged Cast-Iron and Ductile-Iron Pipe with Threaded Flanges.
6. AWWA C150 (ANSI A21.50), Thickness Design of Ductile-Iron Pipe.
7. AWWA C151 (ANSI, A21.51), Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
8. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
9. ANSI B18.2.1, Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Lag Screws.
10. ANSI B18.2.2, Square and Hex Nuts.
11. ASTM A 307, Carbon Steel Externally and Internally Threaded Standard Fasteners.
12. ASTM A 354, Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings in plan and profile and data on pipe, fittings, gaskets and appurtenances, and laying schedules. Submit these with Shop Drawings required under Sections 15A1 and 15A2.
   2. Deviations from Drawings and Specifications.

B. Tests: Submit description of proposed testing methods, procedures, and apparatus. Submit copies of all test reports.

C. Certificates: Submit certificates of compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Sections 15A1 and 15A2.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Joints shall be as specified in piping schedules in Sections 15A1 and 15A2. If not specified, use flanged joints for exposed piping and mechanical joints for buried piping.

B. Ductile-Iron Pipe and Fittings:
   1. Pipe:
      a. Flanged Pipe: Fabricate in accordance with requirements of AWWA C151.
         1) Thickness: As shown on piping schedules. Where not shown or specified, use Class 53 as a minimum.
      b. Non-Flanged Pipe: Conform to AWWA C150 and C151 for material, thickness, dimensions, tolerances, tests, markings and other requirements.
         1) Thickness: As shown on pipe schedules. Where not shown or specified, use Class 53 as a minimum.
   2. Joints:
      a. Flanged Joints: Conform to AWWA C110.
         1) Gaskets: Cloth-inserted rubber, 1/8-inch thick, full face.
         2) Bolts and Nuts: Conform to ANSI B18.2.1 and ANSI B18.2.2, respectively. Exposed bolts and nuts shall be ASTM A 307, Grade B. Buried or submerged bolts and nuts shall be Type 304 stainless steel.
      b. Mechanical Joints: Conform to AWWA C111.
         1) Gaskets: Plain tip.
         2) Bolts and Nuts: High strength, low alloy steel.
   3. Fittings: Conform to AWWA C110.
      a. Pressure Rating: 150 psi.
      b. Material: Cast-iron or ductile iron.
      c. Gaskets: As specified above for joints.
      d. Bolts and Nuts: As specified above for joints.
   4. Coatings and Linings:
      a. Pipe and fittings shall be lined with a bituminous seal coated cement-mortar lining with twice standard thickness in accordance with AWWA C104.

b. Exposed pipe shall be prepared and prime coated as specified hereinafter under "SURFACE PREPARATION AND SHOP PAINTING".
c. Buried pipe and fittings shall be coated on the outside with a bituminous coating, approximately 1-mil thick.
d. All buried pipe and fittings shall be encased in polyethylene protective wrapping per MAG Section 610.5.

C. Couplings:
1. Sleeve Type, Flexible Couplings:
a. Pressure and Service: Same as connected piping.
b. Materials: Cast-Iron.
c. Gaskets: Suitable for use with material in pipe.
d. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have bolts and nuts made of Type 304 stainless steel.
e. Harnessing:
1) Harness couplings as shown, specified or otherwise required to restrain all pressure piping.
2) Adjacent flanges shall be tied with bolts of corrosion resistant alloy steel. Provide flange mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved.
3) Conform to dimensions, size, spacing and materials for lugs, bolts, washers and nuts as recommended by manufacturer and approved by the ENGINEER for the pipe size, wall thickness and working pressure required. However, the following minimum bolting shall be provided unless otherwise acceptable to the ENGINEER.

Pipe Diameter	Number of Bolts	Bolt Diameter	Spaced At
4"	2	5/8"	180°
6"-8"	2	3/4"	180°
10"-12"	2	7/8"	180°

f. Remove pipe stop unless otherwise approved.
g. Product and Manufacturer: Provide couplings as manufactured by one of the following:
1) Dresser Industries, Style 53.
2) Smith-Blair, Division of Rockwell International, Type 431.
3) Or equal.
2. Flanged Adapters:
a. Description: One end of adapter shall be flanged and the other end with a sleeve type flexible coupling.
b. Pressure and Service: Same as connected piping.
c. Material: Cast-Iron.
d. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated.
e. Harnessing:
1) Harness adapters to restrain all pressure piping, unless otherwise approved by the ENGINEER.
2) For 12-inch diameter adapters and smaller provide 1/2-inch minimum stainless steel anchor studs installed

in a pressure tight anchor boss. Provide number of studs required to suit pressure and service conditions. Harness shall be as designed and recommended by manufacturer. However, the following minimum anchor studs shall be provided unless otherwise approved by the ENGINEER.

6-inch dia and less: 2
8-inch dia: 4
10-inch dia: 6
12-inch dia: 8

3) For adapters larger than 12-inch diameter provide split-ring harness clamps with a minimum of 4 corrosion resistant alloy steel bolts. Harness assembly shall be as designed and recommended by manufacturer. Dimensions, sizes, spacings and materials shall be suitable for service and conditions encountered and shall be approved by the ENGINEER.

f. Manufacturer: Provide flanged adapters as manufactured by one of the following:
   1) Dresser Industries, Style 127.
   2) Smith-Blair, Division of Rockwell International, Type 912.

6. Split Type Grooved or Shouldered End Flexible Couplings where shown or approved by the ENGINEER shall be as follows:
   a. Pressure and Service: Same as connected piping. Use shouldered end where required by pressure rating.
   b. Material: Malleable Iron.
   c. Gaskets: Rubber suitable for sewage as recommended by manufacturer.
   d. Bolts and Nuts: Heat treated carbon steel track bolts, plated.
   e. Product and Manufacturer: Provide couplings as manufactured by one of the following:
      1) Victaulic Company, Style 31.
      2) Or equal.

D. Restrained Joints: Product and Manufacturer:
   1. Lok-Fast Joint by American Cast Iron Pipe Company.
   2. Clow Super Lock.
   3. Or equal.

E. Specials:
   1. Taps: Provide taps where shown or required for small pipe connections. Where pipe or fitting wall thickness is too small to provide required number of threads, a boss or pipe saddle shall be installed. Provide taps, small pipe, fittings, valves, specials and adapters to connection for connection to OWNER furnished pressure indicators, switches and other items.
   2. Pipe Adapters: Where necessary to join pipe of different type, the CONTRACTOR shall provide necessary adapters. Ends shall conform to Specifications for the appropriate type joint.

2.2 SURFACE PREPARATION AND SHOP PAINTING

A. Surface preparation and shop painting is required for all ductile iron pipe and all pipe couplings.

B. All exterior pipe and coupling surfaces shall be cleaned with a Commercial Sandblast (SSPC-SP6) and provided with two coats of epoxy paint conforming to the requirements of Section 9L, Painting.

C. All prime coat materials shall be compatible with the finish coat materials to be furnished under Section 9L, Painting.

D. Exposed pipe and fittings shall be prepared and prime coated as specified hereinafter, under "SURFACE PREPARATION AND SHOP PAINTING".

2.3 MARKING FOR IDENTIFICATION

A. All pipline materials shall be stamped, marked or identified with the following:
1. Name of manufacturer.
2. Date of manufacture.
3. Operating design pressure.
4. Pipe class and specification designation.
5. Size and length dimensions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Sections 15A1 and 15A2 for piping installation, testing, cleaning and acceptance.

+ + END OF SECTION + +

SECTION 15A4

STEEL PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all steel pipe and fittings required to complete the Work.
2. The extent of piping is shown on the Drawings and the Schedules in Sections 15A1 and 15A2.
3. All jointing and gasketing materials, flexible couplings, flanged coupling adapters, end caps, closures, harnessing, tie rods and other miscellaneous appurtenances, accessories, linings and coatings shall be provided.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 2D1, Excavation and Backfill.
3. Section 9L, Painting.
4. Section 15A1, Buried Piping Installation.
5. Section 15A2, Exposed Piping Installation.
6. Section 15C3, Pipe Hangers and Supports.
7. Section 15C4, Wall Pipes, Floor Pipes and Pipe Sleeves.
8. Section 15D, Valves and Appurtenances.

1.2 QUALITY ASSURANCE

A. Obtain all steel pipe, fittings and incidentals from not more than one supplier.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. AWWA C200, Steel Water Pipe 6 Inches and Larger.
2. AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4 Inches and Larger-Shop Applied.
3. AWWA C206, Field Welding of Steel Water Pipe.
4. AWWA C207, Steel Pipe Flanges.
5. AWWA C208, Dimensions for Steel Water Pipe Fittings.
6. ASTM A 53, Welded and Seamless Steel Pipe.
7. ASTM A 120, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe For Ordinary Uses.
8. ANSI B2.1, Pipe Threads.
9. SSPC, Steel Structures Painting Council.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. All piping laying schedules and detailed drawings in plan and profile. Show full details of piping, specials, and connections to equipment.

B. Certificates: Submit certificates of compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15A1 and 15A2.

PART 2 - PRODUCTS

2.1 MATERIALS AND SERVICE CONDITIONS

A. Steel pipe 4 inches and larger shall conform to ASTM A 53, pipe smaller than 4 inches shall conform to ASTM A 120. Thicknesses shall be as shown on the piping schedule. Minimum wall thickness shall be 3/8 inch.

B. Dimensions of steel pipe shall be in accordance with ANSI B36.10.

C. Material, manufacturing operations, testing, and inspection of pipe shall be in conformance with applicable portions of AWWA C200.

D. All special sections and fittings shall be made with component parts having the dimensions, ends, and other details as shown and as herein specified.

E. The pipe diameters shown on the Drawings shall be nominal inside diameter for size 12-inch and smaller and the nominal outside diameter for pipe larger than 12 inches.

F. Galvanized steel pipe shall conform to AWWA C200, Schedule 40 and shall be hot-dip galvanized. Fittings shall be hot- dipped galvanized malleable iron conforming to ANSI B2.1.

G. Flanged Joints: Pipe ends shall be fitted with steel slip-on pipe flanges conforming to AWWA C207. Flanges shall be AWWA standard steel ring-type Class D. Flanges shall be attached to pipe by means of two fillet welds. Carbon steel bolts and nuts shall be, as a minimum, ASTM A 307, Grade B.

H. Welded Joints: Joints shall be butt welded joints, unless otherwise specified. The field welding of the joints shall meet the applicable requirements of AWWA C206. Lugs shall be welded to the pipe where required for harnessing of flexible couplings or flanged coupling adapters. The lugs shall be as required by the manufacturer of the couplings or flanged adapters. Field welding of steel pipe 24 inches and smaller will not be permitted.

I. Threaded Joints: Steel pipe less than 4 inches in diameter shall be furnished, unless otherwise shown or specified, with threaded ends and line couplings. Threads shall conform to ANSI B2.1, tapered threads 3/4 inch per foot.

J. Fittings: Fittings shall be fabricated of the same material as the pipeline of which they are a part. Unless otherwise shown or approved all fittings shall conform to AWWA C208. Wall thickness shall be the same as connecting piping.

K. Couplings:
1. Sleeve-Type, Flexible Couplings:
   a. Pressure and service shall be the same as connected piping.
   b. Materials: Steel.
   c. Gaskets: Suitable for specified service.
   d. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 304 stainless steel bolts and nuts.
   e. Harnessing:
      1) Harness all couplings to restrain all pressure piping.
      2) Dimensions, sizes, spacing and materials for lugs, tie bolts, washers, and nuts shall conform to the standards of the manufacturer for the pipe size, wall thickness and working pressure required.
      3) No less than two bolts shall be furnished for each coupling.
      4) Flexible couplings for flanged steel pipe shall be harnessed with tie bolts and lugs in accordance with AWWA Manual M11 "Steel Pipe Design and Installation."
      5) Harnessing indicated on the Drawings is shown schematically only.
      6) Lugs shall be fabricated from steel equal to or better than that specified for the pipe to be harnessed. The lugs shall be shop welded to the pipe.
      7) Lugs and tie bolts shall be designed for 150 percent of the piping system test pressure specified in Sections 15A1 and 15A2.
      8) Tie bolts, nuts and washers shall be ASTM A 193, Grade B7 steel or better.
   f. Product and Manufacturer: Provide sleeve-type flexible couplings as manufactured by one of the following:
      1) Dresser Industries.
      2) Rockwell International Corporation.

2. Flanged Coupling Adapters:
   a. Pressure and service shall be the same as connected piping.
   b. Materials: Steel.
   c. Bolts and Nuts: Alloy steel, corrosion-resistant.
   d. Harnessing:
      1) Flanged coupling adapters for steel pipe shall be harnessed by using tie bolts and lugs as specified for flexible couplings.
      2) Harnessing indicated on the Drawings is shown schematically only.
   e. Product and Manufacturer: Provide flanged coupling adapters as manufactured by one of the following:
      1) Dresser Industries.
      2) Rockwell International Corporation.

L. Lining: All steel pipe and fittings shall be furnished with a cement mortar lining and sealed with a bituminous seal coat. The cement mortar lining shall conform to the requirements of AWWA C205.

2.2 PAINTING

A. The exterior surfaces of steel pipe and fittings shall receive a commercial blast cleaning conforming to SSPC-SP6. Immediately after

cleaning, the pipe surface shall be prime coated in the shop. Pipe shall be field coated after erection. Paint systems shall be in accordance with the requirements of Section 9L.

2.3 IDENTIFICATION

A. All pipeline materials shall be stamped, marked or identified with the following:
   1. Name of manufacturer.
   2. Letter or number designation. The same designation shall appear on the Shop Drawings.
   3. Pipe size.
   4. Material.
   5. Wall thickness.
   6. Rating.

PART 3 - EXECUTION

3.1 INSPECTION

A. The CONTRACTOR shall inspect all piping to ensure that piping is free of defects in material and workmanship. The compatibility of all pipe, fittings, and coatings shall be verified.

B. CONTRACTOR shall pay particular attention to the adequacy and continuity of cement mortar lining in the vicinity of all welded joints. All damaged areas shall be repaired in such a manner so as to ensure that the interior lining is completely continuous, full thickness and free from all defects in material and workmanship.

3.2 INSTALLATION

A. Refer to Sections 15A1 and 15A2 for piping installation, testing, cleaning and acceptance.

+ + END OF SECTION + +

SECTION 15A7

COPPER PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall furnish all labor, tools, materials, equipment, and incidentals required to provide copper piping, fittings including all appurtenances as shown, specified, and required to complete the Work.
2. The extent and size of piping is shown on the Drawings and in the Schedules included in Sections 15A1 and 15A2.
3. All jointing materials, end caps and other miscellaneous appurtenances and accessories shall be provided.
4. It is the intention of the Drawings and of these Specifications to provide complete and workable piping systems and any miscellaneous fittings, specials and appurtenances required for proper completion of the work shall be considered as having been included under this Section.
5. Specifically excluded from this Section are the following:
   a. All piping specifically included with and appurtenant to equipment.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the Work that must be installed with the materials specified herein and which is related to this Section including piping installation Sections, piping systems and other related Sections of Division 15.

C. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 2D1, Excavation and Backfill.
3. Section 15A1, Buried Piping Installation.
4. Section 15A2, Exposed Piping Installation.
5. Section 15C3, Pipe Hangers and Supports.
6. Section 15C4, Wall Pipes, Floor Pipes and Pipe Sleeves.
7. Section 15D, Valves and Appurtenances.
8. Section 15F2, Piping Insulation.
9. Section 15H Sections, Heating, Ventilating and Air Conditioning.
10. Section 15I Sections, Plumbing.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: The piping for each service or system as specified herein shall be provided by a manufacturer who has thoroughly familiarized himself with the design intent of the overall system and will provide piping suitable for the service intended.

B. Each type of pipe and fitting shall be obtained from no more than one manufacturer.

C. Requirements of Regulatory Agencies: Comply with the applicable provisions of the following regulatory agencies:
   1. Underwriters Laboratories, Incorporated.
   2. National Fire Protection Association.
   3. ASME, Boiler and Pressure Vessel Code.
   4. State and Local Building Codes and Ordinances.
   5. National Plumbing Code, where applicable.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM B 42, Standard Sizes for Seamless Copper Pipe.
   2. ASTM B 61, Steam or Valve Bronze Castings.
   3. ASTM B 68, Bright Annealed Seamless Copper Tube.
   4. ASTM B 75, Seamless Copper Tube.
   5. ASTM B 88, Seamless Copper Water Tube.
   6. ASTM B 280, Seamless Copper Tube for Air-Conditioning and Refrigeration.
   7. ASTM B 302, Threadless Copper Pipe.
   8. ASTM B 306, Copper Drainage Tube (DWV).
   9. Product Handbook of Copper Development Association Inc.
   10. ANSI B16.15, Cast Bronze Threaded Fittings.
   11. ANSI B16.18, Cast Bronze Solder Joint Pressure Fittings.
   12. ANSI B16.22, Wrought Copper and Bronze Solder Joint Pressure Fittings.
   13. ANSI B16.23, Cast Copper Alloy Solder Joint Drainage Fittings DWV.
   14. ANSI B16.24, Bronze Flanges and Flanged Fittings.
   15. ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubing.
   16. ANSI B16.29, Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings.
   17. ANSI B16.31, Non-Ferrous Pipe Flanges.
   18. ASTM B32, Solder Metal.
   19. FSO-F-506B, Flux, Soldering: Paste and Liquid.

E. Inspection: The quality of all materials, process of manufacturer and finished pipe and fittings shall be subject to the inspection and approval of the ENGINEER.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data of the pipe system, fittings and appurtenances, with all necessary engineering data. Submit these with Shop Drawings required under Section 15A1 and 15A2.

B. Certificates: Where specified or otherwise required by the ENGINEER submit test certificates. Submit certificates of compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Handle all pipe, fittings and accessories carefully with approved handling devices. Do not drop, roll or skid off trucks. Materials that are dented, gouged, crushed or otherwise damaged will not be permitted in the Work.

B. Store pipe and fittings on wood blocking or platforms so they are not in contact with the ground.

C. Cap ends of pipe and fittings to keep interiors free from contamination.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Copper pipeline systems shall be specially designed and installed for the service intended and shall be as shown and specified.

B. Copper pipe with soldered joints shall be used for all piping 2-1/2 inches in diameter and smaller for process, potable and non-potable water lines, vacuum signal and pneumatic signal lines, air supply lines, process sampling lines, equipment drains and instrument drains unless specified or shown otherwise.

2.2 MATERIALS

A. Copper Piping and Fittings:
   1. Copper piping to be installed in exposed locations shall be Type K hard temper pipe with wrought solder joint pressure fittings. Type K copper pipe shall conform to ASTM B 88. Fittings shall conform to ANSI B16.22.
   2. Copper piping to be installed in buried locations shall be Type K soft temper pipe with wrought copper pressure fittings. Type K copper pipe shall conform to ASTM B 88. Fittings shall be in conformance with ANSI B16.22 or ANSI B16.29, as applicable.
   3. All pipe shall be made of copper free from cuprous oxide, as determined by microscopic examination at a magnification of 75 diameters.
   4. Copper pipe, when furnished in coils, shall be annealed after coiling.

B. Copper Drainage Pipe: The pipe system for sanitary drainage or soil, waste and vent pipe shall be in accordance with ASTM B 306.

2.3 JOINTING

A. The copper piping systems shall be assembled with soldered joints. The fittings shall conform to ASTM B 61 and ANSI Standards listed in paragraph 1.2.D.
   The solder used for pipe joints shall be 50-50 standard solder, conforming to ASTM B 32.

B. All joints shall conform to manufacturers recommendations and shall be made by skilled workmen. Joints shall develop full strength and shall be stronger than the pipe joined.

2.3 MARKING

A. All items shall be marked or labeled with the following information:
   1. Metal or alloy designation.
   2. Temper.
   3. Size and schedule.
   4. ASTM specification number.

5. Name and location of supplier.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Sections 15A1 and 15A2 for piping installation, testing, cleaning and acceptance.

+ + END OF SECTION + +

1) 2-inch and Smaller: 6 feet.
2) 2-1/2-inch and Larger: 8 feet.

b. Steel Pipe:
1) 1-inch and Smaller: 6 feet.
2) 1-1/4-inch and Larger: 10 feet.

c. Stainless Steel Pipe:
1) 2-inch and smaller: 6-feet
2) 2-1/2-inch and larger: 8 feet

d. Plastic Pipe:
1) Maximum support spacing for plastic pipe at ambient temperature shall be one-half the above values specified for steel pipe.

e. Ductile Iron Pipe:
1) Two supports per length.

2. Additional supports shall be placed immediately adjacent to any change in piping direction, and on both sides of valves and couplings.
3. Accurately locate inserts for hanger rods in forms before concrete is placed.
4. Use expansion anchors only to support rods, hangers and brackets for piping 2-inch and smaller and only if the expansion anchors are designed to carry 100 percent of the full load, hanger, and/or bracket and pipe load.

B. Supports for Vertical Piping:
1. Provide riser clamp placed under hub, fitting or coupling with approved solid bearing on steel sleeve at each floor level.
2. Where riser clamps are used with plastic piping they shall be modified so as not to exert any compressive forces on the pipe.

3.3 ACCEPTANCE AND SERVICE

A. Acceptance: All pipe systems shall be brought up to operating pressures and temperatures. Systems shall be cycled to duplicate operating conditions. All malfunctions shall be corrected. CONTRACTOR shall furnish all labor and materials to readjust and correct faults with hangers and supports for the piping systems.

+ + END OF SECTION + +

SECTION 15C4

WALL PIPES, FLOOR PIPES AND PIPE SLEEVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons required to complete the Work under all Sections of these Specifications.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the work which is related to this Section including concrete, piping and piping systems, valves, plumbing, and heating, ventilating and air conditioning.

C. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. Section 3D, Cast-In-Place Concrete.
   3. Section 3I, Grout.
   4. Section 5G, Anchor Bolts, Expansion Anchors and Concrete Inserts.
   5. Section 7J, Sealants.
   6. Section 9L, Painting.
   7. 15A, 15C, 15D and 15E Sections on piping, valves, specials, and gates.
   8. All 15H Sections on Heating, Ventilating and Air Conditioning.
   9. All 15I Sections on Plumbing.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.
   1. AWWA C104 (ANSI A21.4), Cement-Mortar Lining for Cast-Iron and Ductile-Iron Pipe and Fittings for Water.
   2. AWWA C106 (ANSI A21.6), Cast Iron Pipe Centrifugally Cast in Metal Molds, for Water and Other Liquids.
   3. AWWA C110 (ANSI A21.10), Gray-Iron and Ductile-Iron Fittings, 2 in. Through 48 in., for Water and Other Liquids.
   4. AWWA C111 (ANSI A21.11), Rubber Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings.
   5. AWWA C115 (ANSI A21.15), Flanged Cast-Iron and Ductile-Iron Pipe with Threaded Flanges.
   6. AWWA C151 (ANSI A21.51), Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
   7. AWWA C200, Steel Water Pipe 6 Inches and Larger.
   8. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   9. ANSI B16.4, Cast-Iron Screwed Fittings.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval detailed drawings and data on all wall and floor pipes, and pipe sleeves and escutcheons. Shop Drawings shall show location, installation, size, weight, material and fabrication details of all items. Submit and coordinate these with Shop Drawings required for all piping systems.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wall and Floor Pipes:
   1. Material: Same as specified for the piping connected to wall or floor pipe, unless otherwise approved by ENGINEER. For stainless steel piping, use ductile iron wall and floor pipes.
   2. Length: Wall fittings shall be equal to the thickness of the wall in which they are installed plus the exterior projection required for connection.
   3. End Connections: As shown or approved.
   4. Thickness: Same as specified for the piping connected to wall or floor pipe except for stainless steel piping. The ductile iron wall and floor pipes used for stainless steel piping systems shall have a minimum wall thickness equal to Class 54.
   5. Collars: Provide collars at mid-point of wall for anchorage and watertightness unless otherwise shown or approved.
   6. Pipes ends shall be flush with wall face unless otherwise shown.
   7. Flanged ends and mechanical joint bells shall be drilled and tapped for studs. Provide studs of same material as connected piping, except submerged and buried studs shall be of stainless steel.
   8. Steel pipe which is cast into walls or floors shall have a collar at midpoint of wall for anchorage and water tightness, as shown or as required.

B. Pipe Sleeves:
   1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe with integral wall collar continuously welded to midpoint of sleeve for anchorage and watertightness, unless otherwise shown.
   2. Copper Pipe: Use Type K hard drawn copper pipe unless otherwise shown.
   3. Size sleeves to provide annular space required to accomodate mechanical link-type seals that are used.

C. Cast Wall Sleeves:
   1. Material: Cast or ductile iron furnished with integral waterstop.
   2. Dimensions: As required for mechanical joint or calked joint pipe to pass through sleeve. Length as required.

D. Mechanical Seals: Provide link-type mechanical seals in pipe sleeves with adjusting bolts suitable for 20 psi working pressure.
   1. Type: Mechanical seals through non-fire rated walls or floors:
      a. Pressure Plate: Glass reinforced nylon plastic.
      b. Bolt and Nut: 18-8 stainless steel.
      c. Sealing Element: EPDM rubber.
   2. Type: Mechanical seals through fire rated walls or floors; two independent mechanical seal assemblies required:

a. Pressure Plate: Low carbon steel, galvanized.
b. Bolt and Nut: Low carbon steel, galvanized.
c. Sealing Element: Silicone rubber.

3. Product and Manufacturer: Seals shall be as manufactured by:
   a. Thunderline Corporation.

E. Wall and Ceiling Plates:
1. Bare pipes passing through walls and ceilings in finished rooms: Provide escutcheon plates of cast brass or cast iron nickel plated, hinged with set screws.
2. Insulated pipes passing through walls, floors and ceilings in finished rooms: Provide plated escutcheon plates of 18 gage steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall and Floor Pipes: Install as shown and in accordance with approved Shop Drawings and manufacturer's recommendations.

B. Pipe Sleeves:
1. Use sleeves wherever pipes pass through walls, partitions, floors and roofs unless otherwise shown.
2. All sleeves through floor slabs in process areas shall extend a minimum of 2 inches above finished floor.
3. All sleeves through floor slabs in finished areas shall extend a maximum of 1/4 inch above finished floor.
4. Anchor sleeves to concrete and masonry walls as shown or otherwise approved.
5. Sleeves through walls shall be flush with wall face.
6. Seal annular space between pipe and sleeve. Material and installation shall be as specified in Section 7J.
7. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
8. Size Sleeves to provide annular space as follows:

Pipe Size	Sleeve ID Minus Pipe Or Insulation OD
Less than 2 in.	1/2 in. to 3/4 in.
2 in. - 4 in.	3/4 in. to 1 1/4 in.
6 in. - 12 in.	1 1/4 in to 2 in.
Over 12 in.	2 in. to 3 in.

9. For mechanical seals, size sleeves to provide annular space required to suit link-type seals that are provided.
10. Do not install sleeves and pipes through structural members unless specifically shown and approved by ENGINEER. Such sleeves if required shall be Schedule 40, steel pipe or approved seamless steel tubing.

C. Install wall and ceiling plates in accordance with the manufacturer's recommendations and the approved Shop Drawings.

+ + END OF SECTION + +

SECTION 15D

VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide all valves, pressure gages and appurtenances as shown and specified.

B. Coordination:
   1. Review requirements of other Sections and coordinate.

C. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. 15A and 15C Sections on Piping.
   3. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Valves and appurtenances provided under this Section shall be the standard products in regular production by manufacturers whose products have proven reliable in similar services for at least two years.
   2. All valves furnished of any particular type shall be the product of a single manufacturer.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval detailed drawings, data and descriptive literature on all valves and appurtenances.

B. Installation Data: Submit detailed installation data for all valves and appurtenances provided under this Section.

C. Operation and Maintenance Manuals: Submit complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle all valves and appurtenances carefully. Valves which are cracked, dented or otherwise damaged or dropped will not be acceptable.

B. Store all valves and appurtenances in approved enclosed shelter and off the ground, unless otherwise acceptable to ENGINEER.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. All valves shall have manufacturer's name and working pressure cast in raised letters on valve body.
2. All manual valve operators shall turn right to close unless otherwise specified. Valves shall indicate the direction of operation.
3. All valves 3 inches and larger that are exposed shall have flanged ends conforming to ANSI B16.1, Class 125 and buried valves of the same sizes shall be mechanical joint ends conforming to ANSI A21.11.
4. All buried valves shall be provided with adjustable two piece valve boxes and provided with extension stems, operating nuts and covers unless otherwise shown or specified.
5. All bolts, nuts and studs on buried or submerged valves and fittings shall be of stainless steel and coated after installation.
6. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.
7. Provide four T wrenches suitable for operating buried valves installed on this project.
8. All valves shall be suitable for a working pressure of not less than 125 psig.

B. Swing Check Valves:
1. Valves shall be iron body, bronze mounted swing check valves with integral weighted lever arm, rubber lined, cushion chamber, and Buna N Seat, suitable for 125 psi working pressure. The cushion chamber and weighted arm shall be externally attached to the side of the valve body and constructed so as to effectively permit the valve to be operated without any hammering action. Closing speed shall be adjustable to meet the service requirements.
2. Each valve shall absolutely prevent the return of sewage back through the valve as downstream pressure increases above upstream pressure.
3. The valve shall be tight seating. The seat ring shall be renewable, resilient, and held in place by a corrosion resistant retainer.
4. The valve disc shall be suspended from a stainless steel shaft which shall pass through a stuffing box on the valve body. The valve shall have an outside lever arm with an adjustable weight or weights to assist in closing on flow reversal so as to minimize shock and water hammer. Each valve shall be equipped with a latch or similar device to manually lock the valve in the open position for testing.
5. Provide cleanout access.
6. Acceptable Manufacturers:
   a. Golden Anderson Valve Specialty Co., Fig. 25-DR or 250 D.
   b. Or equal.

C. Plug Valves:
1. Plug valves shall be of the non-lubricated, eccentric type. Valves shall be of corrosion resistant construction. Valve shall have a full round or other acceptable type port to assure minimum turbulence and minimum pressure drop. Valve bodies shall be a semi-steel construction and seats shall have a welded-in overlay of nickel alloy. Valves shall have a balanced plug, coated with neoprene solidly bonded to a cast iron or semi-steel core.

2. All plug valve bodies shall be suitable for a minimum working pressure of 175 psig.
3. Provide totally enclosed worm gear operators suitable for submerged service on all valves 6 inches and larger. Provide handwheels for all exposed valves.
4. Provide lever and/or nut operators on valves smaller than 6 inches. Include means to mechanically hold the lever in position.
5. Mount valves so that the seat facing is downstream of the force main.
6. Exposed valves, including those in vaults, shall be furnished with ANSI 125 pound flanges.
7. Buried valves (1½-inch to 3-inch in size) shall be furnished with threaded ends 2-inch square operating nuts and valve boxes, DeZurik Figures 614 and 341. Buried valves, 4" and larger, shall be furnished with mechanical joint ends.
8. Acceptable Manufacturers:
   a. DeZurik Series 100.
   b. Homestead.
   c. Or equal.

D. Butterfly Valves:
1. Butterfly valves shall conform to the requirements of MAG 630.5(B) for all sizes of valves required, except that valve operators and surface preparation and painting shall be as specified herein.

E. Pressure Gages (Sewage Service):
1. General: Furnish and install gages factory assembled with close coupled diaphragm seals and silicone filled. Accuracy specified shall be the combined accuracy of gage and seal. Provide insulation valve.
2. Accuracy: One percent of range.
3. Case: Aluminum alloy.
4. Bourdon Tube: Suitable for filling fluid.
5. Process Connection: One inch.
6. Diaphragm Material: 316 stainless steel.
7. Housing: Ductile iron or 304 stainless steel.
8. Bottom Housing: Removable for cleaning without requiring refilling or recalibration of gage.
9. Gage Size: 6 inch.
10. Ranges: 0 to 80 psig.
11. Acceptable Manufacturers:
    a. Ashcroft.
    b. Helicoid.
    c. Or equal.

F. Backflow Preventor:
1. Product and Manufacturer: Provide backflow preventor manufactured by one of the following:
   a. Beeco Division, Hersey Products Inc., Aergap Model FRP-II.
   b. Febco Sales, Inc., Model 825Y.
   c. Or equal.
2. Type: Reduced pressure principle.
3. Materials:
   a. Body: Bronze.
   b. Valve Discs: EPT rubber.
   c. Diaphragm: Buna-N and nylon.
   d. Springs: Stainless steel.
   e. Screws: Stainless steel.

4. Maximum Working Pressure: 150 psi.
5. End Connection: Screwed.
6. Accessories:
   a. Air gap drain funnel with threaded outlet.
   b. Strainer with blow-off on inlet.

G. Ball Valves:
1. Construction:
   a. Bodies of one-piece forged bronze, ASTM B 283, or cast bronze, ASTM B 145, with screwed ends.
   b. Balls and stems of Type 316 stainless steel.
   c. Seats, body seals and stem seals shall be TFE.
   d. Provide valves with indicator stops and lever handles for quarter-turn operation.
2. Product and Manufacturer: Provide valves as manufactured by one of the following:
   a. Jamesbury Corporation, Style A.
   b. Or equal.

H. Post Hydrants:
1. Post hydrants for the plant nonpotable water system shall be of the exposed head type.
2. Post hydrant shall be provided with a concrete protective base as shown.
3. Depth of bury shall be a minimum of 36 inches.
4. The hydrant shall open counter-clockwise.
5. The post hydrant shall be furnished with all appurtenances to produce a operating system.
6. Manufacturer: Provide hydrants as manufactured by one of the following:
   a. Zurn.
   b. J.R. Smith.
   c. Or equal.

I. Gate Valves:
1. Provide gate valves and valve box and covers as per MAG Section 630.3 for buried water main valves.

J. Telescoping Valves
1. General:
   a. The 6-inch and 8-inch telescoping valves for sludge draw-off shall be rising stem type, of extra heavy construction throughout and designed to provide a vertical travel of 60 inches.
2. Construction:
   a. Each valve shall consist of a fabricated steel or cast iron floorstand incorporating a valve lifting stem and a travel indicating device calibrated in 1/2 inch increments and geared down so that the full 60 inches of travel registers on a 2-foot scale, a hand wheel with handle grip for rapid adjustment, a sliding valve tube and a tube guide collar with gasket.
   b. The sliding valve tube shall be seamless brass tubing 5-1/2 inches outside diameter with a minimum wall thickness of 1/8 inch and arranged to slide inside a 6-inch or an 8-inch diameter ductile iron sludge draw-off pipe. Ductile iron pipe shall be

furnished with no cement lining. A 10 mil bitumastic coating is required. The locations of various size valves are shown on the Drawings. The valve tube shall have two V-notch weirs located 180 degrees apart to accurately control the rate of sludge withdrawal.

c. Each telescoping valve shall be manually operated by means of an 18-inch diameter handwheel with handle. The handwheel shaft shall be designed to prevent rotation of the brass sleeve during operation. It shall be manufactured of 1-1/8-inch minimum diameter brass stock and shall have Acme threads to allow for rapid adjustment of one foot of travel with 16 turns of the hand wheel. The valve lifting stem shall have an Acme thread at one end for engagement with the hand wheel shaft and provisions for attaching the valve tube at the other end. The valve shall be complete with tube guide collar made of steel and neoprene gasket for sealing at the entrance of the valve tube into the sludge draw-off pipe.

d. All parts of the mechanism shall be amply proportioned for all stresses that may occur during fabrication, erection, and intermittent operation. Workmanship shall be of high grade in al respects.

e. Floorstands shall be installed with Type 304 stainless steel anchor bolts provided with the valves.

2. Manufacturer: Provide valves as manufactured by one of the following:
   a. Envirex.
   b. FMC Environmental Equipment Division.
   c. Or equal.

K. Sewage Air Release Valves:
1. Sewage air release valves shall be installed at high points in the piping systems as shown on the Contract Drawings and specified herein.
2. Sewage air release valves shall have an elongated body and be designed to operate (open) while pressurized allowing entrained air to escape through the air release orifice.
3. Each valve shall exhaust to a pipe which shall extend downward to drain. The exhaust pipe shall be the same diameter as the outlet on the valve.
4. The valve inlet shall be 2-inch and the outlet 1/2-inch.
5. Valve body and cover shall be cast iron. Orifice seat shall be Buna-N. Linkage and float shall be stainless steel.
6. Provide inlet, blow-off and backflushing gate valves, quick disconnect couplings and minimum 5' hose for flushing.
7. Operating pressures to be below 25 psi requiring a lower durometer seating.
8. Product and Manufacturer: Provide air release valves as manufactured by:
   a. Apco, GH Industries Model 400.
   b. Or equal.

L. Sewage Combination Air Valves:
1. Sewage combination air valves shall be installed at high points in piping systems as shown on the Contract Drawings and specified herein.

2. Sewage combination air valves shall allow large volumes of air to escape or enter through the larger diameter air and vacuum orifice when filling or draining a pipeline. When the pipeline is filled and pressurized, the large air and vacuum orifice shall stay closed, but the smaller diameter air release orifice shall remain operative and open to allow small pockets of air accumulation, to escape automatically and independently of the large orifice.
3. Each valve shall exhaust to a pipe which shall extend downward to drain.
4. Provide inlet, blow-off and backflushing gate valves, quick disconnect couplings and minimum 5 feet of hose for flushing.
5. The valve inlet shall be 2-inch and the outlet 2-inch.
6. Valve body and cover shall be cast iron. Orifice needle and seat shall be Buna-N. Float and stem to be stainless steel.
7. Operating pressures to be below 20 psi requiring lower durometer seating.
8. Product and Manufacturer: Provide sewage combination air valves as manufactured by:
   a. Apco, GH Industries Model 445.
   b. Or equal.

2.2 VALVE APPURTENANCES

A. Identification: Identify each valve 4 inches and larger with a brass or stainless steel nameplate. Nameplate shall be permanently fastened to valve body at the factory.

B. Painting: All ferrous surfaces shall be shop primed and field painted. Priming shall be in accordance with Section 9L.

C. Valve Boxes: Provide each buried valve with a valve box as follows:
   1. Made of heavy pattern cast-iron, 2 piece adjustable telescoping type.
   2. Lower section shall enclose operating nut and stuffing box and rest on bonnet.
   3. Inside diameter shall be at least 4-1/2 inches.
   4. Provide extension stem and operating nut.
   5. Cover shall be heavy duty cast-iron with direction to open arrow cast in.
   6. Box to be coated inside and out with bitumastic.

2.3 SPARE PARTS AND MAINTENANCE MATERIALS

A. The CONTRACTOR shall furnish a list of recommended spare parts with his proposal for an operating period of one year. This list shall describe each part, the quantity recommended, and the unit price of the part. The OWNER will purchase all, some, or none of the recommended spare parts at his option.

B. Furnish spare parts and maintenance materials in conformance with the requirements of Section 1J1.

2.4 SURFACE PREPARATION AND SHOP PAINTING

A. Surface preparation and shop painting is required for all cast iron, cast steel, and steel body valves and other accessories. Stainless steel shall not be painted.

B. All exterior cast iron, cast steel, and steel surfaces of valves and accessories shall be cleaned with a Commercial Sandblast (SSPC-SP-6) and provided with two coats of epoxy priming paint conforming to the requirements of Section 9L, Painting.
The exterior of the valves and accessories may be given two coats of the manufacturer's standard paint system in lieu of the priming paint.
Minimum acceptable surface preparation for any valves and accessories furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6), except that motors and like items that may be damaged by sandblasting may be prepared by other approved means.

C. All exterior ferrous metal surfaces that will be buried shall be cleaned with a Near White Metal Blast (SSPC-SP10) and shall receive two coats of an approved epoxy paint.

D. All prime coat materials or standard manufacturer's paint coatings shall be compatible with the finish coat materials to be furnished under Section 9L, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with manufacturer's instructions.

B. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access.

C. Install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.

D. Valve boxes shall be set plumb, and centered with the bodies directly over the valves. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation.

B. Conduct functional field test of each valve in presence of ENGINEER to demonstrate that each part and all components together function correctly. All testing equipment required shall be provided by the CONTRACTOR.

3.3 CONTRACTOR'S SERVICES

A. The CONTRACTOR shall furnish the services of a manufacturer's qualified factory trained serviceman from the manufacturer of the valves who shall

assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct the OWNER'S personnel in the care, operation and maintenance of the equipment. A minimum of one, 8-hour day shall be provided for these services.

B. CONTRACTOR shall provide instruction for operating personnel in conformance with the requirements of Section 1H5.

+ + END OF SECTION + +

SECTION 15E

SLUICE GATES AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide sluice gates complete with appurtenances as shown and specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the Work which must be installed with or attached to the sluice gates.

C. Related Work Specified Elsewhere:
   1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
   2. Section 3D, Cast-In-Place Concrete.
   3. Section 3I, Grout.
   4. Section 5G, Anchor Bolts, Expansion Anchors, Fasteners and Concrete Inserts.
   5. Section 9L, Painting.
   6. Section 15A1, Buried Piping Installation.
   7. Section 15A2, Exposed Piping Installation.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Sluice gates and appurtenances provided under this Section shall be the standard product in regular production by manufacturers whose products have proven reliable in similar service for at least five years. If required, the manufacturer shall furnish evidence of installations in satisfactory operation.
   2. All sluice gates shall be the product of one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   2. AWWA C501, Sluice Gates.
   3. ASTM A 108, Steel Bars, Carbon, Cold Finished.
   4. ASTM A 126, Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   5. ASTM A 276, Stainless and Heat-Resisting Steel Bars and Shapes.
   6. ASTM A 307, Carbon Steel Externally and Internally Threaded Standard Fasteners.
   7. ASTM A 320, Alloy-Steel Bolting Materials for Low-Temperature Service.
   8. ASTM A 354, Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   9. ASTM B 21, Naval Brass Rod, Bar, and Shapes.
   10. ASTM B 98, Copper-Silicon Alloy Rod, Bar, and Shapes.
   11. ASTM B 138, Manganese Bronze Rod, Bar and Shapes.

12. ASTM B 584, Copper Alloy Sand Castings for General Applications.
13. Steel Structures Painting Council Specification SP-6, Commercial Blast Cleaning.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Fabrication, assembly and installation drawings.
   2. Manufacturer's literature, illustrations, specifications and engineering data.
   3. Provide setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.

B. Operation and Maintenance Manuals: Submit complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver wall thimbles, anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete in ample time to not delay that Work.

B. Handle all sluice gates and appurtenances with extreme care. Sluice gates which are cracked, chipped, distorted or otherwise damaged or dropped will not be acceptable. Protect all threads, seats, and ends from damage.

C. Store all sluice gates and appurtenances off the ground in approved enclosed shelter. Protect all materials from condensation, corrosion and deterioration.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. General:
   1. Gates shall be cast iron, fully bronze mounted.
   2. All frames, discs and guides shall conform to minimum AWWA standards for tensile, compressive and shear strength.
   3. Gates shall be designed to safely withstand conditions shown.
   4. Gates shall be substantially watertight with leakage not to exceed 0.1 gpm of clean water per foot of gate perimeter at design seating head. In addition, leakage shall not exceed 0.2 gpm of clean water per foot of gate perimeter at design unseating head.
   5. All gates shall have manufacturer's name cast in raised letters on body.
   6. All handwheel operators shall turn right to close unless otherwise specified. Operators shall indicate the direction of operation.
   7. Flange drilling shall be as shown on the Drawings.
   8. All bolts and studs embedded in concrete and studs and nuts required for connection to wall pipes shall be of Type 304 stainless steel.

9. All other bolts, nuts and studs shall, unless otherwise approved or specified, conform to ASTM A 307, Grade B; or ASTM A 354.
10. Bolt heads and nuts shall have hexagon shapes.
11. Gasket material and installation shall conform to manufacturer's recommendations.

2.2 SLUICE GATE CONSTRUCTION

A. Materials of Construction:
1. Iron Castings: ASTM A 126, Class B, for frames, discs, guides, gear housings and other items.
2. Bronze Castings: ASTM B 584, for wedges, thrust nuts and lift nuts.
3. Stainless Steel: ASTM A 276, Type 304, for stems, stem couplings and fasteners.
4. Silicon Bronze: ASTM B 98, for bolts, studs, nuts and adjusting screws.

B. Frame: Frames shall be cast iron, one-piece construction of the flanged type as required and with openings as shown and specified. Each frame shall have machined dovetailed grooves on the front face into which bronze seat facings shall be driven and then machined. The back of each frame shall be machined to bolt directly to the machined face of a pipe flange of a wall fitting. In addition, all surfaces forming joints or bearings shall be machined. Each frame shall have integrally cast pads machined with keyways to receive top and bottom wedge seats, as required. Flange drilling for attachment to wall pipes shall be as shown on the Drawings. Gaskets shall be furnished as required by manufacturer.

C. Disc: Discs shall be of cast iron, one-piece construction, circular.

D. Guides: Guides shall be cast iron, one or two piece construction, conforming to the minimum AWWA standards for withstanding the total thrust caused by water pressure and wedging action. Guides shall be machined on all contact surfaces. Guides shall be of such length as to retain and support at least one-half of the vertical height of the disc in the full open position. Guides shall be integral or attached to the frame with silicon bronze or Type 304 stainless steel studs and nuts, and shall be dowelled to prevent any relative motion between the guides and the frame. Wedges or wedge facings shall be securely attached to the guides at points where, in the closed position, they will make full contact with the wedging surfaces on the disc.

E. Wedges: Wedges shall be solid cast bronze, machined on all contact surfaces, and keyed to the cast iron pads to maintain adjustment by preventing undesirable rotation or lateral motion. Wedges shall be attached to the disc with silicon bronze studs and nuts, and shall have silicon bronze adjusting screws with lock nuts. All sluice gates specified shall be furnished with side wedges.

F. Seat Facings: All seat facings shall be bronze and retained in dovetail grooves.

G. Stems: Operating stems shall be non-rising type, of stainless steel and of the minimum sizes shown or specified. Stems shall be designed by the manufacturer to transmit in compression at least 2-1/2 times the rated

output of the operating mechanism with a 40 pound effort on the handwheel. Stems shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machined-cut threads of the Acme type. Each sluice gate shall be provided with a thrust nut for connecting the stem to the disc.

2.3 APPURTENANCES

A. Wall Pipes: Sluice gates installed on pipe lines shall be mounted on the flange of wall pipes. Flange drilling shall be in accordance with the details shown on the Drawings.

B. Anchor Bolts and Fasteners: All anchor bolts, nuts and other fasteners furnished for connection of the equipment including gates, floorstands, and stem guides to the concrete structures and all stud bolts and nuts for connection of the gates to wall thimbles or pipe flanges shall be of Type 304 stainless steel. They shall be of ample size and strength for the purpose intended. Anchor bolts shall be hooked and provided for direct embedment during placement of concrete. Anchorage items shall conform to the applicable requirements of Section 5G.

C. Manual Operators: Manual operation shall be by handwheel as shown and specified. An arrow with the word "Open" shall be permanently attached or cast on the handwheel indicating the direction of rotation to open the gate.

2.4 PRODUCT AND MANUFACTURER

A. Provide sluice gates and appurtenances as manufactured by one of the following:
   1. Rodney Hunt Company.
   2. Waterman Industries.
   3. Or Equal.

2.5 SHOP TESTING

A. Each gate shall be fully assembled and shop-inspected in the vertical position for proper seating.

B. Gate disc shall be fully opened and closed in its guide system to ensure that it operates freely.

2.6 PAINTING AND COATINGS

A. Painting: All ferrous metal surfaces of the sluice gates and stem guides shall be shop blast cleaned in accordance with SSPC-SP6 and painted with two coats of Inertol No. 49 Thick. A prime coat shall be applied to the castings after cleaning and prior to machining. The shop-applied coatings shall be applied after assembly.

B. All machined surfaces, including drilled and tapped holes, shall be completely covered with a heavy coat of protective grease.

C. The surface of the wall pipes in contact with the concrete shall not be painted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all sluice gates and appurtenances in accordance with manufacturers printed instructions and recommendations, and the approved Shop Drawings.

B. Brace wall pipes internally during placement of concrete. Ensure that pipes are properly aligned and anchored, flanges are flush with concrete face and tapped holes plugged and protected from entry of grout.

C. Set anchor bolts in accordance with manufacturers approved drawings.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation.

B. Conduct functional field test of each sluice gate in presence of ENGINEER to demonstrate that each part and all components together function correctly. All sluice gates shall be tested in an approved manner in the presence of the ENGINEER for excessive water leakage. All testing equipment required shall be provided by the CONTRACTOR. Sluice gates which exceed the maximum leakage specified shall be modified and retested until compliance with specified requirements can be demonstrated.

3.3 MANUFACTURER'S SERVICES

A. CONTRACTOR shall provide the services of a qualified factory-trained serviceman to check and approve the installation of the sluice gates and appurtenances. He shall instruct OWNER'S personnel in operation, care and maintenance and supervise initial operation. A minimum of one, 8-hour day shall be provided for these services.

B. CONTRACTOR shall provide instruction for operating personnel in conformance with the requirements of Section 1H5.

+ + END OF SECTION + +

SECTION 15E3

ALUMINUM SLIDE GATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all slide gates and appurtenances, complete and operational.

B. Related Work Specified Elsewhere:
1. Section 1E4, Shop Drawing and Other Technical Information Submittal and Correspondence Procedure.
2. Section 3I, Grout.
3. Section 9L, Painting. (Surface preparation and shop painting are under Section 15E3.)
4. 15A Sections on Piping.

1.2 QUALITY ASSURANCE

A. Source Quality Control: Obtain aluminum slide gates from no more than one manufacturer.

B. Manufacturer's Qualifications: The manufacturer or supplier shall have experience in producing similar type equipment, and shall show evidence of installations in satisfactory operation.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM A 276, Stainless and Heat-Resisting Steel Bars and Shapes.
2. ASTM A 320, Alloy-Steel Bolting Materials for Low-Temperature Service.
3. ASTM A 354, Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
4. ASTM B 21, Naval Brass Rod, Bar, and Shapes.
5. ASTM B 209, Aluminum.
6. ASTM B 584, Copper Alloy Sand Castings for General Application.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Fabrication, assembly and installation diagrams.
2. Manufacturer's literature, illustrations, specifications and engineering data.
3. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
4. Deviations from Drawings and Specifications.

B. Operation and Maintenance Manuals: Submit complete manuals including:
1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Furnish operation and maintenance manuals in conformance with the requirements of Section 1I3.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Conform to the applicable requirements of Section 1G1.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete in ample time to not delay that Work.

C. Handle all slide gates and appurtenances very carefully. Slides which are distorted or otherwise damaged will not be acceptable. Protect all bolt threads and ends from damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. The CONTRACTOR shall review installation procedures under other Sections and coordinate the Work which is related to this Section.
2. Gates shall be designed to safely withstand conditions listed in gate schedule.
3. Gates shall be substantially watertight with leakage less than 0.5 gpm per foot of seating perimeter at design head.
4. Handwheel operators shall turn right to close unless otherwise specified. Operators shall indicate the direction of operation with arrows.
5. All bolts, studs, cap screws, and adjusting screws shall be of stainless steel of ample section to withstand the force created by operation of the gate under a full head of water.
6. Bolts and nuts shall have hexagon heads.
7. Gasket material and installation shall conform to manufacturer's recommendations.
8. Downward opening gate shall be capable of being lowered to an elevation below the invert of the channel or opening.
9. Slide gates shall open to not less than 6 inches above the maximum water level in the channel in which they are installed.

B. Materials of Construction:
1. Aluminum: For frame and slide, ASTM B 209, Alloy 6061; or ASTM B 308, Alloy 6061. All metal for gate parts shall have a minimum thickness of 1/4-inch.
2. Stainless Steel: For all parts, ASTM A 276 Type 304 unless otherwise specified.

C. Disc:
1. The slide or disc shall be made of a aluminum plate reinforced with structural shapes attached by welding.
2. Reinforcing shall limit deflection under full head to not more than 1/360 of the span.
3. Reinforcing ribs shall extend into the guides overlapping the seating surface of the guide.
4. Stem mounting guides shall be welded to the disk.

D. Disc Guides:
1. The guides shall be of aluminum incorporating a sandwich type construction using plates and structural angles.

2. The guides shall be designed for maximum rigidity as columns to take the thrust developed during gate operation under maximum head.
3. The guides shall extend beneath the opening a sufficient amount to support the disk in the fully open or closed position or as shown on the Drawings.

E. Stem:
1. Operating stems shall be of Type 303 or 304 stainless steel of minimum sizes shown or specified. Stems shall be designed by manufacturer as described below.
2. Stems shall be designed to transmit in compression at least 2-1/2 times the rated output of the operating mechanism with a 40 pound effort on the handwheel.
3. Stems shall have a slenderness ration (L/R) less than 200.
4. The threaded portion of the stem shall have machined cut threads of the Acme type. Stems of more than one section shall be joined by stainless steel couplings threaded and keyed, or bored and pinned to the stems. All threaded and keyed couplings of the same size shall be interchangeable. Rising stems shall be provided with an adjustable stop collar on the stem.
5. The stem will be connected to the disc by means of a bolted connection.

F. Seals:
1. A specially shaped resilient seal shall be mounted on the bottom of the disc to provide flush-bottom closure for slide gates. As an alternate, a poured urethane seal shall be mounted in the invert of the frame to form a flushbottom seal.
2. The shape of the seal shall produce a seating surface having a minimum width of 3/4", and the seal will extend beyond the seating surface of the frame.
3. The vertical face of the seal shall be in contact with the seating surface of the guide to provide a proper seal at the corners.
4. All gates shall be provided with "J" seals along the sides of the frames for water leakage protection.
5. Downward opening gate shall be provided with "J" seals along the bottom of the frame.

G. Anchor Bolts and Fasteners:
1. All anchor bolts and nuts and other fasteners furnished for connection of the equipment to the concrete structure or concrete base pads shall be of Type 304 stainless steel, furnished by the equipment manufacturer, and shall be of ample size and strength for the purpose intended.
2. Anchor bolts shall be hooked, and provided for direct embedment during placement of concrete.
3. Anchorage items shall conform to the applicable requirements of Section 5G.

H. Manual Operator:
1. Operation shall be by handwheel as shown and specified.
2. The handwheel shall operate the gate under the required operating head with not greater than 40-pounds.

I. Manufacturer: Provide slide gates as manufactured by one of the following:
   1. Rodney Hunt Company.
   2. Waterman Industries.
   3. Or equal.

2.2 GATE SCHEDULES

A. Attached to this Section is the "Gate Schedule". Conform to type, size, operation and other data specified unless otherwise approved by ENGINEER.

2.3 SHOP TESTING

A. Each gate shall be fully assembled and shop-inspected in the vertical position for proper seating.

B. Gate disc shall be fully opened and closed in its guide system to ensure that it operates freely.

2.4 SURFACE PREPARATION AND SHOP PAINTING

A. Aluminum slide gates shall not be painted.

B. Surface preparation and shop painting is required for all cast iron, cast steel, steel and other appurtenances. Stainless steel shall not be painted.

C. All cast iron, cast steel, and steel surfaces shall be cleaned and provided with two coats of epoxy priming paint conforming to the requirements of Section 9L, Painting. All prime coat materials shall be compatible with the finish coat materials to be furnished under Section 9L.
The equipment may be given two coats of the manufacturer's standard paint system in lieu of the priming paint. Minimum acceptable surface preparation for any equipment furnished with the manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSPC-SP6), except that items that may be damaged by sandblasting may be prepared by other approved means.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all slide gates and appurtenances in accordance with manufacturers printed instructions.

B. Brace guides and frames during placement of concrete.

C. Set anchor bolts in accordance and with approved manufacturers drawings.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation.

B. Conduct functional field test of each slide gate in presence of ENGINEER to demonstrate that each part and all components together function correctly.

C. All slide gates shall be tested in an approved manner in the presence of the ENGINEER for excessive water leakage.

3.3 MANUFACTURER'S SERVICES

A. CONTRACTOR shall provide the services of a qualified factory-trained serviceman to check and approve the installation of the aluminum slide gates. He shall instruct OWNER'S personnel in operation, care and maintenance and supervise initial operation. A minimum of one, 8-hour day shall be provided for these services.

B. CONTRACTOR shall provide instruction for operating personnel in conformance with the requirements of Section 1H5.

SLIDE GATE SCHEDULE

1.	Designation	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6
2.	Location	Screen Facility	Anoxic Tank	Clarifier Influent	Filter Influent	Filter Effluent	Oxidation Ditch
3.	Quantity	1	1	2	2	2	1
4.	Size (width x height)	2'-6"x2'-0"	3'-0"x3'-0"	2'-6"x2'-0"	2'-0"x2'-0"	2'-0"x5'-0"	4'-0"x2'-0"
5.	Operator	Lifting Handle*	Handwheel	Lifting Handle*	Handwheel	Handwheel	Handwheel**
6.	Inv. El. (Ft.)	386.75	378.50	382.50	379.85	375.95	383.25
7.	Operating Floor Elev. (Ft.)	389.75	391.00	385.50	382.50	382.50	387.00
8.	Type				Self Contained	Self Contained	Self Contained

* Handle mounted on top of gate

** Downward opening weir

+ + END OF SECTION + +

SECTION 15G5

PORTABLE FIRE PROTECTION EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all portable fire protection equipment Work.
   2. The extent of the portable fire protection equipment is shown.
   3. The types of portable fire protection equipment Work required includes, but is not necessarily limited to, the following:
      a. Dry chemical extinguishers.
      b. Carbon dioxide extinguishes.
      c. Mounting accessories, recessed cabinets and miscellaneous fasteners.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the portable fire extinguishers.

C. Related Sections:
   1. Section 10I, Identification Devices.

1.2 QUALITY ASSURANCE

A. Source Quality Control: Furnish portable fire protection equipment Work from only one manufacturer.

B. Requirements of Regulatory Agencies: Provide only portable fire extinguishers that are approved and labeled by UL.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. UL, Fire Classification Rating.
   2. OSHA 1970, Occupational Safety and Health Act of 1970.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval copies of manufacturer's technical data, certification of UL rating, and installation instructions for all portable fire protection equipment Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide manufacturer's standard mounting brackets for portable fire extinguishers size as specified, unless recessed cabinets are shown.

B. Multi-Purpose Dry Chemical:
   1. 10 pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, Class C fires, UL rating 4A-60 BC.
   2. Product and Manufacturer: Provide one of the following:
      a. Cosmic Model 10E by J.L. Industries.
      b. Or equal.

C. Carbon Dioxide:
   1. 10 pound enameled steel container capacity, for Class B and Class C fires UL rating.
   2. Product and Manufacturer: Provide one of the following:
      a. Sentinel Model 10 by J.L. Industries.
      b. Or equal.

D. Recessed Fire Extinguisher Cabinets:
   1. Coordinate size of recessed fire extinguisher cabinets required with extinguisher selected for complete system integration.
   2. Provide concealed hinges and handles with manufacturer's standard door roller catches.
   3. Provide stainless steel doors with No. 4 finish.
   4. Provide manufacturer's standard clear plate glass vision panel.
   5. Product and Manufacturer: Provide one of the following:
      a. Embassy 5734 V1132 with vertical fire extinguisher decal on glass by J.L. Industries.
      b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer must examine the substrates and conditions under which the portable fire extinguishers are to be installed, and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install in locations and at mounting of 3 feet-0 inches. Securely fasten to structure, square and plumb, in accordance with manufacturer's instructions.

B. Wherever exact locations of units are not shown, locate as directed by ENGINEER.

C. Install signs directly above surface mounted portable fire extinguishers, securely mounted, attached to substrate in accordance with manufacturer's instructions. Install level and plumb.

D. Recharge and bring last inspection date up to coincide as nearly as possible with date of Final Acceptance by OWNER, to provide full term inspection interval.

E. Inform OWNER of next required inspection and recharging date.

3.3 SCHEDULE

A. Type A - Dry chemical, wall mounted.

B. Type B - Carbon dioxide, wall mounted.

C. Type C - Dry chemical, recessed cabinet mounted.

+ + END OF SECTION + +

SECTION 15H18

REFRIGERANT PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, material, equipment and incidentals as shown, specified and required to furnish and install complete and workable refrigerant piping systems including all pipe, valves and accessories required for proper operation.

B. Related Sections:
1. Division 1, General Requirements.
2. Section 15A2, Exposed Piping Installation.
3. Section 15C3, Pipe Hangers and Supports.
4. Section 15C4, Wall Pipes, Floor Pipes and Pipe Sleeves.
5. Section 15H37, Air Handling Units.
6. Section 15H38, Air Cooled Condensing Unit - Split System Air Conditioning.
7. Section 15H65, Testing, Adjusting and Balancing.
8. Section 15I11, Insulation, Plumbing.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
1. Underwriters' Laboratories, Incorporated.
2. National Fire Protection Association.
3. Local and State Building Codes and Ordinances.
   a. Uniform Building Code.
   b. Uniform Mechanical Code.
   c. Model Energy Code.
4. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

B. Reference Standards: Comply with the latest applicable provisions and recommendations of the following except as otherwise shown or specified.
1. ANSI B9.1: Mechanical Refrigeration, Safety Code For (ASHRAE 15-78).
2. ASTM B 75, Seamless Copper Tubing, Spec. For,
3. AWS A5.8, Americal Welding Society Specifications for Brazing Filler Material.

1.3 SUBMITTALS

A. Submit product literature for materials specified.

B. Submit Shop Drawings for piping systems and sizing and valving arrangements.

C. Submit test results.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store to keep material clean and free from damage.

B. Handle to prevent damage during installation and storage.

C. Items to be incorporated into wall construction shall be delivered to job site in sufficient time so as not to hold up construction.

1.5 JOB CONDITIONS

A. Protection: Properly plug or cap the open ends of all pipe at the end of each day's work or other stopping point through construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

1.6 GENERAL REQUIREMENTS

A. The Drawings accompanying these Specifications show the general arrangement and extent of Work to be done, but the exact location and arrangement of all parts shall be determined as the Work progresses, to conform in the best possible manner with its surroundings; the exact location of all parts of the Work must be governed by the general building plans and the actual building conditions.

B. The Drawings are intended as an indication of the arrangement of equipment, valves, etc., and are as nearly correct as can be determined in advance of the actual construction of the Work. It must however, be understood that the piping, equipment, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions must be changed in location to clear such obstructions, without additional charge.

C. The connections indicated to the various units are particularly intended as an indication only, the actual connections at the time of installation to be made and arranged as to fully and best suit the requirements of each particular case, adequately provide for expansion and perfect circulation and minimize the amount of space required for the same.

D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, or if piping can be run to better advantage and at the same time accomplish as good or better result, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete Drawings showing all details of the proposed rearrangement for written approval.

E. The Drawings preclude indicating thereon, all offsets, fittings, accessories and details which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of his work, and shall arrange his work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others", to complete the systems to the true extent of the Drawings and Specifications.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Rigid Tubing:
   1. Refrigerant pipe shall be Type L streamlined hard temper cleaned and dehydrated copper tubing supplied with nitrogen charge and pressure tight plugs for each length.

B. Fittings:
   1. Pipe fittings shall be streamlined pattern wrought copper.
   2. Unions shall be wrought copper; minimum 300 psig working pressure; female pattern; brass to brass seat; ground joint; solder to solder connections; conform to ASTM B 75.
   3. Flanges shall be wrought copper; minimum 300 psig working pressure; tong-and-groove raised ground face; bolt holes spot faced; conform to ASTM B 75.
   4. Gaskets shall be of a material sutiable for the fluid, temperature and pressure for which they will be used.

C. Joints: All joints shall be high temperature brazed joints in accordance with AWS A5.8.

2.2 VALVES

A. Manual shut-off valves shall be packed type; back-seating construction; solder connections; wing type cap, also serving as a stem wrench; minimum 425 psig working pressure; brass body; U.L. labeled.

B. Throttling valve shall have solder connections; seal cap; forged brass body; minimum 500 psig working pressure.

C. Pressure relief valves shall have provisions for attaching vent line; sealed; U.L. labeled; sized as required for application. All refrigerant pressure relief valves located inside the building shall be vented outside with insect screen.

D. Check valves shall provide positive seal against reverse flow; spring loaded mechanism; neoprene seats; brass body; minimum 425 psig working pressure; sized as required for application.

E. Solenoid valves, if provided, shall be normally closed type; holding coil voltage as required; manual lift stem; solder connections.

F. Expansion valves shall be sized as required by specific evaporator requirements; solder-flange connections; thermostatic modulating type; complete with sensing bulb and distributor.

2.3 ACCESSORIES

A. Liquid and moisture indicators shall be single port type; forged brass body; reversible color moisture indicator; minimum 500 psig working pressure; leakproof; solder connections; self-cleaning molded sight glass with brass safety cap; U.L. labeled.

B. Strainers shall be Y-pattern; cast bronze body; monel wire cloth screen of mesh as recommended by manufacturer; cleanout plug.

C. Vibration eliminators shall have seamless tin bronze or stainless steel core; high tensile bronze braid convering; solder connections; pressure tested; dehydrated; synthetic covering; minimum 500 psig working pressure; U.L. labeled; minimum 7 inches in length.

D. Driers shall be combination filter-drier type; angle type solder connections; heavy steel body; neoprene gasketed removable flange; spring loaded core; replaceable non-dusting and non-channeling molded desiccant briquettes; sintered bronze outlet filter; minimum 500 psig working pressure; U.L. labeled.

E. Insulate refrigerant liquid line piping. Provide weatherproof aluminum jacket for all refrigerant liquid line piping located outdoor.

F. Piping Insulation: 3/4-inch thick preformed flexible elastometric "insul-tube" pipe insulation with vapor barrier and sealing tapes. Provide 0.016 inch thick weatherproof aluminum jacket for all outdoor insulated pipes.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas to receive piping, valves and accessories for:
   1. Defects that adversely affect execution and quality of work.
   2. Deviations beyond allowable tolerances for piping, valves and accessories.
   3. Start Work only when conditions are satisfactory.

B. Material Cleaning: Thoroughly clean all piping, fittings, valves and accessories prior to installation.

3.2 INSTALLATION

A. All refrigerant piping installations shall conform with ANSI B9.1.

B. Reduction in pipe sizes shall be made using eccentric reducer couplings installed with the level side up.

C. Manual shut-off valves shall be installed on each side of strainers and driers, in liquid and suction lines at evaporator coils, and elsewhere as shown on the Drawings.

D. Each drier shall have a 3 valve full by-pass connection.

E. Each gage shall have a cap seal type throttling valve.

F. All pressure relief valves shall have full size vent extended to the outside of the building.

G. Joints shall be made using a brazing compound containing silver alloys having a melting point of 1350 F or higher, Silfos or equal.

H. Strainers shall be installed immediately ahead of each expansion and solenoid valve, evaporator pressure regulator, back pressure valve, compressor suction valve, and as elsewhere shown on the Drawings.

I. Liquid-moisture indicators shall be installed ahead of any expansion valves, in the liquid line to the receiver, and elsewhere as shown on the Drawings.

J. Gages shall be installed on both the suction and discharge of the compressor and elsewhere as shown on the Drawings.

K. Vibration eliminators shall be used for all inlet and discharge final connections to compressors and other vibration producing equipment.

3.3 TESTING

A. Preparation:
   1. Remove all expansion valves and install a temporary bypass.
   2. Introduce refrigerant into the system to a pressure of 15 psig.

B. Test:
   1. Charge system to 300 psig using dry nitrogen.
   2. Test all joints with a Halide torch. Record all test results.
   3. After the results of the pressure tests have been approved, release test pressure freely to the atmosphere and mechanically evacuate the system to a minimum of 22 inches Hg vacuum and maintain for 24 hours with no leaks. Disconnect the vacuum pump prior to vacuum leak test.
   4. Record and report the test results.
   5. After test results have been approved by the Engineer, fully charge the system with the specified refrigerant.
   6. All leaking joints shall be disassembled and remade using new materials. Retesting shall be conducted on all portions failing the tests.

+ + END OF SECTION + +

SECTION 15H20

DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide and install a complete duct system with all appurtenances required for proper operation and to comply with requirements as shown and specified. Fasteners, supports, hanger joints as required for ductwork installation are included in this section.

B. Related Sections:
1. Section 15H21, Duct Insulation.
2. Section 15H37, Air Handling Units.
3. Section 15H41, Packaged Rooftop Air Conditioning Units - Single Zone.
4. Section 15H51, Centrifugal Inline Fans.
5. Section 15H53, Vane Axial Fans - Fiberglass.
6. Section 15H57, Centrifugal Roof Fans - Aluminum.
7. Section 15H60, Air Intakes and Reliefe Vents - Aluminum.
8. Section 15H64, Automatic Temperature Controls.
9. Section 15H65, Testing, Adjusting and Balancing.
10. Section 15H67, Odor Control System.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with the applicable provisions of regulatory agencies below and others having jurisdiction.
1. Permits: Obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.
2. Local and State Building Codes and Ordinances.
   a. Uniform Building Code.
   b. Uniform Mechanical Code.
3. Underwriters Laboratories, Incorporated.
4. National Fire Protection Association.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified. Specific provisions of this section shall supersede the standards in case of conflict:
1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
2. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
   a. HVAC Duct Construction Standards, 1st Edition 1984.

C. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of work.

1.3 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings showing the following:
1. 1/4-inch scale duct layouts for all ducts which have a proposed altered configuration than what is shown on the Design Drawings.

2. Manufacturer's literature, illustrations, specifications and engineering data showing:
   a. Dimensions.
   b. Details of construction.
   c. Details of installation.
   d. Registers, diffusers, grilles.
   e. Access Doors.
   f. Backdraft dampers, split-dampers, volume dampers.
   g. Flexible connections.
   h. Elbows with turning vanes, air extractors.
   i. Other technical data related to the specified equipment or accessories.

B. Test Reports: Submit the following test reports for review where required.
   1. UL Label.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store equipment and materials so as to keep free from moisture, damage, and deterioration.

1.5 JOB CONDITIONS

A. Sequencing: Obtain ENGINEER'S approval of Shop Drawings before fabricating and installing ductwork and accessories.

1.6 GENERAL REQUIREMENTS

A. The Drawings accompanying these Specifications show the general arrangement and extent of work to be done, but the exact location and arrangement of all parts shall be determined as the work progresses, to conform in the best possible manner with its surroundings; the exact location of all parts of the work must be governed by the general building plans and the actual building conditions.

B. The Drawings are intended as an indication of the arrangement of equipment, ducts, valves, etc., and are as nearly correct as can be determined in advance of the actual construction of the Work. It must however, be understood that the piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions, without additional charge.

C. The connections indicated to the various units are particularly intended as an indication only. The actual connections at the time of installation to be made and arranged as to fully and best suit the requirements of each particular case, adequately provide for expansion and perfect circulation and minimize the amount of space required for the same.

D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, or if piping or ductwork can be run to better advantage and at the same time accomplish as good or better results, the Contractor, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval.

E. The Drawings preclude indicating thereon, all offsets, fittings, accessories and details which may be required. The Contractor shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of his work, and shall arrange his work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others", to complete the systems to the true extent of the Drawings and Specifications.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Products and Manufacturers: Provide products made by one of the manufacturers listed in following Sections.

2.2 DUCTWORK

A. Materials:
   1. Galvanized steel except otherwise noted.
   2. Aluminum (with 3003H-14 alloy and temper).
      a. Shower and toilet rooms exhaust air ductwork (All ductwork associated with exhaust fan EF-2) to be minimum No. 20 B&S gage, 0.032-inch thick (0.45 lbs/ft^2 weight).
      b. Where indicated on Drawings.
   3. Stainless Steel (Type 316L Stainless Steel):
      a. All ductwork associated with exhaust fan EF-5, (Chlorine Room) and screening room ventilation system supply air shall be minimum 22 gauge stainless steel (Type 316L), welded construction.
      b. All exhaust air ductwork related to scrubber system from screening room shall be minimum 20 gage, welded stainless steel (Type 316L).
      c. Where shown on Drawings.
   4. All duct hangers, rods, stiffeners, fasteners, angles, attachments, etc. shall be galvanized steel except Type 316L stainless steel for all ductwork located in chlorine and screen room. Hanger rods shall be minimum 3/8 inch for all ducts with half perimeter up to 72 inches, and1/3 inch diameter for all ducts with half perimeter larger than 72 inches. A pair of rods shall be provided at each duct support point. Maximum hanger spacing shall be 8 feet for ducts ith half perimeter up to 72 inches and 6 feet for ducts with half perimeter larger than 72 inches. Hanger Construction and installation shall conform to SMACNA Standards, except as specified.
   5. Stiffener angles shall be as per SMACNA standards.

B. Construction: Conform to SMACNA Standards.
   1. All sheet metal duct shall conform to the pressure classifications shown on the Drawings and shall be in accordance with the construction details and installation details in the 1st edition of the SMACNA Duct Construction Standards.

C. Leakage: Not to exceed 5 percent.

D. Sleeves: Where ductwork passes through masonry walls, partitions or floors provide 16 gage galvanized steel sleeve and caulk airtight between sleeve and ductwork.

2.3 ACCESSORIES

A. Air Volume Extractors:
   1. Reference: SMACNA Standards.
   2. Manufacturer: Provide extractors as made by one of the following:
      a. Anemostat.
      b. Titus.
      c. Krueger.
      d. Or equal.
   3. Material: Steel.
   4. Blades: Gang-operated curved adjustable blades controlled through a manual adjusting lever.

B. Belt Guards:
   1. Reference: OSHA.
   2. Construction: Expanded hinged steel or hinged sheet steel for weather protection where required.
   3. Size: Fabricate guards to receive 2-inch larger pulleys without alteration to the guard.
   4. Trim openings at shafts for tachometer readings.
   5. Motor shaft opening to be slotted for belt adjustment.
   6. Secure guards to driven machine or foundation (not to motors).

C. Sheet Metal Safing: Provide sheet metal safing to close off and seal airtight all unused areas behind louvers.

D. Access Doors:
   1. Reference: SMACNA Standards.
   2. Type: Gasketed cam lock covers.

E. Flexible Connections (at Air Handling Units and In-line Duct Fans):
   1. Reference: SMACNA Standards for pressure classifications: 2-inches of water gage.
   2. Material: Fiberglass reinforced neoprene sheet, 1/16 inch thick.

F. Turning Vanes:
   1. Reference: SMACNA.
   2. Construction: Galvanized steel, epoxy coated in aluminum ductwork.
   3. Vanes: Single thickness.

G. Splitter Dampers:
   1. Reference: SMACNA Standards.
   2. Manufacturer: Provide dampers as made by one of the following:
      a. Tuttle and Bailey, Hart and Cooley.
      b. Titus.
      c. Or equal.
   3. Material: Steel.
   4. Adjustment: Manual adjusting lever with locking device.
   5. Epoxy coated in aluminum and stainless steel ductwork.

H. Volume Dampers:
   1. Reference: SMACNA Standards.
   2. Manufacturer: Provide dampers as made by one of the following:
      a. Honeywell.
      b. American Warming Company.
      c. Or equal.
   3. Material:
      a. Galvanized Steel for galvanized steel ductwork.
      b. Aluminum for aluminum ductwork.
      c. Stainless steel for stainless steel.
   4. Blades: Opposed blades, inflatable vinyl edge seals.
   5. Provide outside handle, quadrant and approved position indicator and locking device.
   6. Performance:
      a. Damper Leakage: Not more than 16 cfm per square foot at 4-inch W.G.
      b. Certification: Manufacturer shall provide certified test data.

I. Automatic Gravity Dampers:
   1. Blades: Aluminum 0.020 inch thick.
   2. Tie Rod: Aluminum 0.081 inch thick.
   3. Louver Arm: Aluminum 0.081 inch thick.
   4. Bumpers: Waterproof felt.

J. Screens:
   1. Polyvinyl chloride coated.
   2. Heavy gage steel wire.
   3. 1/2 inch mesh.
   4. Attached to openings or ductwork as shown on Drawings.

K. Fire Dampers:
   1. Reference: NFPA, SMACNA and local building codes.
   2. Label:
      a. All fire dampers shall have UL Label attached and galvanized steel construction.
      b. Label shall have a fire rating of minimum 1½ hours.
   3. Type: Galvanized steel blades with interlocking joints and fusible links.
   4. Provide firestopping at walls where fire dampers are installed.
   5. Provide an access door at each fire damper in duct.
   6. Access Door:
      a. Door and frame gage same as duct.
      b. Frame clinch-locked or tee locked to duct.
      c. Door shall be pan type with handle.
      d. Air tight seal.
      e. Stencil each access door "FIRE DAMPER ACCESS" with minimum 1/2-inch high letters.

2.4 REGISTERS, GRILLES AND DIFFUSERS

A. Manufacturer: Provide equipment as made by one of the following:
   1. Barber Colman and Company.
   2. Titus.
   3. Hart and Cooley.
   4. Or equal.

B. Supply Registers:
   1. Type: Horizontal front blades, double deflection individually adjustable with key-operated opposed blade damper behind.
   2. Construction:
      a. Frame and Blades:
         1) Steel in steel duct except aluminum where indicated on the Drawings or specified herein.
         2) Aluminum in a aluminum ducts and stainless steel ducts.
         3) All Registers and grilles located in toilets, and shower rooms to be aluminum.

C. Supply Grilles:
   1. As specified above less key-operated opposed blade damper.

D. Return Register:
   1. Type: Horizontal front blades, set at 45 degree, single deflecxtion with key-operated opposed blade damper behind.
   2. Construction:
      a. Frame and Blades:
         1) Steel in steel duct.
         2) Aluminum in aluminum ducts and stainless steel ducts.

E. Return Grilles:
   1. As specified above for return registers less key-operated opposed blade damper.

F. Ceiling Supply Diffusers:
   1. Type:
      a. Square outlet with square neck.
   2. Construction:
      a. Frame and Core:
         1) Steel in steel duct.
         2) Aluminum in aluminum duct and stainless steel ducts.
         3) All supply and return diffusers located in toilet, shower room, and locker room ceiling to be aluminum.
   3. Core Style:
      a. Louver face.
   4. Provide combination volume control and equalizing deflector.

G. Ceiling Return Diffuser:
   1. As specified above for supply diffusers except without equalizing deflector.
   2. Core Style:
      a. Louver face.
   3. Aluminum construction in locker rooms, toilets and shower rooms.
   4. Provide volume controller.

H. CONTRACTOR shall coordinate ceiling grid system for proper installation of all air outlets in suspended ceiling.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All ductwork shall conform accurately to the dimensions shown, the ducts shall be straight and smooth inside with joints neatly finished; duct-

work shall be installed so as to preclude the possibility of vibration under all operating conditions.

B. Tape and seal all joints as per SMACNA Standards.

C. Elbows shall have a minimum centerline radius of 1 times the width of the duct. Turning vanes shall be provided at all square elbows. Turning vanes shall be single wall and shall be quiet and free from vibration when the system is in operation.

D. Provide flexible connections at inlet and discharge of air handling equipment, 6-inch wide canvas, preassembled to 22 gauge, 3-inch wide poly-vinyl coated galvanized steel.

E. Provide air volume extractors where indicated on the Drawings and as required.

F. Provide manual volume dampers where indicated on the Drawings and as required to facilitate accurate volume control. The duct of the damper shall be reinforced to prevent vibration.

G. Test holes shall be provided at each duct connection to each air handling unit.

H. Provide access doors for all dampers for inspection and maintenance.

I. Air volume extractors shall be provided where indicated on the Drawings at supply registers for scooping or extracting air into the outlet. The extractors shall have fully adjustable, gang operated curved blades controlled through an external manual adjustable device.

J. Provide flexible connections at inlet and discharge of air supply and exhaust fans, 6-inch wide fiberglass reinforced neoprene, preassembled to 22 gauge, 3-inch wide poly-vinyl coated galvanized steel.

K. Install all ductwork and accessories to provide a system free from buckling, warping breathing or vibration.

L. All flexible connections with air handling equipment shall be supported at free end within 12 inches of joint.

M. Provisions shall be made for supporting all dampers and other ductwork accessories as necessary.

3.2 ADJUSTMENT

A. Set volume control devices for approximate positions in preparation for final testing and balancing.

B. Start fan system and check for excessive leaks and vibration and correct.

3.3 CLEANING

A. Remove all loose materials and obstructions from interior of ducts.

B. Remove debris and waste materials resulting from installation.

+ + END OF SECTION + +

SECTION 15H21

DUCT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals required to furnish and install a system of duct insulation complete with all appurtenances required for proper operation and to comply with requirements as shown and specified.

B. Related Sections:
   1. Division 1, General Requirements.
   2. Section 15H20, Ductwork and Accessories.

1.2 QUALITY ASSURANCE

A. Manufacturer's and Installers Qualifications: Manufacturer and installer shall have at least 5 years experience in producing similar type materials and show evidence of at least 5 installations in satisfactory oepration.

B. General:
   1. Insulation systems including covering, mastics, adhesives, sealers and facings shall have the following Fire Hazard Classifications in accordance with ASTM E 84:
      a. Flame spread, 25 maximum.
      b. Fuel contributed, 50 maximum.
      c. Smoke developed, 50 maximum.

C. Source Quality Control:
   1. Perform the following tests and inspections at factory.
      a. Flame Spread.
      b. Smoke Developed.
      c. Fuel Contributed.

D. Requirements of Regulatory Agencies:
   1. Comply with the applicable provisions of regulatory agencies below and other having jurisdiction.
      a. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.
      b. Underwriters Laboratories, Inc.
      c. National Fire Protection Association.
      d. State and Local Building Codes and Ordinances:
         1. Uniform Building Code.
         2. Uniform Mechanical Code.
         3. Model Energy Code.

E. Reference Standards:
   1. Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.
      a. ASTM E 84, Surface Burning Characteristics of Building Materials.
      b. UL 723.
      c. NFPA 90A.
      d. NFPA 255.

F. Manufacturer's Markings:
   1. Stamp or label with manufacturer's name and brand every package or standard container of covering, adhesive and coating delivered to the job site for use.
   2. Exposed side of insulation shall be legibly labeled by the manufacturer to show thickness, type and manufacturer.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Submit for approval the following:
      a. Manufacturer's catalog literature, specifications and illustrations for insulation material showing:
         1) Thermal properties.
         2) Physical properties.
         3) Fire hazard ratings.
         4) Facing information.
         5) Installation instructions.
         6) Jointing recommendations for butt joints and longitudinal seams.
      b. Fabrication instructions for elbows and fittings.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Material:
   1. Materials shall be delivered to job site in corrugated cartons.

B. Storage of Material:
   1. Store material in a clean, dry area out of the weather.
   2. Material shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.
   3. Material shall remain in original cartons till time of installation.

1.5 JOB CONDITIONS

A. Sequencing:
   1. Obtain the Engineers approval of insulation, adhesives, coatings and method of installation before installing any insulation.

B. All duct leaks shall be sealed prior to installation of external insulation to prevent billowing and damage to insulation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Products and Manufacturers:
   1. Provide insulation as made by one of the following:
      a. Owens Corning, Aeroflex 150.
      b. Certain-Teed Products Corporation.
      c. Or equal.

B. Thermal Insulation - Flexible:
   1. Type: Flexible fiberglass blanket with vapor barrier.
   2. Density: Minimum 1 lb per cubic foot.
   3. Facing: Aluminum foil reinforced with fiberglass yarn mesh and laminated to chemically treated, fire resistant kraft paper.
   4. Thickness: 1 inch.
   5. Thermal Conductivity: 0.27 Btu inch/hr ft^2 °F at 75 F mean temperature.

C. Thermal Insulation - Rigid:
   1. Type: Rigid figerglass board with finished vapor barrier facing.
   2. Density: 6 pounds per cubic foot.
   3. Facing: Aluminum foil reinforced Kraft, minimum thickness to be 2 mils.
   4. Thickness: 1 inch minimum.
   5. Thermal Conductivity: 0.22 Btu-in/hr ft^2 °F at 75 F mean temperature.

PART 3 - EXECUTION

3.1 INSPECTION

A. Ensure that all surfaces are clean and dry before applying insulation.

3.2 PREPARATION

A. Ensure that ductwork has been inspected and released for application of insulation.

3.3 INSTALLATION

A. General:
   1. Install insulation so as to make surfaces smooth, even and substantially flush with adjacent duct insulation.
   2. Follow manufacturer's application instructions for all materials used.
   3. Duct sizes indicated on Drawings are clear inside dimensions. Increase duct sizes to give designated inside dimensions when internal insulation is used.

3.4 CLEANING

A. Remove all debris, waste materials and loose foreign matter resulting from installation.

3.5 SCHEDULES

A. Thermal Insulation - Flexible:
   1. Air conditioning supply air and return air ductwork concealed (located above hung ceiling).
      a. All concealed ductwork related to AHU-1 and EF-1 systems.

B. Thermal Insulation - Rigid:
   1. All supply and rotary air ductwork exposed in rooms.
      a. All exposed ductwork related to AHU-1 and EF-1 systems.
      b. AHU-1 unit outside air intake plenum and ductwork.

+ + END OF SECTION + +

SECTION 15H22

FIBERGLASS REINFORCED PLASTIC DUCT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide for the odor control scrubber ventilating system as shown on the Drawings all labor, materials, equipment and incidentals as shown, specified and required to furnish and install a complete fiberglass reinforced plastic ductwork system. Fasteners, couplers, adhesives, field joint weld kits, supports, expansion joints, as required for installation are included in this Section, except as may otherwise be specified below.
2. Items to be furnished and installed under this item includes but not limited to the following:
   a. Fiberglass reinforced plastic duct and fittings (FRP).
   b. Miscellaneous accessories, spare parts and specials as specified herein.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the Work that must be installed with the materials specified herein and which is related to this Section, including ductwork installation Sections, and other related Sections.

C. Related Sections:
1. Section 9L, Painting.
2. Section 15H65, Testing, Adjusting and Balancing of HVAC Systems.
3. Section 15H20, Ductwork and Accessories.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall be experience in the production of substantially similar equipment, and shall show evidence of satisfactory operation in at least 5 installations.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM C 581-655 Tentative Method of Test for Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures.
2. ASTM D 2310, Classification for Machine-Made Reinforced Thermosetting Resin Pipe.
3. ASTM D 2563, Classifying Visual Defects In Glass Reinforced Plastic Laminate Parts.
4. ASTM D 2583, Test for Indentation Hardness of Plastics by Means of a Barcol Impressor.
5. ASTM D 2996, Filament-Wound Reinforced Thermosetting Resin Pipe.
6. ASTM D 4024, Reinforced Thermosetting Resin Flanges, Spec. For,
7. ASTM D 4097, Contact Molded Glass Fiber Reinforced Thermoset Chemical Resistant Tank.
8. PS15-69, Custom Contact Molded Reinforced-Polyester Chemical-Resistant Process Equipment.
9. Standards of Society of the Plastic Industry.
10. NFPA 91, Blowers and Exhaust Systems.

C. Shop Tests:
   1. Manufacturer shall maintain a continuous quality control program and shall furnish the ENGINEER with certified test reports.

D. Fabricators Qualifications: Fabricators shall have at least 5 years experience in producing similar type equipment and shall show evidence of at least 5 installations in satisfactory operations.

E. Requirements of Regulatory Agencies: Comply with the applicable provisions of regulatory agencies below and others having jurisdiction.
   1. Local and State Building Codes and Ordinances.
   2. Underwriters' Laboratories, Incorporated.
   3. National Fire Protection Association.

F. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.

G. Installer shall provide certification that all stainless steel accessories including screws, hangers, etc. for ductwork are Type 316 stainless steel.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval Shop Drawings showing the following:
   1. Ductwork Layout: Detail construction, fabrication, and specification of ductwork laminate construction.
   2. Details of duct system including: Supports, fittings, expansion joints, flexible connectors, anchors, guides and all accessories necessary for piping system.

B. A sample piece of duct approximately 6 inches long of small, medium large sizes, if requested by ENGINEER.

C. Submit design calculations and fabrication procedures for record purposes only. The resin system shall have the manufacturers' name and designation. Also submit a letter stating that the laminates fabricated with the proposed resin system will give satisfactory performance under the specified service conditions.

D. Manufacturers certified literature indicating compliance with proposed pressure (vacuum) classification and wheel loading classification indicated below.

E. Tabulation in check list forms to indicate compliance with ASTM D 2563 Table 2 visual acceptance levels.

F. Submit details of construction for fittings including drawings, dimensions, laminates and flange drilling and thicknesses.

G. Other calculations, dimensions or materials as requested by ENGINEER.

H. Submit color samples to ENGINEER for selection.

I. Deviations from Drawings and Specifications.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store equipment and materials so as to keep free from moisture, damage, and deterioration.

1.5 JOB CONDITIONS

A. Sequencing: Obtain Engineer's approval of Shop Drawings before fabricating and installing ductwork and accessories.

1.6 GENERAL REQUIREMENTS

A. The Drawings accompanying these Specifications show the general arrangement and extent of work to be done, but the exact location and arrangement of all parts shall be determined as the work progresses, to conform in the best possible manner with its surroundings; the exact location of all parts of the work must be governed by the general building plans and the actual building conditions.

B. The Drawings are intended as an indication of the arrangement of equipment, ducts, valves, etc., and are as nearly correct as can be determined in advance of the actual construction of the Work. It must however, be understood that the piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions, without additional charge.

C. The connections indicated to the various units are particularly intended as an indication only. The actual connections at the time of installation to be made and arranged as to fully and best suit the requirements of each particular case, adequately provide for expansion and perfect circulation and minimize the amount of space required for the same.

D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, or if piping or ductwork can be run to better advantage and at the same time accomplish as good or better results, Contractor, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval.

E. The Drawings preclude indicating thereon, all offsets, fittings, accessories and details which may be required.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. The fiberglass reinforced thermosetting plastic duct system shall be specifically designed, constructed, and installed for the scrubber system as intended and shall comply with the following minimum conditions:
   1. Air Temperature, F: 30 to 105.
   2. Corrosion resistance to hydrogen sulfide, mercaptans and other gases commonly encountered in wastewater treatment plants.
   3. Vacuum Service: Ductwork shall be rated for not less than (-) 12 inches of water gage.
   4. Pressure Service: 1 psi gage.

B. Fiberglass reinforced plastic (FRP) ductwork shall be of filament wound construction. FRP ductwork shall be of flame retardent material inside and outside in accordance with NFPA-91. All pipe shall be installed in accordance with manufacturer's recommendations.

C. Exposed FRP ductwork shall be painted in accordance with Section 9L.

2.2 DETAILS OF CONSTRUCTION

A. FRP Duct: Duct shall meet the applicable requirements of ASTM D 2310, Type 1, Grade 1 or 2, with Class "E" liner, 20 mills minimum thickness, and be manufactured in accordance with ASTM D 2996. All interior and exterior surfaces of ducts, dampers and FRP accessories shall be coated with an 85 percent resin, 5 percent antimony trioxide and 10 percent C-glass reinforcement. Exterior surfaces shall have a factory applied paraffinated gel coat finish. CONTRACTOR shall prepare ductwork for painting as described in Section 9L, Painting by sandblasting.

B. Laminates shall consist of a 10 to 20 mil chemical resistant liner with a synthetic surface veil embedded in a resin rich surface. The corrosion barrier shall be a minimum of 100 mils and include ot less than two (2) layers of 1-1/2 ounce mat with 25% glass and 75% resin content. The structural layer shall be of sufficient thickness to meet the minimum thickness requirements specified. The exterior surface layer shall be resin rich "C" - glass or appertured nexus veil not less than 20mils thick. Outside finish shall have a parrafinated gel coat finish with an ultra violet inhibitor. The composition specified for the inner surface and interior layer is intended to achieve optimum chemical resistance.

C. Resins used in the laminate shall be premium corrosion resistant and fire retardant vinylester resins such as Derakane 510A with 5% antimony trioxide, Atlac 711-05A with 3% antimony trioxide, Koppers 9300 with 5% Antimony Trioxide or Hetron 992 with 3% antimony trioxide or equal. The synthetic surfacing veil shall be Veil-Nexus 1012 (apertured) as manufactured by Burlington Industries.

D. Product and Manufacturer: Products shall be of standard manufacture, conforming to applicable requirements of ASTM and as herein specified. Provide duct and fittings by one of the following:
   1. The Ceilcote Company, Incorporated.
   2. Bionomics Industries, Interchem Systems Division.
   3. Ershigs Incorporated.
   4. Hastings Plastics Company.
   5. Or equal.

E. Fittings and Joints: All fittings such as elbows, laterals, tees, and reducers shall be of the same resin as and equal or superior in strength to the adjacent duct section and shall have the same internal diameter as the adjacent duct. Round duct joints shall be butt wrapped or bell and spigot joints as shown or required. Bell and spigot joints shall be sealed with a standard butt joint overlay as per PS 15-69. All interior surfaces of joint to be coated with a paraffinated resin-rich gel coat.

F. Total width of overlay for butt-wrap joints shall be not less than 6-inches for duct diameters from 6 inches up to and including 30-inch pipe, 36 inch and larger duct shall be not less than 10 inches.

G. Standard Elbows:
   1. Standard elbow centerline radius shall be equal to 1-1/2 times the diameter.
   2. Standard elbows up to 24" diameter shall be smooth radius molded elbows. Standard elbows 30" diameter and greater may be mitered sections.
   3. 0° to 44° elbows shall contain one (1) mitered joint and two (2) sections. 45° to 80° elbows shall have a minimum of two (2) mitered joints and three (3) sections. Elbows greater than 80° shall have a minimum of four (4) mitered joints and five (5) sections.

H. Maximum allowable deflection for any size piping/ductwork shall be a 1/2-inch between supports.

I. Tolerances:
   1. Out-of-roundness of duct shall be limited to ± 1/8" or ± 1% of duct inside diamter, whichever is greater for duct sizes 6" diameter and greater.
   2. Length of all flange duct sections shall not vary more than ± 1/8" at 70°F.
   3. All unflanged duct shall be square on the ends in relation to the duct axis and ± 1/8" up to and including 24" diameter and ± 3/16" for all diameters greater than 24".
   4. Fittings:
      1) The tolerance on angles of all fittings shall be ± 1°, up to and including 24" diameter and ± 1/2° for 30" diameter and above.
   5. Flanges:
      a. Flanges faces shall be perpendicular to the axis of the duct within 1/2°.
      b. Flange faces shall be flat to within ± 1/32", up to and including 18" diameter and flat within ± 1/16" for 20" diameter and larger.
      c. Provide custom fillers pieces as required to mate flanges squarely.
   6. Sizes of rectangular ductwork shall be determined by the inside dimensions.

J. Calculations for wall thickness determination shall be based on the structural fiberglass reinforced wall only. Long term deflection shall not exceed 5 percent of duct diameter. Round and rectangular FRP ductwork thicknesses shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum service. Round duct shall be designed by manufacturer to resist specified loadings but in no case shall round FRP duct be less than the following thicknesses:

Diameter*	Filament Wound Thickness	Hand Layup Thickness
Less than 24"	.175"	.25"
24"-30"	.225"	.313"
36"-42"	.325"	.375"

*Where rectangular duct is used the longest dimension shall be considered equivalent to diameter.

K. Fittings and Joints: All fittings such as elbows, laterals, tees, and reducer shall be of the same resin as and equal or superior in strength to the adjacent duct section and shall have the same internal diameter as the adjacent duct. Duct joints shall be butt wrapped or bell and spigot joints as shown or required. Bell and spigot joints shall be sealed with a standard butt joint overlay as per PS 15-69. All interior surfaces of joint to be coated with resin or thixotropic resin paste.

L. All connections to expansion joints, butterfly dampers, tanks, or other equipment shall be flanged. Flanges shall comply with ANSI B16.5. Gaskets shall be chlorobutyl and bolts, nuts and washers shall be Type 316 stainless steel. Flanges shall be hand laid up to PS 15-69 thickness except that minimum thickness shall be 3/4 inch. Each flange face shall be ground flat, and a new 100 mil corrosion barrier shall be applied. The flange shall be anchored to a waxed table to ensure the flatness tolerance outlined in Paragraph 2.2, I., 5. above. The face shall be textured for use with full face chlorobutyl gaskets, 1/8 inch minimum thickness. Flange drilling shall be ANSI B16.1, 125 pounds. All bolt holes shall be back spot faced for a washer seat. All flange bolts shall be torqued to values as recommended by manufacturer.

M. Fasteners: Furnish all bolts, nuts, washers and other fasteners required. Material of metallic fasteners shall be Series 316 stainless steel.

N. Supports: Supports shall be in accordance with materials specified in Section 15H17 for hangers, rods, fasteners, angles, attachments, etc. and with the Drawing details and with manufacturers recommendations. Support spacing shall not exceed 20 feet. Supports shall be furnished at each fitting.

O. There shall be not less than a 1/4-inch buildup of FRP over the duct at each support.

2.3 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. The duct system shall be furnished with the following:
   1. One set of special tools required to maintain and repair the system.
   2. All materials in kit form to make or repair all field joints. Additional kits shall supplied be in a number sufficient to repair 10 percent of the joints.
   3. Names and addresses of all manufacturers of: Fiberglass reinforcements, resins, hardeners and components used to repair and maintain FRP duct system.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location, until transferred to the OWNER at the conclusion of the Project.

C. Material safety data sheets for all components must be furnished.

2.4 FIBERGLASS REINFORCED PLASTIC DAMPERS

A. Furnish and install where indicated on the Drawings manually operated butterfly dampers. Dampers shall be fabricated from materials similar to those specified in Paragraph 2.2,A., Details of Materials and Construction.

B. Dampers shall be butterfly type, with handle for manual operation and quadrant with locknut for balancing purposes.

C. Rating Conditions:
(1) Velocity Through Damper: 5000 fpm.
(2) Pressure Rating: 16 inches water column.

D. Materials:
1. Bearings: Teflon.
2. Blade: FRP, angle reinforced.
3. Frame: FRP.
4. Axles: FRP rods, full length of damper size as shown on the Drawings.
5. Finish: FRP.
6. Handle: Type 316 stainless steel or FRP.
7. Pins: Type 316 stainless steel.
8. Bushings: Teflon.
9. Hardware: Type 316 stainless steel.
10. Angles: FRP.

E. Dimensions: As detailed on the Drawings.

F. Manufacturers: Provide dampers manufactured by one of the following:
1. The Ceilcote Company, Incorporated.
2. Bionomic Industries, Interchem Systems Division.
3. Heil Process Equipment, Xerxes Corporation.
4. Swartwout, Phillips Industries, Series 625.
5. Or equal.

2.5 FRP TRANSITION PIECES

A. Provide transition pieces as shown on drawings and herein specified.

B. Construction:
1. Thickness of transition pieces shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for service in accordance with the pressure classification listed below.
2. All exposed hardware shall be Type 316 stainless steel with stainless steel screws, nuts, bolts and washers as required.
3. Flanges shall be designed as required to connect to fan and/or duct work.

C. Pressure Classification: Manufacturer shall design transition pieces so that they shall be free from buckling, pulsing, warpage, sagging and to the following pressure ratings:
1. Vacuum Service: 10 inches W.C.
2. Pressure Service: 1 psig.

2.6 FLEXIBLE CONNECTORS

A. General: Flexible connectors shall be provided for each 50 linear feet of run with anchors and guides and where shown as a minimum. Additional flexible connectors shall be provided where recommended by the duct manufacturer.

B. Flexible Connections at Ducts: Shall be W-design units constructed of EPDM rubber 3/8-inch thick, reinforced with a strong synthetic asbestos-free fabric suitable for corrosive service in a hydrogen sulfide atmosphere. Working live length of the joint shall be not less than 9 inches. The flexible connections shall be designed to minimize the transmission of vibration and limit the expansion and contraction of the ductwork to 1-inch maximums. Ends shall be flanged, with flanges conforming to ANS B16.1, Class 125. Corners on rectangular expansion joints shall be molded and free of patches or splices. The flexible connections shall be suitable for outdoor service and temperature ranges from -65 F up to 300 F, and pressure to 5 psig. Specially fabricated split Type 316 stainless steel retaining back-up bars shall be supplied to prevent damage to the EPDM rubber flanges when Type 316 stainless steel bolts are tightened. Contractor may substitute Darlyn 1100 by Pathway Bellows, Incorporated, or equal.

C. Hardware: All fasteners (nuts, bolts and washers) shall be Type 316 stainless steel.

D. Product and Manufacturer: Provide joints as manufactured by the following:
   1. Holz Rubber Company.
   2. Pathway Bellows, Incorporated, Darlyn 1100.
   3. Mercer Rubber Company.
   4. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Except as noted below refer to Section 15A2 for piping installation, testing, cleaning and acceptance.

B. All ductwork shall conform accurately to the dimensions shown, the ducts shall be straight and smooth inside with joints neatly finished; ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.

C. Elbows shall have a minimum centerline radius of 1-1/2 times the width of the duct. Turning vanes shall be provided at all square elbows in stainless steel ducts, square elbows are not permitted in any other type of ductwork. Turning vanes shall be double wall and shall be quiet and free from vibration when the system is in operation.

D. Test holes (2) 3" Ø PVC couplings with plugs located at 90° to each other shall be provided at each duct connection to each air handling unit.

E. Provide manual splitter dampers and volume dampers where indicated on the Drawings and as required to facilitate accurate volume control. The duct of the damper shall be reinforced to prevent vibration.

F. Install all ductwork and accessories to provide a system free from buckling, warping, breathing or vibration.

G. Remove all loose materials and obstructions from interior of ducts.

H. Remove debris and waste materials resulting from installation.

I. Install FRP ductwork in accordance with the manufacturer's recommendations.

J. CONTRACTOR shall arrange for field assistance from the duct manufacturer if such assistance is required to insure that the ductwork is installed and jointed correctly.

K. All fittings shall be supported within 18 inches of joint unless otherwise noted.

3.2 INSPECTION OF DUCTWORK

A. The ENGINEER reserves the right to reject any and all equipment found to have the following: blisters, chips, crazing, exposed glass, dry cracks, burned areas, dry spots, foreign matter, or entrapped air at the laminate surfaces which do not satisfy the tolerances specified in ASTM D 2563, Table I Acceptance Level II inside and outside surfaces. Unacceptable Barcol hardness and acetone sensitivity shall also be cause for rejection.

+ + END OF SECTION + +

SECTION 15H30

UNIT HEATERS - ELECTRIC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install electric unit heaters (EUH-1 thru 6) complete with accessories as shown, specified and required for proper operation.

B. Related Sections:
   1. Division 1, General Requirements.
   2. Section 15H64, Automatic Temperature Controls.
   3. Section 15H65, Testing, Adjusting and Balancing.
   4. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have a minimum of 5 years experience in producing substantially similar equipment and shall show evidence of at least 5 installations in satisfactory operation.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
   1. Underwriters Laboratories, Incorporated.
   2. National Electric Code (NEC).
   3. Local and State Building Codes and Ordinances.
      a. Uniform Building Code.
      b. Uniform Mechanical Code.
      c. Model Energy Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Air Moving and Conditioning Association (AMCA).
   2. American Society of Heating, Refrigeration, Air Conditioning Association (ASHRAE).
   3. National Electrical Manufacturers Association (NEMA).
   4. National Fire Protection Association (NFPA)

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, Specifications and engineering data showing:
      a. Dimensions.
      b. Capacities.
      c. Materials of Construction, wiring diagrams.
      d. Finishes.
   2. Drawings showing fabrication methods, assembly, installation details and accessories.

B. Test Reports: Submit the following test certifications for approval.
   1. UL Label.

C. Operation and Maintenance Data: Submit complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and related information, all in conformance with Division 1.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store equipment inside and keep clean and free from damage.

B. Handle to prevent damage during installation and storage.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Design conditions and unit capacities shall be as indicated on the equipment schedules on the Drawings.

B. Manufacturer: Provide one of the following:
   1. Emerson Chromalox, Type MUH (EUH-1 thru 4), Type CUH-EP (EUH-5&6).
   2. Trane.
   3. Or equal.

2.2 DETAILS OF CONSTRUCTION

A. Horizontal Unit Heaters:
   1. Casing:
      a. Material: Minimum 20 gauge die formed steel.
      b. Finish: Phosphate coated and finished with two coats of baked enamel.
      c. Mounting: Provided with wall mounted steel hanger bracket with corrosion resistant coating and mounting hardware.
   2. Heating Elements:
      a. Construction: Copper clad steel sheath with aluminum fins.
      b. Automatic reset thermal overload protection.
      c. Maximum operating temperature: 400 F at 70 F ambient.
   3. Fans:
      a. Type: Broad blade, axial flow-type design.
      b. Construction: Aluminum.
      c. Attached to steel hub.
      d. Dynamically balanced.
   4. Motors:
      a. Type: Single speed.
      b. Enclosure: Totally enclosed fan cooled, explosionproof construction for EUH-5 and 6.
      c. Mounting: Resilient mounted.
      d. Bearings: Permanently lubricated.
      e. Overload Protection: Provide integral thermal overheat and overload protection switch.
      f. Capacity: As shown on the Drawings.
      g. Produced, rated, tested in accordance with NEMA standards.
   5. Air deflectors:
      a. Horizontal type.
      b. Adjustable for downward, upward or straight air flow.

6. Capacity:

Descriptions	EUH-1,2,3	EUH-4	EUH-5,6 Explosionproof
Area Served	See Drawings	See Drawings	See Drawings
Unit Type	Horiz. Disch.	Horiz. Disch.	Horiz. Disch.
Heating Capacity, kW/MBH	5.0/17.1	7.5/25.1	10/34.2
Voltage, phase, Hertz	480v/3Ø/60Hz	480v/3Ø/60Hz	480v/3Ø/60Hz
Fan Air Volume, CFM	350	650	1450
Air Temp. Rise, °F	45	37	22

7. Thermostat:
   a. Factory installed and wired (built-in with unit heater) with thermostat sensing element located in the incoming room air stream for EUH-1 thru 4). Wall mounted explosionproof thermostat for EUH-5 and 6.
   b. Explosionproof thermostat to be furnished by the unit heater manufacturer.
      1) Range 40 to 90F.
      2) 120 volts AC.
      3) Model WR-80 EP by Chromalox or equal.
8. Transformer: Built-in for 24 volt control operation.
9. Integral fan delay switch (unit mounted).
10. Integral power disconnect switch: 3 pole.
11. Unit mounted summer fan switch.
12. For unit heater locations, refer to the Contract Drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect units for damage prior to installation and correct if necessary as recommended by manufacturer.

3.2 INSTALLATION

A. Install cabinets level and plumb.

B. Install units in accordance with details on the Drawings and approved Shop Drawings.

3.3 CONTROLS

A. Unit heaters EUH-1 thru 4, shall be operated by unit mounted, factory installed thermostats.

B. Unit heater EUH-5 and 6 (screening room) shall be controlled by wall mounted explosionproof thermostats.

3.4 CLEANING

A. Clean tar, cement or other dirt from units.

B. Remove debris and other waste material resulting from installation.

3.5 ADJUSTMENTS

A. Set air deflectors for proper air delivery.

+ + END OF SECTION + +

SECTION 15H37

AIR HANDLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, material, equipment and incidentals required to provide and install one air handling unit (AHU-1) complete with motors, direct expansion (D-X) refrigerant coils, electric heating coil, filters, drain pans, all controls and appurtenances required for proper operation and to comply with requirements as shown and specified.

B. Related Sections:
1. Division 1, General Requirements.
2. Section 3D, Cast-In-Place Concrete. (For concrete pad for floor mounted units.)
3. Section 9L, Painting. (Surface preparation and shop painting are in Section 15H37).
4. Section 15H18, Refrigerant Piping Systems.
5. Section 15H20, Ductwork and Accessories.
6. Section 15H21, Duct Insulation.
7. Section 15H38, Air Cooled Condensing Unit-Split Systems Air Conditioning.
8. Section 15H47, Vibration Isolation.
9. Section 15H64, Automatic Temperature Controls.
10. Section 15H65, Testing, Adjusting and Balancing.
11. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have at least 5 years experience in producing similar type equipment and shall show evidence of at least 5 installations in satisfactory operation.

B. Testing Agencies: Fans and coils shall conform to the latest edition of the following standards:
1. Fans, Air Conditioning and Refrigeration Institute (ARI) Standard 430-74.
2. Refrigerant coils shall be certified under ARI Standard 410-74.
3. ASHRAE 52-76 Method of testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
1. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.
2. Local and State Building Codes and Ordinances.
   a. Uniform Building Code.
   b. Uniform Mechanical Code.
   c. Model Energy Code.
3. Underwriters Laboratories Inc.
4. National Fire Protection Association.

D. Reference Standards:
   1. Air Moving and Conditioning Association (AMCA).
   2. American Society of Heating, Refrigeration and Air Conditioning Association (ASHRAE).
   3. National Electrical Manufacturer's Association (NEMA).
   4. Air Conditioning and Refrigeration Institute (ARI).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, specifications and engineering data showing:
      a. Dimensions and weight.
      b. Materials of construction, filter data.
      c. Performance data, fan curves, noise data, equipment weights.
      d. Method of support.
   2. Other technical data related to the specified materials and equipment requested by the ENGINEER.

B. Operation and Maintenance Data:
   1. CONTRACTOR shall furnish in accordance with requirements of Division 1, operation and maintenance manual prepared by the manufacturers of all items of equipment furnished under this Section. The manual shall include maintenance instructions, copies of approved shop and installation drawings for all equipment and manufacturer's recommended lubricant and spare parts lists.

C. Test Reports: Submit the following test certifications for approval.
   1. UL Label.
   2. ARI Label.
   3. AMCA Label.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Material:
   1. Units shall be protectively crated or mounted on skids with substantial wood members.
   2. Units shall be equipped with a minimum of four lifting lugs.
   3. Spacer bars shall be used in lifting units to prevent damage to casing.
   4. Manufacturer's recommendations for rigging of units shall be complied with.
   5. Units shall be structurally designed to withstand stresses of hoisting.

B. Storage of Material:
   1. Store units in a clean, dry area, out of the weather.
   2. Cap all pipe connections and duct connections.
   3. Unit shall remain in original crate till time of actual installation.
   4. Unit shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.

1.5 JOB CONDITIONS

A. Protection:
   1. Make provisions to protect the units at site from vandalism, rain, snow, corrosion or physical damage prior to the installation.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Minimum performance data for each unit shall be as scheduled on the Drawings. Provided equipment shall not exceed scheduled horsepower, outlet air velocity and air or water pressure drops for accessories.

B. Product and Manufacturer: Provide units as made by one of the following:
   1. Trane Company.
   2. Buffalo Forge Company.
   3. Or equal.

C. Capacity:

Description	AHU-1
1. Fan Data:	
a. Capacity, CFM	1700
b. Static Pressure, inches w.g.	1-3/4
c. RPM	1600
d. Motor	1-1/2 HP
e. Voltage, phase	460V/3Ø
2. D-X (Direct Expansion) Cooling Coil:	
a. Required cooling capcity total/ sensible, MBH	58/50
b. Minimum Coil Face Area ft^2	3.0
c. Air Pressure drop inch w.g.	0.50
d. Type of Refrigerant	R-22
3. Filter Data:	
a. Filter box (combination mixing box)	flat
b. Filter thickness, type	2" throwaway
c. Filter area, ft^2	3.46
d. Air pressure drop, inch w.g.	0.25
4. Electric Heating Coil (EHC-1):	
a. Type: Flanged ends.	
b. Capacity: 15 KW, 480V, 3Ø, 60 Hz.	
c. No. of Stages: Three (3).	

2.2 DETAILS OF CONSTRUCTION

A. Type: (Air Handling Unit):
   1. Factory assembled.
   2. Modular in design.
   3. Vertical as shown on Drawings.
   4. Draw-thru type.
   5. Suitable for indoor location as shown on Drawings.

B. Components:
   1. Fan Section.
   2. D-X Refrigerant (Direct Expansion) coil section.
   3. Electricd heating coil, flanged ends, mounted in air handling unit.
   4. Access doors and panels.
   5. Combination filter mixing box.
   6. Motor.
   7. Belts, pulleys, drives.
   8. Belt guard.
   9. Drain Pan.
   10. Vibration Isolation.

C. Fan Section:

1. Construction:
   a. Frame: Welded steel angle or channel frame.
   b. Panels: Heavy gage reinforced steel, 16 gauge minimum thickness.
   c. Insulation: One inch thick, 3/4 pound density fiberglass.
   d. Fan shaft shall be accurately turned, ground and polished hot rolled steel. Fan shafts shall be swaged, stub in tube, or solid as designed by the unit manufacturer. Shafts shall not pass through their first critical speed as unit comes up to rated rpm. Shafts will be coated with a preservative prior to shipment for corrosion protection.
   e. Fan Wheel: Aluminum or steel with corrosion resistant paint.
2. Fan Type: Double width, double inlet non overloading centrifugal fan. Fan wheels shall be forward curved (fc) or airfoil (AF) as required for stable fan operation.
3. Balancing: The fan wheel, motor, drives and belts shall be dynamically balanced as a complete assembly at the factory.
4. Bearings: Bearings shall be sized for an average life of 200,000 hours at specified operating conditions. Externally-mounted bearings shall be flange type and all internally-mounted bearings shall have grease lines extended to the exterior of the unit.
5. All surfaces, including fan panel and accessories shall be chemically cleaned, phosphatized, washed and dried and coated with enamel finish on both inside and outside.
6. Insulated and welded metal drain pan shall be provided under the complete fan and coil section with threaded drain connections on both sides of the unit. Run drain pipe to nearest floor drain.
7. Motors:
   a. Drip-proof, solid shaft, ball bearing type.
   b. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, NEC, and ANSI.
   c. Motors shall be normal starting torque, normal slip, squirrel cage induction type.
   d. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 55 C.
   e. Motors mounted out of the airstream shall be open drip proof with 1.15 service factor unless otherwise scheduled on Drawings.
   f. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower.
   g. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of fan operation.
   h. Locked rotor currents shall be as specified in NEMA standards.
   i. Lubrication may be grease or oil type.
   j. Characteristics:
      1) 1/2 Horsepower and Larger: 480 volt, 3 phase, 60 Hertz.
8. Drive:
   a. All drives must be factory installed, tensioned and aligned using a matched set of belts except when motor is shipped loose.
   b. Fans shall have belt drives selected for a minimum 1.2 service factor.
   c. Drives shall be variable pitch type and suitable for adjustment within plus or minus 10 percent of specified rpm but not to exceed the maximum rpm of the unit.
9. Belt Guard: Expanded metal cover with tachometer holes. Belt guard shall conform to OSHA Standards.

10. Access Doors: Provide gasketed removable panels or access doors with quick opening compression handles for access to internal components.

D. Coils:
1. General:
   a. Refrigerant Coils:
      1) Coils shall be removable from the unit without dismantling the entire unit. Coils shall have continuous wavy platefin surface with seamless 5/8-inch OD copper tubes expanded into aluminum fin collars for secure bonding. Casings shall be galvanized steel. Each coil shall be leak tested before shipment.
      2) All coil capacities, pressure drops, leaving air temperatures and selection procedures shall be certified in accordance with ARI Standard 410-74.
      3) When the air conditioning unit employs more than one cooling coil, the upper coil(s) shall be provided with a drain channel to prevent condensate runoff from passing through the airstream of the lower coil.
      4) Coils shall have the same end connections.
   b. Refrigerant Distribution and Testing:
      1) Coils shall be supplied with a refrigerant distributor circuited to meet capacity at scheduled conditions.
      2) Coils shall be proof-tested at 450 psig and leak tested at 300 psig air pressure under water. Each coil shall be cleaned, dehydrated and charged with a dry nitrogen before shipment.

E. Access Doors (Panels):
1. Construction:
   a. Frame, Panels and Insulation: As specified for fan section.
   b. Doors: Heavy gauge steel, insulated.
   c. Locks: Compression latch with inside and outside handle.
   d. Gasket: Neoprene gasket all around door.

F. Filters and Combination Mixing Boxes:
1. General:
   a. Filter efficiency and weight arrestance shall be determined in accordance with ASHRAE Standard 52-76, Air Cleaning Devices used in General Ventilation for removing Particulate Matter.
2. Throwaway Filters:
   a. Throwaway type filters shall have 2-inch thick fiberglass media contained in a rigid frame. Filters shall have a metallic supporting maze across both entering and leaving faces of the media. Filters shall be sized not to exceed scheduled face velocities. Filters shall be UL Class II. Average arrestance shall be 82 percent with dust holding capacity 75 grams per square foot at 0.25-inch wg resistance. Clean resistance shall be 0.12-inch wg at 300 fpm using AFI static test method. Dust spot efficiency shall not be less than 20 percent.
3. Medium capacity combination filter mixing boxes shall be factory fabricated and finished in the same finish as the air handling unit casing. The mixing box frame shall have a flanged connection on both the inlet and outlet sized to match the air handling unit with the necessary fastener holes prepunched. The assembly shall be provided with all bolts, screws and fasteners required for assembly

by the unit manufacturer. Combination filter mixing boxes shall be furnished with opposed blade damper sets for merging of return air and outside airstreams inside the box. Damper blades shall rotate on rustproof nylon bushings. Damper construction shall be ultra los leak type with rolled stainless steel jamb seals and blade edges with felt tips.

a. The combination filter mixing box shall have an integral filter section capable of receiving 2-inch throwaway filters with angular "V" frame as specified before. Quick opening hinged access doors shall provide access to all filters for filter removal. Filters shall fit snuggly to prevent air bypass.
b. Mounting: Steel framework fabricated for unit at least 8 inches above roof pad.
c. Coating: Epoxy coating baked for 30 minutes inside and outside.

4. Motor Operated Dampers:
   a. Damper actuators shall be as specified in Section 15H64.

G. Electric Heating Coil (EHC-1):

1. Products and Manufacturers: Provide electric heating coils made by one of the following:
   a. Electroduct, Brasch Manufacturing Company.
   b. Indeeco, Industrial Engineering and Equipment Company.
   c. Or equal.

2. Type: Standard flanged, air handling unit mounted heaters. Multi-stage heating operation.
3. Construction:
   a. Coils: 80 percent nickel, 20 percent chromium.
   b. Insulators: Floating ceramic bushings recessed into embossed openings.
   c. Frames: Aluminized frames, support brackets spaced 4-inches center-to-center, spot welded to aluminized frame.
   d. Terminals: Stainless steel insulated with high temperature phenolic bushings, machine crimped to coil.
4. Overtemperature Protection: Disk-type, automatic reset thermal cut-out and disk-type, load carrying manual reset thermal cut-out factory wired in series with each heater stage.
5. Capacity:
   a. EHC-1: 15KW, 3 stage operation.
   b. Electric Power: 480 volts, 3 phase, 60 Hertz.
6. Airflow Switch:
   a. Type: Differential pressure, diaghram operated.
   b. Setting: 0.07-inches of water pressure.
7. Control Options to be furnished: Thermal cut-outs, magnetic contactors and control circuit transformer.
8. Control Location:
   a. Thermal cut-outs, air flow switch and all other heater controls shall be supplied heater manufacturer. Unit shall have provision to accept remote interlock wiring from air handling system temperature controls (located in ATC-1 panel). Refer to Specification Section 15H64 for control operation.
   b. If mounting control panel directly on electric heating coil requires more space than alloted on Contract Drawings, then control panel shall be wall mounted and all wiring interlock shall be CONTRACTOR'S responsibility.
9. Terminals: Blocks shall be sized for 75 C, copper wire.
10. Field Wiring: All field wiring and conduit is under Division 16, Electrical.

2.3 TOOLS AND SPARE PARTS

A. Tools:
   1. Provide 2 sets of fin combs for each fin spacing required.

B. Spare Parts:
   1. Provide one spare set of replacement filters.
   2. Provide one spare set of belts for each V-belt drive.

2.4 PAINTING

A. All exterior surfaces of air handling unit housing, supports, motors and drives shall be epoxy coated.

B. Fan wheels, interior surfaces of unit housing and other metal surfaces (except coils) exposed to incoming air stream shall be coated as specified.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine supports to receive unit for proper location and dimensions.

3.2 INSTALLATION

A. Mount unit on supporting steel or concrete pad.

B. Make final connections of ductwork, piping and control wiring as detailed on the Drawings and approved Shop Drawings.

3.3 ADJUSTMENT

A. Adjust belts for proper tension.

B. Adjust pulleys for proper fan speed.

C. Adjust damper linkages for proper operation.

3.4 CLEANING

A. Clean tar cement and other debris from exterior of unit.

B. Remove debris and waste materials resulting from installation.

C. Replace filters used during start-up and adjusting with clean filters.

+ + END OF SECTION + +

SECTION 15H38

AIR COOLED CONDENSING UNIT - SPLIT SYSTEM AIR CONDITIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals required to furnish and install one split system air conditioning consisting of an outdoor roof mounted air cooled condensing unit (ACCU-1) complete with compressors, condenser coil, condenser fan, motor, control box, motor starters and separately mounted direct expansion refrigerant coil (located in AHU-1 housing) and complete with all controls, control wiring, piping and appurtenances required for proper operation and to comply with requirements as shown and specified.

B. Related Sections:
1. Division 1, General Requirements.
2. Section 7H1, Flashing and Trim.
3. Section 9L, Painting. (Surface preparation and Shop Painting are in Section 15H38)
4. Section 15H18, Refrigerant Piping Systems.
5. Section 15H37, Air Handling Units. (For D-X cooling coil).
6. Section 15H64, Automatic Temperature Controls.
7. Section 15H65, Testing, Adjusting and Balancing.
8. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have at least 5 year's experience in producing similar type equipment and shall show evidence of at least 5 installations in satisfactory operation.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction:
1. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.
2. Local and State Building Codes and Ordinances:
   a. Uniform Building Code.
   b. Uniform Mechanical Code.
   c. Model Energy Code.
3. Underwriters' Laboratories, Inc.
4. National Fire Protection Agency.
5. Air-Conditioning and Refrigeration Institute.

C. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Air Conditioning and Refrigeration Institute Standards No. 210 and 270.
2. Underwriters' Laboratories Listed.
3. American Standards for Testing and Materials (ASTM) B 75.

D. Source Quality Control: Perform the following shop tests and inspections at the factory:
   1. Coils shall be pneumatically leak tested under water at 200 psig.
   2. Fan wheels and shafts shall be statically and dynamically balanced.
   3. Refrigeration system and controls shall be tested prior to shipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, specifications and engineering data showing:
      a. Dimensions and weight.
      b. Details of construction.
      c. Wiring and control diagrams.
      d. Equipment weights.
      e. Other materials and data related to the specified equipment as requested by the ENGINEER.

B. Operation and Maintenance Data:
   1. CONTRACTOR shall furnish in accordance with the requirements of Division 1, operation and maintenance manual prepared by the manufacturers of all items of equipment furnished under this Section. The manual shall include maintenance instructions, copies of approved shop and installation drawings for all equipment and manufacturer's recommended lubricant and spare parts lists.

C. Test Reports: Submit the following test certifications for approval.
   1. ARI Label.
   2. UL Label.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Material:
   1. Unit shall be protectively packed and crated to prevent any damage to unit.
   2. Manufacturer's recommendations for rigging of unit shall be complied with.
   3. Unit shall be structurally designed to withstand stresses of hoisting.

B. Storage of Material:
   1. Store unit in a clean, dry area, out of the weather.
   2. Cap all pipe connections.
   3. Unit shall remain in original crate till time of actual installation.
   4. Unit shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.

1.5 JOB CONDITIONS

A. Protection:
   1. Protect unit at job site from damage prior to installation of unit.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Product and Manufacturer: Provide unit as made by one of the following:
   1. The Trane Company, Model No. BTA-60D400A.
   2. Or equal.

B. Performance Data:
   1. Mark No. ACCU-1.
   2. Design Parameters:
      a. Net Cooling Capacity: 60 MBH at 45 F saturated suction temperature and 95 F ambient air temperature.
      b. Minimum Energy Efficiency Ratio (EER): 8.2.
      c. Ambient Air Temperature Range: 45 to 115 F.
   3. Compressor Data:
      a. Type: Hermetic.
      b. No. of Compressors: 1.
      c. Size: 5 ton cooling capacity each.
      d. Capacity steps: 100-50-0 percent.
      e. Horsepower: 5.
   4. Condensor Fan Data:
      a. Type: Propeller.
      b. No. of Fans: 1.
      c. Nominal CFM: 4,600 total.
      d. Fan Drive/RPM: Direct/1100.
      e. Horsepower: 1/2 each.
   5. Condensor Coil Data:
      a. Face Area: 19.5 Ft^2
      b. Rows/Fins per foot: 2/144.
   6. General Data:
      a. No. of refrigerant circuits: 1.
      b. Refrigerant type: R-22.
      c. Condensor Charge: 10.25 lbs.
   7. Electrical Data:
      a. Total input power: 12.4 amperes, 480V, 3 phase, 60Hz

2.2 DETAILS OF CONSTRUCTION

A. Assembly:
   1. Unit shall be completely factory pre-assembled, pre-piped, and pre-wired; consisting of compressor, condenser coil, condenser fan and motor, refrigerant receiver, sight glass, charging valve, unit controls and a holding charge for refrigerant-22. Unit shall be designed for outdoor mounting and shall have a minimum refrigerating capacity and characteristics as shown on the Drawings and specified in this Section. Provide with insulated liquid line, and insulated suction line, pre-charged soft copper refrigerant tubing of sufficient length to connect evaporator coil.

B. Casing:
   1. Casing shall be low silhouette type constructed of minimum 16 gage zinc coated steel; exterior surfaces phosphatized, painted with epoxy primer, and finished with baked on enamel. Supporting channel, fan and motor base and motor mount shall have a heavy zinc coating. Coil frame shall be minimum 12 gage zinc coated steel. Provide removable access panels for proper access to all controls

and parts requiring maintenance. Provide drain connection for water drainage. Compressor shall mount in a separate compartment.

C. Condenser Fan and Drive:
   1. Condenser fans and drives shall be axial flow propeller fans having zinc plated or aluminum statically and dynamically balanced blades and permanently lubricated ball bearings. Fans shall be powered by weatherproof, permanently lubricated ball bearing heavy-duty motors with built-in thermal overload protection; shafts ground and polished steel.

D. Refrigerant Compressor:
   1. Compressor shall be hermetic type mounted on steel base. Units shall be forced-feed lubrication with filters, magnetic plugs, centrifugal cleaning, suction screen inlet, mufflers, crankcase heater and liquid line filter-dehydrator, and enclosed in a sound attenuating compartment on rubber-in-shear isolators. Motors shall be suitable for voltage fluctuations of plus or minus 15 percent of nameplate voltage and shall have two thermostats located directly in motor winding.

E. Condensing Coil:
   1. Condensing coil shall be designed specifically for air cooled condensing; constructed of 3/8 inch diameter seamless copper tubing and heavy-duty aluminum fins mechanically bonded to the tubes; factory tested at 425 psig air pressure under water and vacuum dehydrated at 175 F.

F. Controls:
   1. Control box containing and controls shall be mounted on exterior of condensing unit casing with controls directly accessible when access panel is removed; controls factory pre-wired complete with magnetic contactor for both compressor and condenser fan motor, three-phase compressor overload protection, high and low pressure cutouts, oil pressure switch and non-recycling pumpdown control relay, crankcase heater relay, low ambient control, condenser fan interlock, etc., as required. Control box shall be weatherproof. Condensing unit (ACCU-1) control box shall have provisions to interlock with air handling unit (AHU-1) controls located in ATC-1 control panel. Furnish an unit mounted power disconnect switch.

G. Refrigerant Piping:
   1. Refrigerant piping shall be Type L streamlined soft temper, cleaned and dehydrated copper tubing.
   2. Pipe fittings shall be streamlined pattern wrought copper.
   3. Unions shall be wrought copper; minimum 300 psig working pressure; female pattern; brass to brass seat ground joint, solder to solder connections.
   4. Refer to Specification Section 15H18.

H. Direct Expansion Refrigerant Coils: (Located in AHU-1 as specified in Section 15H37).
   1. Coil shall have the capacity as scheduled on the Drawings. Coil shall be ARI rated.
   2. Coil shall be of nonferrous construction with mechanically bonded smooth plate fins. All tube joints shall be brazed with phoscopper or silver alloy.
   3. Refer to Specification Section 15H37.

I. Antishortcycle Timer:
   1. Shall prevent rapid on-off compressor cycling in light load conditions byn ot allowing compressor to operate for a predetermiend time upon shutdown. System shall consist of all control components to permit a five-minute fixed-off timing period.

J. Time Delay Timer:
   1. Shall prevent compressors in unit from coming on lime simultaneously.
   2. Timer controls shall provide a four-minute timing period.

2.3 SPARE PARTS

A. Furnish a list of required spare parts as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine mounting pad to receive unit for:
   1. Horizontal mounting surface.
   2. Proper anchorage.
   3. Uneveness, irregulatories, and incorrect dimensions that would affect quality and execution of installation.

B. Examine piping, and electrical connections prior to installing unit for defects, errors, or omissions which would prevent installation of the unit.

C. Examine unit at time of delivery for damaged or missing components.

D. Do not proceed with installation of unit until all items found defective upon examination have been corrected as recommended by manufacturer and approved by ENGINEER.

3.2 INSTALLATION

A. Rig unit into place on supports on roof with anchor bolts and vibration isolators. Coordinate with General Contractor for unit location and installation details.

B. Make final connections of piping and control wiring, as detailed on the Drawings and approved Shop Drawings.

3.3 ADJUSTMENT AND CLEANING

A. Remove all debris, waste material, and loose foreign matter from interior of unit prior to starting fans.

B. Clean tar, dirt or marks from exterior of unit.

C. Adjust all controls for proper settings.

D. Adjust refrigeration suction and discharge pressures according to manufacturer's recommendations.

+ + END OF SECTION + +

SECTION 15H41

PACKAGED ROOFTOP AIR CONDITIONING UNITS - SINGLE ZONE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, material, equipment and incidentals required to furnish and install packaged rooftop air conditioning units (AHU-2) complete with motors, all controls and appurtenances required for proper operation.

B. Related Work Specified Elsewhere:
1. Section 7H1, Flashing and Trim.
2. Section 9L, Painting.
3. Section 15H20, Ductwork and Accessories.
4. Section 15H47, Vibration Isolation.
5. Section 15H64, Automatic Temperature Controls.
6. Section 15H65, Testing, Adjusting and Balancing.
7. Division 16, Electrical.

C. Items Furnished But Installed Under Other Sections:
1. Roof mounting frames and curbs.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have at least 5 years experience in producing similar type equipment and shall show evidence of at least 5 installations in satisfactory operation.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction:
1. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.
2. Local and State Building Codes and Ordinances:
   a. Uniform Building Code.
   b. Uniform Mechanical Fan.
   c. Model Energy Code.
3. Underwriters Laboratories, Inc.
4. National Fire Protection Agency.
5. Air-Conditioning and Refrigeration Institute.

C. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Air Conditioning and Refrigeration Institute Standards No. 210 and 270.
2. Underwriters Laboratories Listed.

D. Source Quality Control: Perform the following shop tests and inspections at the factory:
1. Coils shall be pneumatically leak tested under water at 200 psig.
2. Fan wheels and shafts shall be statically and dynamically balanced.
3. Refrigeration system and controls shall be tested prior to shipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval Shop Drawings showing the following:
   1. Dimensions and weight, performance data.
   2. Details of construction, method of support and installation.
   3. Wiring and control diagrams.
   4. Manufacturer's literature, illustrations, specifications and engineering data.
   5. Other materials related to the specified equipment as requested by the ENGINEER.

B. Operation and Maintenance Data:
   1. CONTRACTOR shall furnish 6 copies of a hard cover bound operation and maintenance manual prepared by the manufacturers of all items of equipment furnished under this Section. The manual shall include maintenance instructions, copies of approved shop and installation drawings for all equipment and manufacturer's recommended lubricant and spare parts lists. Manuals shall be furnished before the AC units are delivered.

C. Test Reports: Submit the following test certifications for approval.
   1. ARI Label.
   2. UL Label.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Material:
   1. Units shall be equipped with a minimum of four lifting lugs.
   2. Spacer bars shall be used in lifting units to prevent damage to casing.
   3. Manufacturers recommendations for rigging of units shall be complied with.
   4. Units shall be structurally designed to withstand stresses of hoisting.
   5. Units shall be protectively crated.

B. Storage of Material:
   1. Store units in a clean, dry area, out of the weather.
   2. Cap all pipe connections and duct connections.
   3. Units shall remain in original crate till time of actual installation.
   4. Units shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.

1.5 JOB CONDITIONS

A. Protection:
   1. Roof openings and penetrations shall be capped to prevent rain and snow from entering building prior to installation of units.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Product and Manufacturer: Provide units as made by one of the following:
   1. Trane Company, Model TC-D, Downflow.

2. Carrier Corporation, Model CD.
3. Or equal.

B. Ambient Conditions: Capable of operating at rated capacities at 120 F.

C. The rooftop air conditioning unit (AHU-2) shall have the following minimum capacities:
1. Type: Downflow discharge system.
2. Capacity:
   a. Net Total Cooling: 60.0 MBH.
   b. EER: 9.0.
3. Evaporator (Indoor Air) Fan Data:
   a. Type: Centrifugal.
   b. Air Volume: 1,600 cfm.
   c. External Static Pressure: 0.25 inches of water gage.
   d. Number of Fans: One.
   e. Fan Motor Horsepower: 3/4 HP, 460 volt, 3 phase, 60 Hertz.
   f. Motor RPM: 1,075.
   g. Drive: Direct.
4. Evaporator (Indoor Air) Coil Data:
   a. Type: Plate Fin.
   b. Face Area: 5.49 square foot minimum.
   c. Rows/Fins Per Inch: 4/12.
   d. Refrigerant Control: Expansion valve and capillary tube.
   e. Tube Size: 3/8 inch.
5. Condenser (Outdoor Air) Fan Data:
   a. Type: Propeller.
   b. Air Volume: 4,800 cfm.
   c. Number of Fans: One.
   d. Fan Motor Horsepower: 1/2 HP, 460 Volt, 3 Phase, 60 Hertz.
   e. Motor RPM: 1,075.
   f. Drive: Direct.
6. Condenser (Outdoor Air) Coil Data:
   a. Type: Plate fin.
   b. Face Area: 14.8 square foot minimum.
   c. Rows/Fins Per Inch: 2/15.
   d. Refrigerant Control: Expansion valve and capillary tube.
   e. Tube Size: 3/8 inch.
7. Auxiliary Electric Heating Coil:
   a. None.
8. Compressor Data:
   a. Quantity: One.
   b. Horsepower: 5 HP, 460 volt, 3 phase, 60 Hertz.
   c. Refrigerant: R-22.
   d. RPM: 3,450.
9. Total electrical power requirement data for the air conditioning unit including compressor, evaporator fan, condenser fan:
   a. Power Supply: 7.0 KW, 480 volts, 3 phase, 60 Hz.

2.2 DETAILS OF CONSTRUCTION

A. Type: Downflow, self-contained, factory piped, wired and assembled roof top air conditioning units with prefacbricated roof curb, outside air intake hood and filters, all furnished by the air conditioning unit manufacturer.

B. Casing:
   1. Reference: Underwriter's Laboratory rain test requirements.
   2. Construction: Phosphatized, zinc coated steel.
   3. Finish: Factory applied epoxy resin primer and baked enamel finish.
   4. Factory Insulation: Casings and access panels shall be insulated with one inch thick, one pound density foil faced glass fiber insulation.
   5. Gaskets: All access panels shall be gasketed.
   6. Handles: All access panels shall have quick release latches and handles.
   7. Outside air, return air, relief air dampers, all factory installed.

C. Direct Expansion Cooling:
   1. Compressor:
      a. Type: Hermetrically sealed, welded shell with anti-slugging devices and service shut-off valves.
      b. Controller: Suction pressure operated capacity controller.
      c. Provide spring-type vibration isolators.
      d. Crankcase heaters.
      e. Safety Controls:
         1) Fusible relief device.
         2) Current overloads.
         3) Motor winding thermostat.
   2. Evaporator Coil:
      a. Type: Dual-circuited multi-row coil.
      b. Construction: 3/8-inch OD seamless copper tube mechanically bonded to aluminum fuses.
      c. Coil shall be installed with the following accessories:
         1) Expansion valve.
         2) Dryer.
         3) Solenoid valve.
         4) Sight glass with moisture indicator.
         5) Holding charge of R-22.
   3. Refrigeration Controls include:
      a. Condenser fan.
      b. Evaporator fan.
      c. Compressor contactors.
      d. 24 volt transformer.
      e. Safety Controls:
         1) High and low pressure controls.
         2) Winding thermostats.
         3) Compressor overloads.
      f. Cycle Guard: Prevent unit cycling on overloads and allow safety controls to be reset at thermostat.
      g. Refrigerant Circuit Controls: Each refrigerant circuit shall have an independent, and complete set of refrigeration controls.
   4. Drain Pan:
      a. Internally sealed.
      b. Insulated.
      c. Threaded drain connection in evaporator section.
   5. Condenser Coil:
      a. Type: Dual-circuited multi-row coil.
      b. Construction: 3/8-inch OD seamless copper tube mechanically bonded to aluminum fins.
   6. Condenser Fans:
      a. Type: Multi-blade upflow propeller type fans.

b. Statically and dynamically balanced.
c. Direct drive.
d. Permanently lubricated motor.
e. Built-in thermal overload protection.
f. Motor U.L. listed for outdoor use.

D. Indoor Air Fans:
1. Type: Belt driven, forward curved, centrifugal type.
2. Drive: V-belt drive with adjustable motor sheaves.
3. Motor:
a. Permanently lubricated fan and motor bearings.
b. Thermal overload protection.
c. Non-overloading at any point on the fan curve.
4. Fan and motor isolated from unit with rubber motor mounts.

E. Air Filters:
1. Type: Continuous filament, glass fiber, 2-inch thick, viscosine coated removable media with filter cell, throwaway type.
2. Efficiency: 78 percent AFI weight test method.
3. Use standard size filters.
4. Frame: Factory installed filter frame for 2-inch thick filters.

F. Central Control Panel: Provide the following accessories:
1. Control switches:
a. System Switch: Two positions, On and Off with pilot light.
b. Provision of all components to wire remote devices (thermostat, smoke detector, smoke alarm dampers, etc.).
2. Thermostat: Wall mounted thermostat assembly shall be wired to control panel for cooling controls.

H. Accessories:
1. Roof Mounting Frame:
a. Construction: 12 gage zinc coated steel.
b. Shall match perfectly with base of unit.
c. Factory applied weatherproofing seal.
2. Outside Air Intake Hood:
a. Rainhood with screen and filters.
3. Economizer Control Mode:
a. Type: Enthalpy controlled economizer cycle with the following:
1) Humidistat.
2) Outdoor air thermostat.
3) Damper and spring return operator.
4) Pressure relief damper.
5) Mixed air thermostat.
6) Controller.
7) Ventilation control knob to control minimum position of outdoor air dampers.
8) Factory installed.

2.3 CONTROLS

A. Automatic Temperature Controls (AHU-2):
1. Electrical/Electronic type.
2. Field installation:
a. Wall mounted central control panel.
b. Smoke detector.
c. Wiring from panel to air conditioning unit, smoke detector, remote smoke alarm SA-1.

B. Control Sequence:
   1. General:
      a. Unit shall be operated manually from the on/off switch with pilot light located in central control panel for AHU-2.
      b. Fan shall run continuously.
      c. Normally closed outside air damper shall open.
      d. Refrigeration controls shall be energized.
      e. Room thermostat shall modulate outdoor air damper and return air damper or compressor to maintain room conditions. Outdoor air damper shall return to minimum position when outdoor temperature or relative humidity are too high for proper cooling with outdoor air.
      f. The outdoor air dampers shall close when the unit is in the "OFF" position.
   2. Mechanical cooling shall be locked out below 55 F and cooling accomplished by utilization of outdoor air by enthalpy controller.
   3. Mixed air control system will modulate return and outside air dampers to provide:
      a. Minimum ventilation at all times.
      b. Up to 100 percent outside air for natural cooling by enthalpy controller.
      c. Ventilation lockout shall prevent outside air damper from opening until return air reaches preset level.
   4. Smoke detector SD-2A shall stop unit if products of combustion are detected in room air and provide a common audio-visual alarm at remote smoke alarm SA-1.

2.4 TOOLS AND SPARE PARTS

A. Tools:
   1. Provide 2 sets of fin combs, for each fin spacing required.

B. Spare Parts:
   1. Provide one spare set of replacement filters.
   2. Provide one spare set of belts for each V-belt drive.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine roof curbs to receive unit for:
   1. Horizontal mounting surface.
   2. Water tightness.
   3. Proper anchorage.
   4. Uneveness, irregularities, and incorrect dimensions that would affect quality and execution of installation.

B. Examine piping, ductwork, insulation and electrical connections within curb prior to installing unit for defects, errors, or omissions which would prevent installation of the unit.

C. Examine unit at time of delivery for damaged or missing components.

D. Do not proceed with installation of unit until all items found defective upon examination have been corrected as recommended by manufacturer and approved by ENGINEER.

3.2 INSTALLATION

A. Rig unit into place.

B. Make final connections of ductwork, piping and control wiring, as detailed on the Drawings and approved Shop Drawings.

3.3 ADJUSTMENT AND CLEANING

A. Remove all debris, waste materials, and loose foreign matter from interior of unit prior to starting fans.

B. Clean tar, dirt or marks from exterior of unit.

C. Adjust all controls for proper settings.

D. Adjust refrigeration suction and discharge pressures according to manufacturer's recommendations.

+ + END OF SECTION + +

SECTION 15H47

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install vibration isolators for all items of equipment listed, complete with all appurtenances.

B. General:
1. Vibration control shall be achieved by use of approved vibration eliminators installed as directed by the manufacturer of the eliminators.
2. All Work shall operate under all conditions of load without objectionable sound or vibration.
3. In the case of moving machinery, sound or vibration noticeable outside the room in which it is installed or annoyingly noticeable inside its own room, will be considered objectionable.
4. Objectional sound or vibration will be corrected by the CONTRACTOR in a manner approved by ENGINEER and at no additional expense to the OWNER.

C. Related Sections:
1. Division 1, General Requirements.
2. Section 15H37, Air Handling Units.
3. Section 15H38, Air Cooled Condensing Unit - Split System Air Conditioning.
4. Section 15H51, Centrifugal In-Line Fans.

1.2 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of 5 years experience in producing substantially similar equipment and shall show evidence of at least 5 installations in satisfactory operation.

B. Design Criteria:
1. Vibration isolators shall be selected for uniform state deflections according to distribution of weight.
2. Selections shall be based on lowest rotational speed as disturbing frequency.
3. Total rated capacity of isolators shall be at least 150 percent the weight of equipment supported.

C. Reference Standards: Comply with applicable provisions and recommendations of the following except as shown or specified:
1. ASHRAE, 1987 Systems Volume.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, specifications, and engineering data showing:
   a. Isolation mounting, deflections, equipment weights.
   b. Spring diameters.

c. Compressed spring height at rated load.
d. Solid spring height.
e. Equipment operating speed.
f. Other technical data related to the specified material and equipment as requested by the ENGINEER.

2. Drawings showing fabrication methods, assembly, installation details and accessories.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Mark all eliminators with identification as to item of equipment and exact location.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Manufacturer: Provide product(s) of one of the following:
1. Mason Industries.
2. Vibration Eliminator Company.
3. Or equal.

2.2 DOUBLE DEFLECTION MOUNTINGS

A. Material: Neoprene.

B. Minimum Static Deflection: 0.35 inch.

C. All metal surfaces neoprene coated.

D. Friction pads on top and bottom.

E. Steel rails shall compensate for overhang.

F. Provide bolt holes at proper locations.

2.3 SPRING HANGERS

A. Type: Spring isolators, laterally unrestrained.

B. Efficiency: 95 percent at rated load.

C. Construction:
1. Designed so that ratio of horizontal to vertical spring constants is between one and two.
2. Steel spring with 0.3 inch deflection neoprene element.
3. Neoprene element shall have rod isolation bushing.
4. Hanger shall permit rod to swing through 30 degree arc before contacting metal.
5. Spring shall have addition travel to solid of 50 percent of rated deflection.

2.4 UNHOUSED SPRING MOUNTINGS

A. Type: Spring isolator, free standing, laterally stable unhoused.

B. Efficiency: 95 percent of rated load.

C. Construction:
   1. Baseplate with 1/4-inch acoustical friction pad between baseplate and support.
   2. Leveling bolts rigidly bolted to the equipment.
   3. Spring diameter 0.8 of the compressed spring height at rated load.
   4. Minimum spring deflection before becoming solid shall be at least 50 percent greater than the specified minimum deflection.

2.5 HOUSED SPRING MOUNTINGS

A. Type: Spring isolator, free standing, laterally stable with housing.

B. Efficiency: 95 percent at rated load.

C. Construction:
   1. Housing: Shall include vertical limit stops.
   2. Clearance: Maintain 1/2-inch clearance around restraining bolts and between housing and spring.
   3. Weatherproofing: Hot dip galvanized for outdoor use.
   4. Baseplate with 1/4-inch acoustical friction pad between baseplate and support.
   5. Leveling bolts rigidly bolted to the equipment.
   6. Spring diameter 0.8 of the compressed spring height at rated load.
   7. Minimum spring deflection before becoming solid shall be at least 50 percent greater than the specified minimum deflection.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect anchor bolts for proper locations.

3.2 INSTALLATION

A. Install as per manufacturers recommendations.

3.3 CLEANING

A. Remove foreign objects which might bridge vibration isolators.

3.4 SCHEDULES

A. Use types of isolators for equipment specified below unless otherwise specified.

Equipment	Type
1. Suspended In-Line Duct Fans (EF-1 and EF-5)	Spring Hangers
2. Floor Mounted Air Handling Unit (AHU-1)	Unhoused Spring Mounting

Equipment	Type
3. Air Cooled Condensing Unit (ACCU-1)	Housed Spring Mountings

B. Air handling units shall be installed on minimum 6-inch high reinforced concrete pads.

+ + END OF SECTION + +

SECTION 15H51

CENTRIFUGAL IN-LINE FANS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install an in-line centrifugal fan (EF-1 and EF-5) complete with accessories required for proper operation and to comply with the requirements as shown and specified.

B. Related Sections:
   1. Division 1, General Requirements.
   2. Section 9L, Painting (Surface preparation and shop painting are in Section 15H7).
   3. Section 13B, Pre-Engineered Building.
   4. Section 15H20, Ductwork and Accessories.
   5. Section 15H47, Vibration Isolators.
   6. Section 15H64, Automatic Temperature Controls.
   7. Section 15H65, Testing, Adjusting, and Balancing.
   8. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have a minimum of 5 years experience in producing substantially similar equipment and shall show evidence of at least 5 installations in satisfactory operation.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
   1. National Fire Protection Association.
   2. Underwriters Laboratories, Incorporated.
   3. National Electric Code.
   4. National Electric Manufacturers Association.
   5. Local and State Building Codes and Ordinances.
      a. Uniform Building Code.
      b. Uniform Mechanical Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Air Moving and Conditioning Association (AMCA) Standard: 210-74 and 300.

D. Source Quality Control: Perform the following tests and inspections at factory:
   1. Fan wheels shall be statically and dynamically balanced.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, specifications, and engineering data showing:
      a. Dimensions.

b. Materials of construction.
c. Mounting details.
d. Performance Data - AMCA approved fan curves, for each model specified, weights.

2. Drawings showing fabrication methods, assembly, installation details and accessories.

B. Test Reports: Submit the following test certifications for approval.
1. AMCA Label.

C. Operation and Maintenance Data: CONTRATOR shall furnish 6 copies of a hard cover bound operation and maintenance manual prepared by the manufcturer of all items of equipment furnished under this Section and all in conformance with Division 1. The manual shall include maintenance instructions, copies of approved shop and installation drawings for all equipment and manufacturer's recommended lubricant and spare parts lists.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery:
1. Fans shall come completely assembled with motors and drives shipped loose.
2. Intake and discharge parts shall be protected against entry of foreign objects.

B. Storage of Material:
1. Store units in a clean, dry area, out of the weather.
2. Unit shall remain in original crate or skid until time of actual installation.
3. Unit shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Manufacturer: Provide product(s) of one of the following:
1. Loren Cook Company.
2. Penn Ventilator Company.
3. Or equal.

B. Type: In-line, tubular centrifugal fan (EF-1, EF-5).

C. Capacity:

	Description	EF-1	EF-5
1.	Area served:	Operations Room	Chlorine Room
2.	CFM:	1360	3240
3.	Static Pr.:	5/8 inch WG	1/2 inch WG
4.	Brake H.P.	0.40 HP	0.65 HP
5.	Motor Data:	1/2 HP, 480v/3 phase	1 HP/480v/3 phase
6.	Fan Drive:	Belt	Belt
7.	Fan RPM:	1390	915
8.	Motor RPM:	1750	1750
9.	Remarks:	-	Corrosion Resistant Coating

D. Construction:
   1. Housing:
      a. Heavy gage welded steel.
      b. Integral straightening vanes.
      c. Flanged inlet and outlet connections.
      d. Split housing access.
      e. Welded supports for suspended mounting.
   2. Wheel:
      a. Air foil design.
      b. Non overloading.
      c. Statically and dynamically balanced.
      d. All welded construction.
      e. Steel or aluminum.
      f. Venturi shaped intake rim.
   3. Inlet: Streamlined inlet cone.
   4. Inner Tube Construction:
      a. Welded to housing.
      b. Access plate for servicing.
      c. Isolate bearings and drive from air stream.
   5. Shaft: Turned, ground and polished steel.
   6. Bearings:
      a. Greaseable ball bearings.
      b. External grease fittings.
      c. B-10 minimum life rating of 100,000 hours.
   7. Motor Mounts:
      a. Adjustable.

E. Motors:
   1. Drip-proof, solid shaft, ball bearing type.
   2. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, NEC, and ANSI.
   3. Motors shall be normal starting torque, normal slip, squirrel cage induction type.
   4. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 55 C.
   5. Motors shall be provided with a service factor of 1.15.
   6. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower.
   7. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of fan operation.
   8. Locked rotor currents shall be as specified in NEMA standards.
   9. Lubrication may be grease or oil type.
   10. Overload Protection: Provide integral overload protection on all single phase motors.
   11. Disconnects: Provide factory mounted, factory wired unfused disconnects for all single phase motors.

F. Drive:
   1. V-belt and adjustable sheaves.

G. Access to Unit:
   1. Split housing or access door.

H. Belt Guard: OSHA approved with tachometer hole.

I. Coatings:
   1. Phenolic, phenol formaldehyde resin or equal. Minimum five coats.
   2. Coat entire fan with coating mentioned above.

J. Spare Parts:
   1. Provide one spare belt for each belt drive fan.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine Fans for:
   1. Hanger locations.
   2. Uneveness, irregularities and incorrect dimensions.

3.2 INSTALLATIONS

A. Installation shall be in accordance with the manufacturer's instructions and recommendations. CONTRACTOR to coordinate for hanger installation locations for fan mounting.

B. Installation shall include furnishing and applying an initial supply of lubrication as recommended by the manufacturer.

C. Ductwork shall be supported independently of fan.

D. Check and align fan and motor.

3.3 START-UP ADJUSTMENT AND TESTING

A. Lubricate bearings if required prior to starting fans.

B. Check for proper rotation.

C. Adjust fans for proper air flow.

D. Leave fans in working order.

3.4 CLEANING

A. Clean dirt and marks and other debris from exterior of fans.

B. Remove debris and waste material resulting from installation.

+ + END OF SECTION + +

SECTION 15H57

CENTRIFUGAL ROOF FANS - ALUMINUM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals required to furnish and install the centrifugal roof fans (EF-2 thru 4) complete with accessories for proper operation and to comply with the requirements as shown and specified.

B. Related Sections:
   1. Division 1, General Requirements.
   2. Section 7H1, Flashing and Trim.
   3. Section 9L, Painting (Surface preparation and shop painting are in Section 15H57).
   4. Section 15H20, Ductwork and Accessories.
   5. Section 15H64, Automatic Temperature Controls.
   6. Section 15H65, Testing, Adjusting and Balancing.
   7. Division 16, Electrical.

C. Items Furnished:
   1. Prefabricated Roof Curbs.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualificatons: Manufacturer shall have a minimum of 5 years experience in producing substantially similar equipment and shall show evidence of at least 5 installations in satisfactory operation.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
   1. National Fire Protection Association (NFPA).
   2. Underwriters Laboratories, Incorporated (UL).
   3. National Electric Code (NEC).
   4. National Electric Manufacturers Association (NEMA).
   5. Local and State Building Codes and Ordinances.
      a. Uniform Building Code.
      b. Uniform Mechanical Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Air Moving and Conditioning Association (AMCA) Standard: 210-74 and 300.

D. Source Quality Control: Perform following tests and inspections at factory:
   1. Fan wheels shall be statically and dynamically balanced.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's Literature, illustrations, specifications and engineering data to include the following:
      a. Dimensions.
      b. Materials of construction.
      c. Mounting details.
      d. Performance Data - AMCA approved fan curves, for each model specified, weights.
      e. Prefabricated curb details.
   2. Drawings showing fabrication methods, assembly, installation details and accessories.

B. Test Reports: Submit the following test certifications for approval.
   1. AMCA Label.

C. Operation and Maintenance Data: CONTRACTOR shall furnish 6 copies of a hard cover bound operation and maintenance manual prepared by the manufacturer of all items of equipment furnished under this Section and all in conformance with Division 1. The manual shall include maintenance instructions, copies of approved shop and installation drawings for all equipment and manufacturer's recommended lubricant and spare parts lists.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store to keep material clean and free from damage.

B. Handle to prevent damage during installation and storage.

C. Items to be incorporated into roof construction shall be delivered to job site in sufficient time so as not to hold up construction.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Product and Manufacturer: Provide exhausters as manufactured by one of the following:
   1. Loren Cook Company.
   2. Penn Ventilator Company.
   3. Or equal.

2.2 CENTRIFUGAL ROOF FANS

A. Style: Upblast Centrifugal Roof Fan.

B. Capacity:

Description	EF-2	EF-3	EF-4
1. Area Served:	Toilet	Mech. Room	Chlorinator Room
2. Volume, CFM:	365	260	365
3. Static Pr.:	1/2" WG	1/4" WG	1/2" WG
4. Brake H.P.:	0.10	0.08	0.12
5. Motor Data:	1/6 HP,115v/ 1 phase	1/6 HP,115v/ 1 phase	1/6 HP,115v/ 1 phase

Description	EF-2	EF-3	EF-4
6. Fan Drive:	Direct	Direct	Direct
7. Fan RPM:	1550	1050	1550
8. Motor RPM:	1550	1050	1550

C. Housing:
   1. Main Housing:
      a. Spun aluminum construction reinforced to withstand wind forces without damage.
      b. Waterproof construction for inlet through roof, motor, impeller, drive and wiring.
   2. Motor Housing:
      a. Same material and construction as main housing.
      b. May be portion of main housing.
      c. Weatherproof, ventilated housing baffled to separate motor from air stream unless noted on fan schedule.
      d. Removable for access to motor.
   3. Isolate vibrations of motor and impeller assembly from base and housing with rubber or neoprene cushions.
   4. Wire Raceway: Waterproof construction.
   5. Finish:
      a. Natural brushed aluminum with clear anodized finish.

D. Base:
   1. One piece aluminum construction with molded-in venturi.
   2. Finish and color to match main housing.
   3. Screwed or lagged to curb in manner that allows for easy removal for damper service.

E. Impeller:
   1. Air foil design.
   2. Backward curved.
   3. Non-sparking construction.
   4. Dynamically and statically balanced.
   5. Fabricated of extruded aluminum.
   6. Self-aligning, permanently lubricated impeller shaft ball bearings designed for thrust load. Bearings shall be capable of over 200,000 hours bearing life.

F. Motor:
   1. Type: Single speed.
   2. Enclosure: TEFC.
   3. Horsepower: As shown on Drawings. Motor to be non-overloading at any point on operating curve of exhauster.
   4. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 55 C.
   5. Mounting: Motor to be mounted on adjustable or slotted face plates with rubber or neoprene cushions.
   6. Bearings: Permanently lubricated.
   7. Power Supply: As noted on Drawings.
   8. Motors shall be provided with a service factor of 1.15.
   9. Single phase motors shall be provided with integral overload protection and factory mounted, factory wired power disconnect switch.

G. Drive:
   1. Direct Drive:

2.3 ACCESSORIES

A. Backdraft Dampers:
   1. Gravity operated:
      a. Multiple, interlocked blades.
      b. Felt gasketed blade edges.
      c. Stainless steel or brass bearings.
      d. Tie rod connecting each blade.
      e. Counterweights or adjustable spring attached to tie rods.
      f. Located in roof curb.
      g. Furnished by centrifugal roof fan manufacturer.
      h. Aluminum construction.

B. Bird Screen: Poly-Vinyl chloride coated, metal screen securely anchored to housing at air outlet.

C. Curb Gasket: Self-adhesive rubber gasket cemented to inner edge of curb to provide air and water seal between curb and housing.

D. Base to Curb Fasteners: Cadmium plated lag screws or bolts.

E. Prefabricated Roof Curb:
   1. Weatherproof, continuous welded aluminum construction.
   2. Insulated with 1-1/2 inch minimum rigid board fiberglass.
   3. 45 degrees canted type sides.
   4. Provide treated wood nailer on top of curb with self-adhesive rubber gasket adhered to inner edge of curb to provide air and water seal between curb and curb cap.
   5. Eight inch minimum curb height measured from finished roof to top of wood nailer.
   6. All fasteners shall be cadmium plated.
   7. Furnished by centrifugal roof exhauster manufacturer.
   8. CONTRACTOR to coordinate for roof opening size, curb installation, flashing and reinforcement requirements.

F. Coatings:
   1. Natural brushed aluminum with clear anodized finish.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine curbs to receive fans for:
   1. Level fan mounting surface.
   2. Water tightness.
   3. Proper anchoring and flashing of prefabricated curb to roof deck.
   4. Uneveness, irregularities, and incorrect dimensions that would effect quality and execution of installation.

B. Do not proceed with installation of fan until curbs conform to Specification requirements.

3.2 INSTALLATION

A. Install ventilator and backdraft dampers on roof mounted prefabricated curb in accordance with manufacturer's installation instructions.

B. Anchor to wood nailer on curb with lag screws or bolts.

3.3 TESTING AND ADJUSTING

A. Start unit and observe for excessive noise or vibration.

3.4 CLEANING

A. Remove all debris and waste materials resulting from installation.

B. Clean tar, dirt and marks from exterior of units.

C. Touch up all chips in factory finishes.

+ + END OF SECTION + +

SECTION 15H59

PROPELLER ROOF SUPPLY AIR FAN

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide the propeller roof supply air fans (SF-2) complete with accessories as shown and specified.

B. Related Sections:
   1. Division 1, General Requirements.
   1. Section 7H1, Flashing and Trim.
   2. Section 9L, Painting (specifications for surface preparation and shop painting required under this Section are in Section 15H59).
   3. Section 15H20, Ductwork and Accessories.
   4. Section 15H64, Testing, Adjusting and Balancing of HVAC Systems.
   5. Section 15H65, Automatic Temperature Controls.
   6. Division 16, Electrical.

C. Items Furnished:
   1. Prefabricated Roof Curbs.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have a minimum of 5 years experience in producing substantially similar equipment and shall show evidence of at least 5 installations in satisfactory operation.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
   1. National Fire Protection Association.
   2. Underwriters Laboratories, Incorporated.
   3. National Electric Code.
   4. National Electric Manufacturers Association.
   5. Local and State Building Codes and Ordinances:
      a. Uniform Building Code.
      b. Uniform Mechanical Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Air Moving and Conditioning Association (AMCA) Standard: 210-85 and 300.

D. Source Quality Control: Perform following tests and inspections at factory:
   1. Fan wheels shall be statically and dynamically balanced.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's Literature, illustrations, specifications and engineering data to include the following:
      a. Dimensions.

b. Materials of construction.
c. Mounting details.
d. Performance Data - AMCA approved fan curves, for each model specified.
e. Prefabricated curb details.

2. Drawings showing fabrication methods, assembly, installation details and accessories.

B. Test Reports: Submit the following test certifications for approval.
1. AMCA Label.

C. Operation and Maintenance Manuals: CONTRACTOR shall furnish 6 copies of a hard cover bound operation and maintenance manual prepared by the manufacturer of all items of equipment furnished under this Section and all in conformance with Division 1. The manual shall include maintenance instructions, copies of approved shop and installation drawings for all equiopment and manufacturer's recommended lubricant and spare parts lists.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store to keep material clean and free from damage.

B. Handle to prevent damage during installation and storage.

1.5 JOB CONDITIONS

A. Roof openings and penetrations shall be capped to prevent rain and snow from entering building prior to installation of fan.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Product and Manufacturer: Provide exhausters as manufactured by one of the following:
1. Loren Cook Company, Type AQD.
2. Penn Ventilator Company.
3. Acme Engineering Company.
4. Or equal.

2.2 PROPELLER/AXIAL ROOF SUPPLY FAN (SF-2)

A. Style: Round top. Low profile.

B. Design conditions shall be as indicated on the equipment schedules on the Drawings.

C. Capacity:

Description	SF-2	SF-2
1. Area served:	Screenings Room	RAS Pump Station
2. CFM:	2400	5000
3. Static Pr.:	3/8 inch WG	1/2 inch WG
4. Brake H.P.	0.41 HP	0.97 HP
5. Motor Data:	1/2 HP, 480V/3 phase	1.0 HP, 480 V/3 phase
6. Fan Drive:	Belt	Belt

Description	SF-2	SF-2
7. Fan RPM:	915	805
8. Motor RPM:	1750	1750
9. Remarks:	Explosionproof motor	T.E.F.C. Motor

D. Housing:
1. Main Housing:
   a. Aluminum construction reinforced to withstand wind forces without damage.
   b. Waterproof construction for inlet through roof, motor, impeller, drive and wiring.
   c. Removable for access to motor.
2. Motor Housing:
   a. Same material and construction as main housing.
   b. Weatherproof, ventilated housing baffled to separate motor from air stream unless noted on fan schedule.
3. Isolate vibrations of motor and impeller assembly from base and housing with rubber or neoprene cushions.
4. Wire raceway: Waterproof construction.
5. Finish:
   a. Natural brushed aluminum or aluminum with clear anodized finish.

E. Base:
1. One piece aluminum construction with molded-in venturi.
2. Finish and color to match main housing.
3. Screwed or lagged to curb in manner that allows for easy removal for damper service with stainless steel bolts or screws.

F. Propeller:
1. Air foil design.
2. Aluminum: 6 bladed.
3. Non-sparking construction.
4. Dynamically and statically balanced.
5. Fabricated of extruded aluminum.
6. Self-aligning, permanently lubricated impeller shaft ball bearings designed for thrust load.
7. Factory applied corrosion resistant coating, 8-10 dry mils.
8. Product and Manufacturer: Provide one of the following:
   a. Plasite 7122 Hi-Resistant Protective Coating.
   b. Or equal.

G. Motors:
1. Explosionproof.
2. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, NEC, and ANSI.
3. Motors shall be normal starting torque, normal slip, squirrel cage induction type.
4. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 55 C.
5. Motors shall be provided with a service factor of 1.15.
6. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower.
7. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of fan operation.
8. Locked rotor currents shall be as specified in NEMA standards.
9. Lubrication may be grease or oil type.

10. Overload Protection: Provide integral overload protection on all single phase motors.
11. Disconnects: Provide factory mounted, factory wired unfused disconnects for all single phase motors.

H. Drive:
1. V-belt and adjustable sheaves.

2.3 ACCESSORIES

A. Prefabricated Roof Curb:
1. Weatherproof, continuous welded minimum 14 gage aluminum construction.
2. Insulated with 1-1/2 inch minimum rigid board fiberglass.
3. 45 degree canted type sides.
4. Provide treated wood nailer on top of curb with gasket as per "C" above.
5. Twelve inch minimum curb height measured from finished roof to top of wood nailer.
6. Curb to Roof Deck Fasteners: Type 316 stainless steel lag screws and bolts.
7. Refer to architectural Drawings for curb flashing details.
8. Contractor shall furnish prefabricated roof curbs from the same manufacturer as for the roof fan.

B. Bird Screen: Expanded aluminum bird guard with frame, 85 percent free area minimum, easily removable for cleaning.

C. Curb Gasket: Self-adhesive rubber gasket cemented to inner edge of curb to provide air and water seal between curb and housing.

D. Base to Curb Fasteners: Stainless steel lag screws or stainless steel bolts.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine curbs to receive fan for:
1. Level fan mounting surface.
2. Water tightness.
3. Proper anchoring of fan to roof curb.
4. Unevenness, irregularities, and incorrect dimensions that would effect quality and execution of installation.

B. Do not proceed with installation of supply fan until curbs conform to Specification requirements.

3.2 INSTALLATION

A. Install supply fan in accordance with manufacturer's installation instructions.

B. Anchor to wood nailer on curb with lag screws or bolts.

3.3 TESTING AND ADJUSTING

A. Start unit and observe for excessive noise or vibration.

B. Adjust fan sheaves for proper fan speed.

C. Adjust belt tension.

3.4 CLEANING

A. Remove all debris and waste materials resulting from installation.

B. Clean tar, dirt and marks from exterior of units.

C. Touch up all chips in factory finishes.

+ + END OF SECTION + +

SECTION 15H60

AIR INTAKES AND RELIEF VENTS - ALUMINUM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install gravity roof intake and relief air vents (RV-1 and RV-2) complete with accessories for proper operation and to comply with the requirements as shown and specified.

B. Related Sections:
   1. Division 1, General Requirements.
   2. Section 15H20, Ductwork and Accessories.
   3. Section 15H65, Testing, Adjusting and Balancing.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction:
   1. Local and State Building Codes and Ordinances.
      a. Uniform Building Code.
      b. Uniform Mechanical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, specifications, and engineering data to include the following:
      a. Dimensions.
      b. Materials of construction.
      c. Details of installation.
      d. Prefabricated curb details.
   2. Drawings showing fabrication methods, assembly, installation details and accessories.

B. Operation and Maintenance Data: Submit complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information, all in conformance with Division 1.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store to keep material clean and free from damage.

B. Handle to prevent damage during installation and storage.

C. Items to be incorporated into roof construction shall be delivered to job site in sufficient time so as not to hold up construction.

1.5 JOB CONDITIONS

A. Roof openings and penetrations shall be capped to prevent rain and snow from entering building prior to installation of air intakes or relief vents.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Manufacturer: Provide product(s) of one of the following:
   1. Loren Cook Company, Type PR (Relief Air) and Type TR (Intake Air).
   2. Penn Ventilator Company.
   3. Or equal.

2.2 AIR INTAKES AND RELIEF VENTS

A. Type: Low contour, round hood.

B. Capacity:

	RV-1 - Relief Air Vent	RV-2 - Intake Air Vent
1. Throat Size:	16" x 16½"	30-3/4" x 30-3/4"
2. Throat Area:	1.5 square feet	6.25 square feet
3. Air Volume:	1360 CFM	3250 CFM
4. Roof Opening:	22½" x 22½"	36½" x 36½"
5. Damper Type:	Gravity	Motor operated (MD-3)

C. Housing:
   1. Spun aluminum construction reinforced to withstand wind forces without damage.
   2. Housings for intake and relief units shall be of similar shape and style and shall match centrifugal roof fans in appearance.
   3. Finish:
      a. Natural brushed aluminum or aluminum with clear anodized finish.

D. Base:
   1. One-piece spun aluminum or welded aluminum construction.
   2. Finish and color to match housing.
   3. Screwed or lagged to curb in manner that allows for easy removal for damper service.

2.3 ACCESSORIES

A. Backdraft Dampers:
   1. Gravity operated:
      a. Multiple, interlocked blades.
      b. Felt gasketed blade edges.
      c. Stainless steel or brass bearings.
      d. Tie rod connecting each blade.
      e. Counterweights or adjustable spring attached to tie rods.
      f. Located in roof curb.
      g. Furnished by same manufacturer as air intake and relief vents.
   2. Motor Operated:
      a. As specified for gravity operated dampers except adjustable spring or counterweight not required.
      b. Motor and linkage provided by air intake and relief vent manufacturer.

B. Bird Screen: 1/2-inch (13 mm) mesh, poly-vinyl chloride coated, metal screen securely anchored to housing at air outlet.

C. Curb Gasket: Self-adhesive rubber gasket adhered to inner edge of curb to provide air and water seal between curb and housing.

D. Base to Curb Fasteners: Cadmium plated lag screws or cadmium plated bolts.

E. Prefabricated Roof Curb:
   1. Weatherproof, continuous welded galvanized steel construction.
   2. Insulated with 1-1/2 inch minimum rigid board fiberglass.
   3. 45 degrees canted type sides.
   4. Provide treated wood nailer on top of curb with gasket as per "C" above.
   5. Eight inch minimum curb height - measured from finished roof to top of wood nailer.
   6. Curb to Roof Deck Fasteners: Cadmium plated lag screws or cadmium plated bolts.
   7. CONTRACTOR to coordinate for curb installation, roof openings, flashing and reinforcement requirements.
   8. Curb shall be furnished by air intake or relief vent manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine curbs to receive air intake and relief vent for:
   1. Horizontal mounting surface.
   2. Water tightness.
   3. Proper anchoring and flushing of prefabricated curb to roof deck.
   4. Unevenness, irregularities, and incorrect dimensions that would affect quality and execution of installation.

B. Do not proceed with installation of air intake and relief vents until curbs conform to Specification requirements.

3.2 INSTALLATION

A. Install roof vents in accordance with manufacturer's installation instructions. CONTRACTOR to coordinate for roof penetration, curb and vent installation, flashing and reinforcement requirements.

B. Anchor to wood nailer on curb with lag screws or bolts.

3.3 CLEANING

A. Remove all debris and waste materials resulting from installation.

B. Clean tar, dirt and marks from exterior of units.

C. Touch up all chips in factory finishes.

+ + END OF SECTION + +

SECTION 15H64

AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals to furnish and install an electric/electronic system of automatic temperature controls complete with all appurtenances required for proper operation and to comply with requirements as shown and specified.

B. General:
1. Descriptions contained hereinafter are for guidance and to show the functions desired. They do not describe or specify all components required to interface equipment. All parts and equipment necessary to meet functional requirements shall be provided.
2. The control system manufacturer shall be completely responsible for the proper operation and functions of all control systems herein specified. He shall be responsible for coordination of all interfaces with other contractors to achieve the required control operation.

C. Related Sections:
1. Division 1, General Requirements.
2. Section 10C, Louvers.
3. Section 11L1, Chlorination Equipment (for chlorine leak detector).
4. Section 30, Unit Heaters - Electric.
5. Section 37, Air Handling Units.
6. Section 15H38, Air Cooled Condensing Unit - Split System Air Conditioning.
7. Section 15H41, Packaged Air Conditioning Units - Single Zone.
8. Section 15H51, Centrifugal In-Line Fans.
9. Section 15H57, Centrifugal Roof Fans - Aluminum.
10. Section 15H65, Testing, Adjusting and Balancing.
11. Section 15H67, Odor Control System.
12. Division 16, Electrical.

D. Items Furnished Under this Section:
1. Thermostats, remote bulb sensors, reset controllers.
2. Smoke detectors, firestats.
3. Transformers, if required.
4. ATC panel mounted relays with necessary contacts.
5. Motorized dampers, actuators for motorized louvers and dampers.
6. Enthalpy controllers.
7. Minimum position switches.
8. Smoke alarms.
9. Control Panels.
10. Control panel mounted H-O-A switches, relays, pilot lights, bells.
11. Starters for air cooled condensing units.

E. Items Furnished Under Other Sections:
   1. All 480 and 120 volts wiring and conduit (Division 16).
   2. Starters except where specified (Division 16).
   3. Hand-Off-Auto switches, pushbuttons, stop-start buttons except those located on ATC-1 panel and AHU-2 control panel (Division 16).
   4. All interlock field wiring, and conduit from ATC-1 panel to all remote located devices (Division 16).
   5. Louvers (Section 10C).
   6. Chlorine leak detectors (Section 11L1).
   7. All field wiring and conduit to thermostats, firestats, smoke detectors, enthalpy controllers, ATC panels, smoke alarms motorized dampers and louvers, unit heaters, electric heaters fans, air handling units air cooled condensing units, wall mounted fan control switches is under Division 16.

1.2 QUALITY ASSURANCE

A. Standards of Workmanship: All materials, equipment and installation shall be in strict accordance with requirements of Division 16, Electrical.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
   1. Underwriters Laboratories, Incorporated.
   2. National Fire Protection Association.
   3. Local and State Building Codes and Ordinances.
      a. Uniform Building Code Congress International.
      b. Uniform Mechanical Code.
      c. Model Energy Code.

C. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. National Electric Code.
   2. Standards of National Electric Manufacturers Association.
   3. Institute of Electrical and Electronic Engineers.
   4. Instrument Society of America.

D. Required Manufacturers' Services:
   1. Furnish a qualified representative of the manufacturer to supervise or perform the following services:
      a. Installation of the various control systems specified under this Section.
      b. Initial startup of the various systems.
      c. Placing the systems in fully automatic operation.
      d. Final testing of the control systems.

1.3 SUBMITTALS

A. Submit Shop Drawings showing the following:
   1. All items and accessories of equipment furnished under this Section.
   2. Wiring diagrams and schematics.
   3. Manufacturer's literature, illustrations, Specifications and engineering data.
   4. Sequence of operation description.
   5. Damper test reports.
   6. Graphics and wiring schematics for control panels.

B. Operation and Maintenance Data: CONTRACTOR shall furnish in accordance with the requirements of Division 1, six copies of operation and maintenance manual prepared by themanufacturers of all items of equipment furnished under this Section. The manual shall include maintenance instructions, copies of approved shop and installation drawings for all equipment and manufacturer's recommended lubricant and spare parts lists.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Products and Manufacturers: Provide one of the following:
   1. Barber-Coleman Company.
   2. Johnson Service Company.
   3. Honeywell.
   4. Or equal.

2.2 THERMOSTATS, SENSORS AND CONTROLLERS

A. Type: Across the line (120 volts, single phase AC).
   1. Heavy duty type. Two position room thermostat.
   2. Integral thermometers.
   3. Adjustable set points.
   4. Contacts shall have proper ampere rating for intended use.
   5. With locking cover, plastic guard.
   6. Thermostat Range:
      a. Heating: 45 to 75 F.
      b. Cooling: 75 F to 105 F.

B. Type: High Limit Thermostats - Firestats:
   1. Manual reset limit control.
   2. Remote bulb.
   3. Single pole double throw mercury switch.
   4. Range: 100 to 170 F, set at 130 F.
   5. 120 volt, 1 phase, 60 Hertz, AC.
   6. Immersion well.

C. Type: With integral timeclock and night set-back.
   1. Line voltage or low voltage.
   2. Clock and thermostat displayed externally.
   3. Adjustable set points.
   4. Provide 120V/24V transformers, relays, etc. required to interface with other system components.
   5. With locking cover.

D. Type: Across the line bulb thermostat (for summer/winter changeover).
   1. Set Point Range: -40 F to 140 F, set point fixed at 70F.
   2. Six foot long copper capillary.
   3. Bulb: Copper.
   4. 120 volts AC, proportional action, SPDT snap acting switch.

E. Type: Multi-Stage Thermostats (For Electric Heaters EHC-1):
   1. Line voltage, 120 volts, single-phase, 60 Hertzes, A.C.
   2. Integral thermometer.
   3. Adjustable set point.

4. Contacts shall have proper ampere rating for intended use.
5. 2 F differential between stages.
6. Protective thermostat case.
7. Range 40 to 80 F.

2.3 TIME CLOCKS

A. Programmable single circuit time control.

B. The solid state 7-day time based control shall have the capability of being independently programmed for each day of the week.

C. Keyboard shall provide access to all programming, program review and circuit override.

D. LED display shall display time of day with one minute resolution, day and circuit status.

E. The unit shall have 24 memory addresses (on or off) allowing 168 switching events.

F. Power Input: 120 Vac, 60 Hz.

G. Power Output: 1 SPDT relay. Contacts shall have proper ampere rating for intended use. Voltage shall be as required by controlled device.

H. Power Outage Battery Carryover:
   1. Nickel-cadmium.
   2. 48 hour carryover of time and program.

I. Time clock circuit isolation relay.

J. Manufacturer:
   1. EC71 Electronic Time Control by AMF Paragon with locking cover.
   2. Or equal.

K. All time clocks shall be located locally in the room served by the system controlled. Each time clock shall have a nameplate indicating the system controlled.

2.4 SMOKE DETECTORS

A. Duct Mounted:
   1. Ionization type for 120 Vac operation.
   2. Cross sectional sampling tube.
   3. Two sets of alarm operated auxiliary contacts SPDT.
   4. Contact rating 10 amp, 120 Vac.
   5. UL approved.
   6. Product and Manufacturer:
      a. Fire-Lite Alarms Incorporated, DH-20 duct detector housing with Fire-lite smoke detector head and AC wiring kit.
      b. Gamewell Model 69433.
      c. Or equal.

B. Surface Mounted:
   1. Ionization type.
   2. Adjustable sensitivity.

3. Auxiliary Relay: 120 Vac, 1 ampere, 2 sets of contacts.
4. In accordance with NFPA Standard No. 90A. 120 Vac wiring kit.
5. With all mounting accessories.
6. Product and Manufacturer:
   a. Ademco, Model 590D.
   b. Fire-Lite Alarms, Incorporated.
   c. Or equal.

2.5 AUTOMATIC MOTORIZED DAMPERS

A. Reinforced Opposed Blade Type:
1. Reference: SMACNA Standards.
2. Construction:
   a. Frame: 13 gauge steel. (Aluminum when located in aluminum duct). Thickness of aluminum frame to be minimum 1/8 inch.
   b. Blades: 16 gauge steel, galvanized. (Aluminum when located in aluminum duct). Thickness of aluminum blades to be minimum 0.084 inch.
   c. Blade Shafts: 1/2-inch cadmium plated steel.
3. Provide inflateable neoprene rubber blade edge seals for air tight damper closure.
4. Blade ends shall be sealed with spring stainless steel continuous strips fastened to frame.
5. Bearings: Oil impregnated bronze bearings at each end of shaft.
6. Blade design shall be designed for minimal resistance to air flow.

2.6 ACTUATORS - LOUVERS, DAMPERS

A. Type: Electric, spring return, two position (LM-1 and LM-2, MD-3).
1. Oil immersed gear train.
2. Line voltage or unit mounted low voltage control transformer.
3. Mechanical spring shall return actuator to normal position when de-energized.
4. Sufficient torque to operate louver, furnished.
5. Two position.
6. Internal heater for outdoor locations only.
7. Louver, linkage kit.
8. 120 volts, AC. Provide 120V/24V control transformers where required.

B. Type: Electric, Reversible, Proportional: MD-1A, MD-1B, MD-1C (AHU-1 System).
1. OIl immersed gear train.
2. Line voltage or unit mounted low voltage control transformer.
3. Electronic drive.
4. Sufficient torque to operate, damper furnished.
5. Adjustable drive start point.
6. Upon power interruption actuator shall spring return to normal position.
7. Damper, linkage kit.
8. 120 volts, AC, provide 120V/24V control transformers where required.
9. MD-2A and MD-2B: Outside and return air damper for AHU-2 system are furnished under Section 15H41.

2.7 ENTHALPY CONTROLLERS

A. Enthalpy Controller:
   1. Permits use of outdoor air based on temperatures and humidity sensors in outdoor air stream. (For Air Handling systems).
   2. Controls outdoor air damper, closes cooling valve.
   3. Mounting plate and wiring compartment.
   4. Humidity Sensing Element: Thin nylon ribbon.
   5. Temperature Sensing Element: Liquid filled bulb.
   6. Switching Action: Single pole, double throw, 120 volts, single phase.
   7. Humidity Control Range: 10 to 80 percent.
   8. Factory set at 73 F and 50 percent relative humidity.
   9. Dial Settings: A, B, C and D set temperature based on relative humidity.

2.8 SMOKE ALARM (SA-1)

A. Sounding bell and flashing light with alarm silencing button.

B. Wall mounted, with label "SMOKE ALARM" in 1-1/2" letters.

C. 120 Volts, single phase, 60 hertz, heavy duty construction, UL Listed.

D. Provision to accept wiring from remote HVAC control panels.

E. Manufacturer and Products:
   1. Bell: Pyrotronics, Model BAC-6 or equal.
   2. Light: Pyrotronics, Model V-33 or equal.

2.9 RELAYS, PUSHBUTTONS, SELECTOR SWITCHES, PILOT LIGHTS, INDICATING LIGHTS, TIMERS

A. Relays, pushbuttons, selector switches, pilot lights, indicating lights and start/stop switches, timers shall be in accordance with the requirements specified in Division 16, Electrical.

2.10 MINIMUM POSITION SWITCH

A. Type: Manual potentiometer.
   1. Potentiometer assembly.
   2. Dial: 0 percent to 100 percent.
   3. Adjustment knob.
   4. Range: 0 percent to 100 percent minimum position.
   5. 120 volts, single phase.

2.12 AUTOMATIC TEMPERATURE CONTROL PANELS FOR HVAC EQUIPMENT (ATC)

A. Furnish one centralized automatic temperature control panel (ATC-1) at the locations indicated on the Drawings. Furnish ATC control panel air handling units, electric duct heaters, condensing unit, fans, smoke detectors, thermostats, smoke alarm and relays, for mounting of all temperature control items as required, including but not limited to, system running and fail lights for each supply, return/ exhaust fans, and condensing units, H-O-A switches, motor fail light for each equipment, common smoke alarm, relays, auxiliary dry contacts for interlocking with remote devices. Provide a "Press to Test" button for all the panel lights.

g. During winter or heating season:
   1) Supply fan SF-1, EF-1, EF-2 shall operate.
   2) Multi-stage Room thermostat T-1C, shall control stages of EDH-1 to maintain room temperature to set point.
h. During unoccupied periods, a room thermostat T-1E shall cycle the supply fan to maintain its setting. Night set-back (unoccupied) thermostat T-1E shall override room thermostats T-1C and T-1D to reduce energy cost during heating and cooling.
i. Smoke detector SD-1A, shall stop SF-1, and EF-1, EF-2 and provide an audiovisual alarm at ATC panel if any of the smoke detectors senses products of combustion in room air. At ATC panel (ATC-1), auxiliary contacts shall be provided for a common remote fire alarm at the fire alarm panel.
j. A common remote smoke/fire warning alarm (SA-1) consisting of a light and bell shall be provided at the location indicated on the plans. Electrical CONTRACTOR shall field wire to this alarm panel (SA-1) from the ATC panel (ATC-1) as required.

2. AHU-2 System: Rooftop Air Conditioning Unit Electrical Room:
   a. Refer to specification Section 15H41.

C. Exhaust Fans:
1. EF-3 (Mechanical Room):
   a. Fan shall be operated by a wall mounted HOA switch with pilot light and a room thermostat.
   b. In'auto' position, fan shall be controlled by a room thermostat (set at 80 F, adjustable).
   c. Motorized louver LM-1 shall be interlocked with fan, so that louver shall be open when fan is operting.
2. EF-4 (Chlorinator Room):
   a. Fan shall be oprated by a wall mounted HOA switch with pilot light and a room thermostat.
   b. In 'auto' position, fan shall be controlled by a room thermostat (set at 80 F, adjustable).
   c. Motorized louver LM-2 shall be interlocked with fan, so that louvers shall be open when fan operates.
3. EF-5 (Chlorine Room):
   a. Fan shall be operated by either of two HOA switches (S-1 and S-2) with pilot lights located outside room and a room thermostat as shown on the Drawings.
   b. In "auto" position, fan shall operate with thermostat control.
   c. Motorized damper MD-3 located at roof intake vent RV-2 shall be interlocked with EF-5, so that MD-3 shall be open when EF-5 starts.
   d. Fan shall be interlocked with chlorine leak detector to shut down upon activation of the chlorine leak detector.
   e. H-O-A switch is furnished under Division 16.
   f. All field wiring and conduit is under Division 16.
   g. Chlorine leak detector is specified in Section 11L1.
   h. Smoke detector SD-3 shall stop EF-5 if products of combustion are present in room air.

D. Electric Unit Heaters:
1. Units shall have factory installed unit mounted thermostats as described in Section 15H30.

3.3 ADJUSTMENT AND TESTING

A. Adjust all system components for specified operation.

B. Test each control system for proper operation.

+ + END OF SECTION + +

SECTION 15H65

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Furnish all labor, materials, equipment and incidentals required to perform the testing, balancing and adjusting herein specified for proper operation of HVAC systems.

B. Related Sections:
1. Section 15H18, Refrigerant Piping Systems.
2. Section 15H20, Ductwork and Accessories.
3. Section 15H30, Unit Heaters - Electric.
4. Section 15H37, Air Handling Units.
5. Section 15H38, Air Cooled Condensing Unit-Split System Air Conditioning.
6. Section 15H41, Packaged Rooftop Air Conditioning Units - Single Zone.
7. Section 15H51, Centrifugal In-Line Fans.
8. Section 15H57, Centrifugal Roof Fans - Aluminum.
9. Section 15H64, Automatic Temperature Controls.
10. Section 15H67, Odor Control System.
11. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Balancers Qualifications:
1. Submit biographical data on employee proposed to directly supervise the testing, balancing and adjusting work.
2. Biographical data on employee shall include proof of registration as Professional Engineer in the State of Airzona and/or certification by the National Environmental Balancing Bureau (NEBB).

1.3 SUBMITTALS

A. Data Sheets:
1. Submit samples of data sheets on each item of equipment for review.
2. Submit data sheets on each item of testing equipment required.
3. Include name of device, manufacturer's name, model number, latest date of calibration, and correction factors.

B. Report Forms:
1. Submit specimen copies of report forms.
2. Forms shall be 8-1/2 by 11-inch paper for looseleaf binding, with blanks for listing of the required test ratings and for certification of report.
3. Reports shall be on the organizations approved forms imprinted with the company's name.
4. Certified report outlining procedure used to balance the system and the types of measuring devices used.

C. Valve Tags: Submit sample of valve tag with sample identification lettering.

D. Fill in test results on approved forms.

E. Submit three certified copies of required test reports to the Engineer for review.

1.4 JOB CONDITIONS

A. Heating and ventilating equipment shall be completely installed and in continuous operation as required to accomplish the test, adjust and balance work specified.

B. Test, adjust and balance shall be performed when outside conditions approximate design conditions indicated for heating and cooling functions.
   1. Design Conditions:
      a. Indoor:
         1) Chlorine Room: 60°F - Winter.
         2) Administration Building: 68°F - Winter and 80°F - Summer.
      b. Outdoor: 33°F - Winter and 109°FDB/78°FWB - Summer.

1.5 OPERATING INSTRUCTIONS

A. Reports shall be certified by the testing engineer that the methods used and the results achieved are as specified.

1.6 CORRECTIVE ADJUSTMENTS

A. Should corrective measures caused by faulty installation require retesting, adjusting and balancing, such work shall be at no additional expense to the OWNER.

B. Inspections:
   1. Fan Belt Deflection: No less than 1/4-inch or more than a 1/2-inch.
   2. Touch-Up Painting: Examine all equipment and touch-up all scratches, chips or otherwise marred factory finishes.

PART 2 - INSTRUMENTS

2.1 AIR BALANCE INSTRUMENTS

A. Provide all velometers, anemometers, pitot tubes, differential air pressure gages, manometers, hook gages, static pressure probe units, etc. as may be required to perform all air balance tests of HVAC equipment, ducts, registers, etc.

2.2 SYSTEM PERFORMANCE MEASURING INSTRUMENTS

A. Provide insertion thermometers, sling psychrometers, tachometers, revolution counters, clamp-on volt-ammeter recorders, and other instruments as required to measure all facets of the complete HVAC system performance.

2.3 VALVE TAGS

A. Manufacturer: Provide tags as made by one of the following:
   1. Seton Name Plate Corporation.
   2. New York Stencil Works.
   3. Or equal.

B. Construction:
   1. Material: Brass.
   2. Size: 1/2-inch diameter.
   3. Chain: Brass.
   4. Lettering Size: 1/4-inch black filled letters over 1-1/2-inch black filled numbers.

C. Legend: Valve tag identification shall be as follows:
   1. RL - Refrigerant Liquid line.
   2. RS - Refrigerant Suction line.

PART 3 - EXECUTION

3.1 INSPECTION

A. Pre-Startup Inspection:
   1. Verify proper equipment mounting and setting.
   2. Verify that control, interlock and power wiring is complete.
   3. Verify alignment of motors and drives.
   4. Verify proper piping connections and accessories.
   5. Verify that lubrication is completed.

B. First Run Observations:
   1. Verify direction of rotation.
   2. Verify setting of safety controls.
   3. Monitor heat build up in bearings.
   4. Check motor loads against nameplate data.

C. Equipment Check:
   1. Verify proper overload heater sizes.
   2. Verify function of safety and operating controls.
   3. Verify proper operation of equipment.
   4. Report on inspection, observation and checking procedures.

3.2 AIR SYSTEMS

A. Test, adjust and balance systems in accord with the SMACNA "HVAC Systems - Testing, Adjusting and Balancing" manual.

B. Preliminary:
   1. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.

C. Central Systems:
   1. Test rpm for all equipment, including adjust each fan, and air handling unit, to design requirements within the limits of mechanical equipment provided.

2. Test and record motor voltages and running amperes including motor nameplate data, and starter heater ratings for each unit as listed above.
3. Make pitot tube traverse of main supply, exhaust and return ducts, determine cfm at all fans and units and adjust fans and units to within 5 percent of design requirements.
4. Test and record system static pressure, suction and discharge.
5. Test and adjust system for design outside air, cfm.
6. Record all fan and air handling unit speeds.
7. Record air quantity delivered by each fan and air handling unit.

D. Distribution:
1. Adjust zones or branch ducts in proper design cfm, supply and return.

E. Air Terminals:
1. Identify each air terminal from reports as to location and determine required flow reading.
2. Test and adjust each air terminal to within 10 percent of design requirements.
3. Test procedure on air terminals shall include recording comparison of required fpm velocity and observed velocity, adjustment of terminal, and recording comparison of required cfm and observed cfm after adjustment.
4. Adjust flow patterns from air terminal units to minimize drafts to extent design and equipment permits.

F. Verification:
1. Prepare summation of readings of observed cfm for each system, compare with required cfm, and verify that duct losses are within specified allowable range.
2. Verify design cfm at fans as described above.
3. If the air systems are not properly balanced, the Contractor shall rebalance and recheck all data in the presence of the Engineer and as approved by them.

3.3 AUTOMATIC CONTROL SYSTEM

A. In cooperation with the control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

B. Testing organization shall verify all controls for proper calibration and list those controls requiring adjustment by control system installer.

3.4 REFRIGERANT PIPING SYSTEMS

A. Test piping systems as specified in Section 15H18.

3.5 MAINTENANCE AND REPAIR

A. Maintenance and Repair:
1. Provide all labor, tools and equipment to provide a preventive maintenance program and make repairs for all equipment and con-

trols for a one year period after final acceptance by the OWNER. CONTRACTOR shall provide the following services for the same period of one year:

a. Receive calls for all problems and take steps to immediately correct deficiencies which may exist.
b. Provide a quarterly inspection of all equipment, and record the findings on a check list hereinafter specified.
c. Provide a preventive maintenance schedule for the principle items of equipment.

B. Check List:

1. Provide a check list and post a copy of it where directed by the OWNER.
2. Include each piece of equipment specified or shown.
3. Provide 2 columns for required semi-annual inspections.
4. Provide columns for the following:
   a. Equipment condition.
   b. Equipment operation.
   c. Equipment lubrication.
   d. Preventive maintenance.

Preventive maintenance shall be performed in accordance with the manufacturer's recommendations and accepted practice.

3.6 CONTRACTOR'S INSTRUCTIONS

A. CONTRACTOR shall provide the necessary skilled labor and helpers for operating all the systems and equipment at the appropriate season for the respective piece of equipment to conduct an instruction period of not less than one 8-hour day for the plant operators designated by the OWNER. They shall be instructed fully in the operations, adjustment and maintenance of all equipment and controls. At least 48 hours, excluding Saturdays, Sundays and holidays, advance notice shall be provided prior to instruction period. Informal or unwitnessed instructions or instructions to nondesignated personnel will not be recognized.

+ + END OF SECTION + +

SECTION 15H67

ODOR CONTROL SYSTEMS, SCRUBBERS AND ADSORBERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, equipment, materials, and incidentals to furnish, check, install, calibrate, test, document, start-up, and place in satisfactory operation odor control systems, complete with wet crossflow scrubber, two carbon adsorbers and all appurtenances as shown, specified and required for proper operation, in accordance with this Specification and with the Drawings included with this Specification.

B. General:
1. Descriptions contained hereinafter are for guidance and to show the functions desired. They do not describe or specify all components to interface equipment. All parts and equipment necessary to meet functional requirements shall be provided.
2. CONTRACTOR shall be completely responsible for the proper operation and functions of the odor control systems herein specified. CONTRACTOR shall be responsible for coordination of all interfaces with other contractors to achieve the required odor control system operation.
3. The wet crossflow scrubber shall use chlorinated water as the oxidizing agent and sodium hydroxide solution to increase the solubility of hydrogen sulfide.
4. The carbon towers shall use IVP carbon as the adsorption medium.
5. Some equipment will require modification from the standard to meet the Specifications.
6. When two or more units of equipment for same purpose are required they shall be the product of one manufacturer.
7. All fasteners (nuts, bolts and washers) used for odor control system shall be Type 316 stainless steel except for fasteners in direct contact with chlorinated water shall be Hastelloy-C.
8. For valves specified under this Section refer to Section 15D.
9. A single 30 ampere, 480 volt, 3 phase electrical service and a service disconnect switch will be provided for odor control system under Division 16. All additional electrical requirements including single phase motor starters and control and instrumentation of the equipment being supplied as part of the odor control system shall be provided by the CONTRACTOR as part of this Section. Electrical equipment and materials shall conform to the applicable sections of Division 16.
10. The screen room and the sewage lift station wet well shall be considered NEMA Class I, Division 1, Group D hazardous areas, additionally, areas shall also be considered a corrosive areas due to hydrogen sulfide gas present in the areas.
11. All components of odor control system shall be factory prime coated unless otherwise specified.

C. Related Sections:
1. Section 3D, Cast-In-Place Concrete.

2. Section 5G, Anchor Bolts, Expansion Anchors, Fasteners and Concrete Inserts.
3. Section 9L, Painting. (Specifications for Surface preparation and shop painting required under this Section are in Section 09900.)
4. Section 15A2, Exposed Piping Installation.
5. Section 15A9, Polyvinyl Chloride (PVC) Pipe Chlorinated Polyvinyl Chloride (CPVC) Pipe.
6. Section 15C3, Pipe Hangers and Supports.
7. Section 15C4, Wall Pipes, Floor Pipes and Pipe Sleeves.
8. Division 16, Electrical.
9. Section 15H47, Vibration Isolation.
10. Section 15H64, Automatic Temperature Controls.
11. Section 15H65, Testing, Adjusting and Balancing of HVAC Systems.

D. Items furnished under this Section shall include but not be limited to the following:
1. Packed tower horizontal crossflow, packed bed scrubber.
2. Scrubber stacks, FRP transitions and accessories.
3. Chemical feed system including chemical storage tank, chemical feed pumps and accessories.
4. Recirculation pumps.
5. Crossflow scrubber fan.
6. Carbon adsorber fans.
7. Flexible connections and expansion joints.
8. All required gauges and monitoring devices.
9. All motors.
10. Motor starter equipment.
11. Odor control system control panel.
12. Painting.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have at least 5 years experience in the production of substantially similar equipment, and shall show evidence of at least 5 installations in satisfactory operation.

B. Manufacturer shall have the facility to run a full scale factory test with all equipment connected and functioning as an odor control system complete with fans, pumps, chemical tanks, instrumentation connected and functioning as per the design parameters specified herein and is shown on the Drawings.

C. Products used in the Work of this Section shall be produced by Manufacturers regularly engaged in the production of such items and have a successful history of product acceptability, as interpreted by ENGINEER.

D. It is the intent of these Specifications to install equipment, including drives, of heavy-duty construction, operating with a minimum of maintenance for continuous and intermittent service, whichever imposes the severest service on the equipment. Equipment of less quality and inferior design to that specified herein shall not be considered acceptable.

E. It is intended that all the Work of this Section be furnished by a single supplier who acting through the CONTRACTOR shall provide a complete system. The sole responsibility for proper operation of the odor control system shall rest with CONTRACTOR.

F. Listing, labeling or marking, as conforming to the Standards of Underwriter's Laboratories, Inc., American National Standards Institute, Inc., United States Bureau of Mines, or other nationally recognized testing organization approved by Code, on various pieces of equipment furnished shall be prima facie evidence of conformity with the approved standards for safety to life and property.

G. Materials Testing: Material employed in items fabricated of fiberglass reinforced plastic shall be capable of withstanding maximum calculated stresses that may occur during fabrication, installation and continuous operation, with allowance for an adequate safety factor. To confirm materials properties, tests shall be conducted by an independent, qualified testing laboratory on representative material samples in accordance with the following latest revision of ASTM standards:
   1. ASTM C 581, Determining Chemical Resistance of Thermosetting Resins used in Glass Fiber Reinforced Structures Intended for Liquid Service.
   2. ASTM C 582, Contact-Molded Reinforced Thermosetting Plastic Laminates for Corrosion Resistant Equipment.
   3. ASTM D 638, Test for Tensile Properties of Plastics.
   4. ASTM D 695, Test for Compressive Properties of Rigid Plastics.
   5. ASTM D 746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   6. ASTM D 790, Test for Flexural Properties of Plastic.
   7. ASTM D 883, Standard Nomenclature Relating to Plastics.
   8. ASTM D 1505 Test Method for Density of Plastics by the Density Gradient Technique.
   9. ASTM D 1693 Test Method for Environmental Stress Cracking of Ethylene Plastics.
   10. ASTM D 2310, Machine Made Reinforced Thermosetting Resin Pipe.
   11. ASTM D 2563, Classifying Visual Defects in Glass Reinforced Laminate Parts.
   12. ASTM D 2583, Test for Indentation Hardness of Plastics by Means of a Barcol Impressor.
   13. ASTM D 2996, Filament Wound, Reinforced Thermosetting Resin Pipe.
   14. ASTM D 3299, Filament-Wound Glass Fiber Reinforced Polyester Chemical Resistant Tanks
   15. ASTM D 4097, Contact Molded Fiber Reinforced Thermoset Chemical Resistant Tanks.
   16. NBS Voluntary Product Standard PS15-69 Custom Contact Molded Reinforced-Polyester Chemical-Resistant Process Equipment.

   Test results shall be submitted for the review and approval of the ENGINEER prior to manufacturer of fiberglass reinforced plastic items.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. CONTRACTOR shall submit for review to ENGINEER, sufficient literature, detailed specifications, and drawings to show dimensions, make, style, speed, size, type, horsepower, service factors, efficiency, materials used, design features, internal construction, weights, and any other information required by ENGINEER for review

of all odor control equipment. No odor control equipment will be accepted, and installation will not be allowed until such review has been completed.

2. Shop drawings submitted for review shall include electrical interconnection diagrams, schematic control diagrams, and a detailed written description of how control system is to function.
3. Additional requirements for information to be included with shop drawings are specified below:
   a. Shop Drawings for the horizontal crossflow packed chemical scrubbers shall include as a minimum the following:
      1) Dimensions of scrubbers including internal and external fittings, pipe and duct connections and appurtenances.
      2) Resin and material used.
      3) Service Conditions: Chemical environment and temperature.
      4) Statement that fabrication shall be in accordance with these Specifications.
      5) A statement from the manufacturer that the materials and resin used are suitable for the intended service.
      6) Total operating weight of scrubbers and fittings.
      7) Description of fabrication.
      8) Dimensions of nozzles and nozzle pattern showing details of construction and attachment to scrubber.
      9) Details of packing supports.
      10) Complete, detailed instructions on the installation of the scrubbers, which reference specifically the methods for these installations.
      11) Spray nozzle header piping and support details.
      12) Spray nozzle data, pressure drop, coverage, flow rate, dispersion angle.
      13) Specification of scrubber laminate construction.
      14) Description of surface preparation and primer paint as specified in this Section.
      15) Tabulation in checklist form to indicate compliance with ASTM D 2563 Table 1 Acceptance Levels.
      16) Inlet and outlet connection bolt hole pattern.
   b. Shop Drawings for the carbon adsorption towers shall include as a minimum the following:
      1) Dimensions of scrubbers including internal and external fittings, pipe and duct connections and appurtenances.
      2) Resin and material used.
      3) Service Conditions: Chemical environment and temperature.
      4) Statement that fabrication shall be in accordance with these Specifications.
      5) A statement from the manufacturer that the materials and resin used are suitable for the intended service.
      6) Total operating weight of adsorption tower filled with caustic and fittings.
      7) Description of fabrication.
      8) Details of carbon supports.
      9) Complete, detailed instructions on the installation of the adsorption, which reference specifically the methods for towers these installations.
      10) Data sheets for activated IVP carbon to be used for adsorption.
      11) Specifications of scrubber laminate construction.
      12) Description of surface preparation and primer paint as specified in this Section.

13) Tabulation in checklist form to indicate compliance with ASTM D 2564 Table 1 Acceptance Levels.

c. Submittals for each chemical feed pump shall include as a minimum the following:
   1) Manufacturer's certified rating data.
   2) Certified shop drawings showing all important details of construction, dimensions, and anchor bolt locations.
   3) Descriptive literature, bulletins, and/or catalogs of the equipment.
   4) Total weight of the equipment.
   5) A complete bill of materials.
   6) A list of the manufacturer's recommended spare parts with the manufacturer's current price for each item. Include gaskets, packing, etc. on the list.
   7) Pulsation dampener and pressure gauge.
   8) Stroke positioner.
   9) Complete data on motors and motor controls.
   10) Description of surface preparation and primer paint as specified in this Section.

d. Shop Drawings for the chemical storage tank shall include as a minimum the following:
   1) Dimensions of tank, fittings, pipe connections and appurtenances.
   2) Resin and material used.
   3) Service Conditions: Chemical environment and temperature.
   4) Statement that fabrication shall be in accordance with these specifications.
   5) A statement from the manufacturer that materials and resin used are suitable for intended service.
   6) Total operating weight of tank and fittings.
   7) Description of fabrication.
   8) Dimensions of nozzles showing details of construction and attachment to tank.
   9) Complete, detailed instructions on installation of tanks, which reference specifically the methods for this installation.
   10) Tank label data and caution sign sample.

e. Submittals for the scrubber exhaust fans and carbon adsorber fans shall include as a minimum the following:
   1) Manufacturer's certified rating data.
   2) Certified shop drawings showing all important details of construction, dimensions, and anchor bolt locations.
   3) Descriptive literature, bulletins, and/or catalogs of the equipment.
   4) The total weight of the equipment.
   5) A complete bill of materials.
   6) A list of the manufacturer's recommended spare parts with manufacturer's current price for each item. Include gaskets, packing, etc. on list.
   7) Complete data on motors, motor starters and controls.
   8) Data on noise.
   9) Description of surface preparation and primer paint as specified in this Section.
   10) Inlet and outlet connection bolt hole patterns.
   11) Vibration eliminator data.

f. Submittals for the chemical solution recirculating pumps shall include as a minimum the following:

1) Manufacturers certified rating data.
2) Certified shop drawings showing all important details of construction, dimensions, and anchor bolt locations.
3) Descriptive literature, bulletins, and/or catalogs of equipment.
4) Certified pump performance curves.
5) Total weight of equipment.
6) A complete bill of materials.
7) A list of manufacturers recommended spare parts with current price of each item. Include gaskets, packing, etc. on list.
8) All information required by Section 01730.
9) Description of surface preparation and primer paint as specified in this Section.
10) Vibration eliminator data.

g. Expansion joints and flexible connectors.
h. Gauges and monitoring devices.
i. Flow diagrams, process and instrument diagrams and loop sheets per ISA STDS S5.4 and S5.1.
j. Material list.
k. Horizontal crossflow scrubber packing, data and sample.
l. Horizontal crossflow scrubber mist eliminator, data and sample.
m. Horizontal crossflow scrubber packing and mist eliminator support grating.
n. Submit a nine inch square fiberglass reinforced plastic sample, laminated, natural resin color, representative of materials and fabrication techniques proposed for the shell of the vessels.
o. Submit a certificate from resin manufacturer listing nomenclature, composition, and characteristics of the resin.
p. Submit a list of five similar installations, with contacts, currently operating using the proposed scrubber.
q. Paint systems including catalog cuts, descriptive data, specification sheets for all equipment, piping and appurtenances with manufacturer's master color chart. Submit a 1 square foot sample of a typically painted FRP surface.
r. Electrical single line diagram and riser diagrams showing power, control and instrumentation conduit and cable requirements.
s. Product information for single loop controllers. Provide descriptive information on the controllers for approval prior to programming; include following information as a minimum:
   1) Hardware description including layout and installation re-requirements and all environmental constraints.
   2) Operational description explaining how control and monitoring functions are performed and displayed.
   3) Functional descriptions covering procedures for programming.
t. Panels, Consoles and Cabinets Information:
   1) Layout Drawings, include following:
      a) Front, rear, end and plan views to scale.
      b) Dimensional information.
      c) Tag number and functional name of components mounted in and on panel, console or cabinet.
      d) Product information on all panel components.
      e) Nameplate location and legend including text, letter size and colors to be used.
      f) Location of anchoring connections and holes.
      g) Location of external wiring and/or piping connections.
      h) Mounting and installation details.

i) Proposed layouts and sizes of graphic display panels.

2) Wiring and/or piping diagrams, include following:
   a) Name of panel, console or cabinet.
   b) Wiring sizes and types.
   c) Piping sizes and types.
   d) Terminal strip numbers.
   e) Color coding.
   f) Functional name and manufacturer's designation for components to which wiring and piping are connected.

3) Electrical control schematics in accordance with JIC standards.

u. System Checkout:

1) CONTRACTOR shall furnish following documentation to ENGINEER.
   a) Calibration sheets for each installed instrument.
   b) Loop sheet, per ISA standard S5.4, for each installed loop, with installers signature.

B. Operation and Maintenance Data: Comply with Section 1I3.

C. Materials Testing Data:
   1. CONTRACTOR shall furnish results of materials tests performed in accordance with ASTM methods described in Section 1.2, for approval by the ENGINEER.

1.4 GUARANTEE

A. In addition to manufacturer's standard guarantee, CONTRACTOR shall include the services of factory-trained servicemen to supervise or perform following services:
   1. Monitor and advise CONTRACTOR in installation of complete odor control systems.
   2. Initial start-up of odor control systems.
   3. Placing systems into full operation.
   4. Final performance testing and adjusting of all components.
   5. Instructing OWNER's treatment plant operators in proper care, operation, and maintenance of systems and equipment. Manufacturer's instruction services shall be for a minimum of two working days, and for such additional times as may be required for performance tests. All required time and expenses shall be included in bid price.
   6. An inspection once every fourth month for first twelve months after OWNER's acceptance to assure that proper operation, greatest efficiency and lowest operation expenses are being realized. An inspection report shall be submitted to the OWNER following each inspection.
   7. Certify all performance tests and assist OWNER in obtaining all required system approvals and operating permits from all regulatory agencies having jurisdiction.

B. Product Delivery, Storage and Handling:
   1. CONTRACTOR shall be responsible for safe transportation, procuring any necessary permits, handling, and open air storage of the adsorber towers, scrubber, fans, pumps and other materials purchased as specified in this Section.
   2. Manufacturer shall protect all flange faces and the more fragile appurtenances of the sub-assemblies, with padding between pieces in

order to prevent one piece from impacting with another, and by crating or other means for shipment.

3. Duct sub-assemblies adsorber tower and scrubber shall be unloaded with care and stored in a location where they will be free from damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and affect the service life of the duct or equipment.
4. Large sub-assemblies shall be supported during unloading to prevent excessive deflection and overstressing.
5. Pumps shall come completely assembled and protected against entry of foreign objects.
6. Suction and discharge ports shall be protected against entry of foreign objects.
7. Store equipment and materials so as to keep free from moisture, damage, and deterioration.
8. Vessels shall be crated and installed on a shipping skid or saddles for ease of movement and protection during transportation.
9. Openings shall be covered to protect flange surfaces and to prevent foreign materials from entering the vessels.
10. Vessels shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any tanks in transportation.
11. Vessels shall be clearly marked for any precautions in handling.
12. Trip recorders shall be used when shipping large vessels by rail.

1.5 EQUIPMENT INSPECTIONS

A. CONTRACTOR shall inform County when specific equipment (i.e., scrubbers, carbon adsorbers, chemical storage tanks, pumps, fans, etc.) for this Contract goes into production, so that County, at their option, may visit premises, prior to shipment of any equipment, for approval of various items of major equipment. Manufacturer of major equipment shall not ship any equipment until the County has inspected and approved equipment, or manufacturer receives written permission from County to ship equipment.

B. CONTRACTOR shall notify two weeks before any vessel is ready for test so that inspector may inspect vessel or tanks, and witness tests before any vessel or tank is shipped, County will also witness loading of completed vessel for shipment. Inspection by the County shall not be construed to relieve CONTRACTOR of responsibility for accuracy of the fabrication and assembly, or the quality of workmanship.

C. CONTRACTOR shall retain, label and submit cut-out samples to the County for assessment of properties and laminate construction.

D. Prior to hydro testing of any vessel, vessel shall be made available indoors for County's inspection, which will include but not be limited to following:
   1. Vessel size, dimensions and fabrication tolerances.
   2. Proper nozzle and appurtenance placement per fabrication drawings.
   3. Minimum design thicknesses.
   4. Minimum structural joint widths and thicknesses.
   5. Inner seam integrity and continuity.

E. Resin cure shall be checked by Barcol hardness test. Hardness shall be within 90% of resin manufacturer's specification. Barcol test shall be required for inside and outside surfaces of all fiberglass fabrications.

F. Prior to final inspection, all surfaces shall be made clean by brushing, wiping, or with a compressed-air blast to remove all loose foreign materials.

G. A thorough inspection of each piece of equipment will be conducted upon arrival at construction site to inspect for damage incurred in transit. Any damage shall be immediately repaired by respective equipment fabricators personnel (not a sales representative)

1.6 FACTORY TESTING

A. Factory Scrubber Testing:
   1. Each scrubber shall be factory tested by filling with water to a level 10 foot - 0 inches above overflow outlet of scrubber sump. Blind flange or plug all outlets as required for testing.
   2. Each scrubber sump shall remain full for 48 hours and there shall be no leaks, however small. Any leak shall be repaired in shop by a factory serviceman with reinforcing and resin to match the tank. Repaired surface shall be equal in strength and corrosion resistance to original tank material.
   3. All materials, labor and equipment for above tests and retests shall be furnished by CONTRACTOR. This will not, however, relieve CONTRACTOR from rep with required chemical.

B. Factory Test of Chemical Storage Tank and Carbon Adsorber Towers:
   1. Each vessel shall be tested by filling with water to overflow prior to being placed in service. Each vessel shall remain full for 48 hours and there shall be no leaks, however small. Any leak shall be repaired by a manufacturer's factory-trained serviceman with reinforcing and resin to match tank. Repaired surface shall be equal in strength and corrosion resistance to original vessel material.
   2. All materials, labor and equipment for above tests and retests shall be furnished by CONTRACTOR. This will not, however, relieve CONTRACTOR from rep filled with the required chemical or carbon.
   3. Barcol hardness readings shall be taken at various areas inside and outside of FRP vessels and recorded. Submit barcol hardness readings to ENGINEER.

C. Field Test of Scrubber, Carbon Adsorbers and Chemical Tank:
   1. Visually inspect each vessel interior for damage during shipping and repair all damages.
   2. Test each vessel by filling to overflow level with water for 24 hours with no loss of water.

1.7 WARNING SIGNS

A. Permanent warning signs shall be mounted at all mechanical equipment which may be started automatically or from remote locations. Signs shall be made in accordance with Porcelain Enamel Institute Specification S-103, and shall be suitable for exterior use. Mounting details

shall be in accordance with manufacturer's recommendations; location as accepted by ENGINEER. Fasteners shall be Type 316 stainless steel.

B. Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18-gauge vitreous enamelling stock. Copy shall read:

CAUTION
THIS EQUIPMENT MAY START
AUTOMATICALLY
BY REMOTE CONTROL

1.8 MOTORS AND DRIVES

A. Motors and drives shall conform as a minimum to requirements herein.

B. Driving motors shall be supplied as part of equipment system and shall be as specified in this Section and under each individual equipment specification, and as shown on the Drawings. All motors shall conform to latest ANSI, NEMA, and IEEE Standards for motors of specified class and rating. Unless specified otherwise for a particular piece of equipment, motor bearings shall be of anti-friction type with an AFBMA B-10 life rating of not less than 50,000 hours; motor bearings shall be grease or oil-lubricated with convenience provisions for inspection and servicing.

C. Unless indicated otherwise, each piece of equipment shall be mounted on a common base or baseplate with electric motor driver. Bases and baseplates shall be of structural fabricated steel. Additional requirements are included with individual equipment specifications.

D. All motor nameplates shall be Type 316 stainless steel and provide the following information:
1. NEMA Design Letter.
2. Voltage.
3. Phases.
4. Frequency.
5. Horsepower.
6. Full Load Current.
7. Class of Insulation.
8. Full load rpm.
9. Ambient temp./service factor.
10. Time rating.
11. KVA code.
12. Nominal and guaranteed full load efficiencies.
13. Frame size.
14. Manufacturer, Type or Model.
15. Manufacturer Catalog Number with Date Code.

1.9 EQUIPMENT FABRICATION

A. All FRP scrubber, carbon adsorption towers, chemical tank and related FRP accessories shall be fabricated in a heated and well ventilated structure protected from weather and temperature extremes. Entire fabrication, curing and assembly process of any piece of FRP equipment shall be indoors. CONTRACTOR shall submit an affidavit certifying that all FRP equipment shall be fabricated, cured and assembled as described in this specification.

1.10 EQUIPMENT

A. Equipment which have mechanical defects and do not meet vibration requirements, will be rejected and shall be replaced at the CONTRACTOR's full expense for furnishing, installing, removal, and replacement.

B. Mechanical defects shall include excessive vibration, improper balancing of rotative parts, improper tolerances, binding, excessive bearing heating, defective materials, improper fitting of parts, and any other defect which will in time damage the equipment or impair its operation.

C. Requirements shall be met concerning minimum and maximum dimensions and the specifications for materials. If it is found upon delivery that materials do not agree with the requirements of the Specifications as to size, type, quality, or metallurgy, they will also be rejected as unfit for use in this work.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. General:
   1. Odor control system crossflow horizontal scrubber shall treat odorous air from the Operations Building screen room and existing lift station wet well as shown on Drawings and carbon adsorbers shall treat odorous air from the aeration tanks and the effluent air from the crossflow horizontal scrubber system. Odorous air from wet well and screen room is anticipated to contain up to 25 ppm of hydrogen sulfide and trace amounts of mercaptans, as well as other inorganic and organic malodorous compounds associated with wastewater processes. Odorous air from the aeration tanks is anticipated to contain up to 25 ppm of hydrogen sulfide and trace amounts of mercaptans, as well as other inorganic and organic malodorous compounds associated with wastewater processes. Horizontal crossflow scrubber shall be provided with a minimum 10 foot long packed bed. Malodors shall be removed in packed bed by contact with combined recirculated and fresh make-up scrubbant solution. Chlorinated water and sodium hydroxide solutions have been selected as the make-up scrubbant solution for the horizontal crossflow scrubber. Activated IVP carbon has been selected as the adsorption media for the carbon adsorbers.
   2. System Manufacturer: Provide systems furnished by one of the following:
      a. The Ceilcote Company, Incorporated.
      b. Heil Company.
      c. Interchem Systems, Bionomics Industries Incorporated.
      d. Or equal.
   3. Component Manufacturers:
      a. Acceptable component manufacturers are listed with the component specification.

B. Scrubber:
   1. General: Scrubber shall be of horizontal, crossflow, irrigated, packed bed type and shall consist of demister section, spray chamber, main packed bed section, and scrubbant collection sump, gas inlet, gas outlet and exterior pipe supports where required.

2. Materials and Construction:
   a. Housing: Scrubber housing shall be of fiberglass reinforced vinylester hand lay up or filament wound construction, which shall be fire retardant inside and outside, be resistant to sunlight, corrosive fumes, and suitable for use with acidic or basic scrubbing solution.
   b. Laminates shall consist of an inner surface, an interior structural layer, and an exterior structural layer. Composition specified for inner surface and interior layer is intended to achieve optimum chemical resistance.
   c. Resins used in laminate shall be premium corrosion resistant and fire retardant vinylester resins such as Atlac 711 with 3% antimony trioxide, Koppers 9300 with 5% Antimony Trioxide or Hetron 992 with 3% antimony trioxide or equal. Synthetic surfacing veil shall be Veil-Nexus 1012 (apertured) as manufactured by Burlington Industries.
   d. FRP construction shall be in accordance with United States Department of Commerce, National Bureau of Standards, Voluntary Product Standard PS-15-69 "Custom Contact Molded Reinforced Polyester Chemical Resistant Process Equipment" and ASTM D 4097 where applicable and conforming with the minimum provisions listed in following table:

LAMINATE PHYSICAL PROPERTIES (73.4 F)*

Thickness (inches)	1/4	5/16	3/8
Ultimate Tensile Strength (min. PSI) ASTM Method D638	12,000	13,500	15,000
Modulus of Elasticity Procedure A of ASTM Method D790 (Tangent)	8×10^5	9×10^5	10×10^5
Flexural Strength-(Min PSI) ASTM Method D790	19,000	20,000	22,000
Compressive Edge Strength (min. PSI) ASTM D-699	18,000	20,000	20,000
Glass Content by Ignition	20%	28%	28%

* The production sample test average shall not be below the minimum values shown.

   e. Vessels shall average a glass content plus or minus 5% by weight per PS 15-69.
   f. Corrosion resistant resin rich liner shall be reinforced using a single appertured Nexus synthetic veil. Minimum thickness shall be 10 mils.
   g. Corrosion barrier shall be a minimum of 100 mils and be applied by either the hand laid up technique or chopper gun. Chopper gun is only permitted if an automated process is used. Manual operation of chopper gun shall not be permitted.
   h. Glass content shall be 25% plus or minus 5% by weight, unless otherwise noted in table above.

i. Structural layer shall be of sufficient thickness to meet minimum thickness requirements specified. Glass reinforcements shall be in accordance with the appropriate standards of construction. Structural layer shall be fabricated from using either the hand laid up, filament wound technique or approved chopper gun technique. In no case shall total thickness be less than 0.25 inches.

j. Exterior shall be reinforced using a single "A" glass veil with a layer of surfacing veil followed by a clear resin rich coating similar to the inner surface. Topcoat shall be parafinated to insure vessel cure is not air inhibited, after curing, top coat shall be sand blasted to provide a surface suitable for paint adhesion. Scrubber shall be factory coated with a primer coat of paint as specified in paragraph 2.2. Factory applied pigmented gel coat will not be considered equal.

k. All vessels shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum. All design calculations must be in accordance with Paragraph 2.1.B.2.p. Vessels shall have bottom knuckle reinforcement and be designed for full hydrostatic head load.

l. Scrubber shall be furnished with an inlet air sample line and valve and an outlet air sample line with a valve (3-1/2 feet above grade) to allow the measurement of the H_2S level of scrubber intake and exhaust.

m. Scrubber manufacturer shall provide factory mounted pipe supports for recirculation piping and inlet and outlet air sample line piping.

n. All vessels shall have interior of bottoms sloped to allow complete drainage of the vessels.

o. All necessary connections for piping, level indication, and ductwork shall be provided as shown on Drawings or required. All connections shall be flanged and gusseted with bolt holes (ANSI dimensions). Suitable EPDM gaskets shall be provided. At minimum, connections shall be provided as shown in schedule for liquid level indicator, scrubber sump drain, scrubber sump overflow, air sampling, recirculating scrubbant suction, scrubber sump chemical addition, spare nozzle connection, recirculating scrubbant feed, scrubber air intake and exhaust. Scrubber air intake shall be of size shown on schedule. Connection openings shall be appropriately sized for anticipated flows and service conditions and as shown in schedule. All pipe connections shall be of same material as vessel and be gusset reinforced with strength requirements of 1500 foot-pounds of bending and 2000 foot-pounds of torque. Scrubber walls shall be reinforced around all outlets. Drain connections shall be side bottom flanged with conically gusseted connections at the low point of vessel to provide complete drainage of sump. All connections shall be properly protected from damage during shipment from factory to the site and during storage at site prior to installation. Scrubbers shall be shipped empty, packing, gratings, spray nozzle headers and hardware shall be shipped separately and shall <u>not</u> be shipped inside of any scrubbers. Furnish factory installed pipe supports for air sample piping and discharge spray header piping as shown on Drawings and as required to prevent pipe vibration and swaying. Gaskets shall be EPDM peroxide cured.

p. Vessel housings shall be designed for full bottom support and shall be provided with a minimum of 4 lifting lugs and a minimum of 4 hold down lugs. All supports, lifting lugs and hold down lugs shall be designed to account for all anticipated loads and shall comply with local code requirements. All anchor bolts, nuts and washers shall be Type 316 stainless steel. Vessel housing and base shall be designed with ample supports so that whole assembly shall be self-supporting in any operating condition and shall be unaffected in prevailing wind velocities up to 100 miles per hour or as required by the local code, whichever value is greater. Whole assembly shall be suitable for outdoor installation and for year round weather conditions for Glendale, Arizona. All structural computations shall be signed by an ENGINEER, Registered in the State of Arizona for record purposes and be submitted to ENGINEER.

q. Scrubber shall be provided with a scrubbant collection sump integral with scrubber housing, which shall provide not less than three minute retention time of scrubbant solution or minimum depth as listed in schedule below whichever is greater. An overflow connection shall be provided in sump which shall prevent scrubbant level from rising above bottom of the air inlet under all anticipated liquid load conditions. Interior of the sump shall be built up and sloped to the drain at not less than 1/2-inch per foot slope.

r. Demister section shall be furnished with a polyethylene wire mesh material not less than 6 inches thick with support grids fabricated of FRP. Mesh mist eliminator manufacturer shall furnish hold downs for mesh demister material. Provide structural FRP supports as required for mesh packing support grid. Wire mesh shall have minimum density of 4.0 lb/cu ft and surface area of 125.0 sq ft/cu ft with 97.0 percent voids. Demister mesh shall be capable of removing greater than 99 percent of all droplets 10 microns in diameter and larger. Demister mesh and FRP supports shall be constructed in sections with each section being able to pass through access hatch of scrubber. Mesh type mist eliminators shall be products of one of the following:
   1) Koch ENGINEERing Company, Incorporated.
   2) Otto H. York Company, Incorporated.
   3) Or equal.

s. Spray chamber shall contain spray nozzles of extra large free passage design full cone type, constructed of Teflon, no other material will be considered. Spray nozzles shall be easily removable for cleaning and shall be attached to spray header with tees. All spray headers, piping and supports shall be of corrosion resistant materials. Recirculation scrubbing liquid distribution system located above packing shall consist of a uniformly distributed spray system, with no moving parts, supported across full diameter of scrubber. Spray nozzle headers shall be flanged at housing wall with opening being large enough to allow spray header with spray nozzles attached to be easily withdrawn through flanged opening. Spray pattern shall provide even distribution of scrubbing solution over entire exposed packing surface with less than 5% wall wash at design scrubbant flow rates. Each spray nozzle shall be designed to operate at an inlet pressure of 10 psig with flow rate given in the schedule. Spray nozzles shall be the products of one of the following:

1) Bete Fog Nozzle Incorporated.
2) Spraco Incorporated.
3) Or equal.

t. Access hatches shall be provided near top and bottom of main packed bed section to allow easy inspection, cleaning and maintenance of packing material. An access hatch shall be provided to allow inspection and cleaning of sump. An access hatch shall be provided for access to the mist eliminator. Support gratings and bed limiters shall be removable through access hatches. All access hatches shall be in easily accessible locations and coordinated with all ductwork and piping. All access hatches shall be designed to withstand all expected stresses and shall be corrosion resistant to acidic and basic scrubbant solutions. Access hatches shall be outfitted with removable corrosion resistant panels, all stainless steel Type 316 hardware including nuts, washers, bolts and extruded silicon gaskets. Clear acrylic panels not less than 1/2 inch thick may be used for the access panels. Minimum size of access doors shall be 24-inches high by 30-inches wide with not less than eight (8) hold-down bolt assemblies.

u. Area on the back of all flanges around each bolt hole shall be the diameter of a standard washer and shall be flat and parallel to flange face. This area shall be spot faced, if necessary, to meet this requirement. Flanges shall be manufactured by hand lay-up method and shall conform to ANSI 150 lb standard dimensions for bolting. Flanges shall be checked for alignment, thickness and mating prior to shipment to field.

v. Blind flanges and access doors shall be same thickness and material unless otherwise stated, as flanges to which they are attached. Tolerances and flatness shall be same as for flanges.

w. Each vessel shall be suitable for following chemical services:
1) Sodium Hydroxide, 50% by weight @ 100 F.
2) Sodium Hydroxide, 2% by weight @ 150 F.
3) Chlorinated water, 100 mg/l of chlorine.

x. Certification of chemical resistance testing shall be included with submittals.

y. Main Bed Packing: Material used for 10 foot main packing bed shall be corrosion resistant PVC, CPVC or polyethlene; polypropylene shall not be considered equal for main bed packing.
1) Physical Properties:
a) Size: Nominal 2-inch.
b) Geometric Surface Area, ft^2/ft^3: 38.
c) Packing Factor: 14.
d) Void Space: 98%.
e) Weight, lbs/ft^3: 3.8.
f) Maximum pressure drop per foot: 0.09 inch.
2) Manufacturer: Provide products of one of the following:
a) Jaeger Tri-Packs, Incorporated. No. 1 (2 inch size).
b) The Ceilcote Company. Type K (2 inch size).
c) Or equal.

aa. Furnish and install FRP support grating for packed beds, and mist eliminators. Grating spacing shall be 1-1/2-inch by 1-1/2-inch with 1/4-inch thick bars. Grating weight shall not be less than 2.5 lbs per square foot. Free area of grating shall not be less than 70 percent. Grating shall be capable of supporting a uniform load of not less than 98 pounds per square foot at less than 1 percent deflection when spanning 3-feet.

Furnish and install similar grating for packed bed packing support and fine mesh mist eliminator support grating. Provide minimum 6-inch FRP channel supports across scrubber to support the packing support grating so the maximum unsupported span of grating is 3-feet. Provide vertical channel supports as required. Grating sections shall be installed through access doors.

bb. CONTRACTOR shall return after three months of continuous scrubber operation and inspect packing bed for settlement and add packing media as required.

4. Packed Scrubber Schedule:

a.	No. of Scrubbers	A
b.	Inlet Air Flow (cfm):	5000
c.	Odor Concentrations (ppm H_2S):	25
d.	Inlet and Outlet Diameter:	22"
e.	Main Bed Packing Depth:	4'-0"
f.	Main Bed Packing Length:	10'-0"
g.	Pressure Drop (Packing):	1"
h.	Spray Header Recirc. Rate (gpm):	90
i.	Make-up Water Flow Range (gpm):	0-10
j.	Manometer Connections (2 required):	2 @ 3/16"
k.	Pressure Drop (Mist Elim.):	0.5" W.C.
l.	Total Static Pressure Drop Through Scrubber shall not exceed:	3.0" W.C.

5. Clearances: All equipment furnished under this Section shall be suitable for installation as shown on the Drawings and specified herein. CONTRACTOR shall be responsible for determining necessary clearances and headroom required to move all equipment to its final location.

6. Manufacturer: Provide products of one of the following:
   a. The Ceilcote Company.
   b. Heil Process Equipment, Xerxes Corporation.
   c. Interchem Systems, Bionomics Industries Incorporated.
   d. Or equal.

C. Carbon Adsorbers:

1. General: Carbon adsorber tower shall be vertical dual bed type and shall consist of single air inlet, dual air outlet, access manways, dual carbon beds with supports, lifting hooks, hold down brackets, caustic manifold as detailed on drawings, inlet damper and automatic discharge dampers on each outlet.

2. Materials and Construction:
   a. Each carbon tower housing shall be of fiberglass reinforced vinylester hand lay up or filament wound construction, which shall be fire retardant inside and outside, be resistant to sunlight, corrosive fumes, and suitable for use with acidic or basic scrubbing solution.
   b. Laminates shall consist of an inner surface, an interior structural layer, and an exterior structural layer. Composition specified for inner surface and interior layer is intended to achieve optimum chemical resistance.
   c. Resins used in laminate shall be premium corrosion resistant and fire retardant vinylester resins such as Atlac 711 with 3% antimony trioxide, Koppers 9300 with 5% Antimony Trioxide or Hetron 992 with 3% antimony trioxide or equal. Synthetic

surfacing veil shall be Veil-Nexus 1012 (apertured) as manufactured by Burlington Industries.

d. FRP construction shall be in accordance with United States Department of Commerce, National Bureau of Standards, Voluntary Product Standard PS-15-69 "Custom Contact Molded Reinforced Polyester Chemical Resistant Process Equipment" and ASTM D 4097 where applicable and conforming with the minimum provisions listed in following table:

LAMINATE PHYSICAL PROPERTIES (73.4 F)*

Thickness (inches)	1/4	5/16	3/8
Ultimate Tensile Strength (min. PSI) ASTM Method D638	12,000	13,500	15,000
Modulus of Elasticity Procedure A of ASTM Method D790 (Tangent)	8×10^5	9×10^5	10×10^5
Flexural Strength-(Min PSI) ASTM Method D790	19,000	20,000	22,000
Compressive Edge Strength (min. PSI) ASTM D-699	18,000	20,000	20,000
Glass Content by Ignition	20%	28%	28%

* The production sample test average shall not be below the minimum values shown.

e. Vessels shall average a glass content plus or minus 5% by weight per PS 15-69.

f. Corrosion resistant resin rich liner shall be reinforced using a single appertured Nexus synthetic veil. Minimum thickness shall be 10 mils.

g. Corrosion barrier shall be a minimum of 100 mils and be applied by either the hand laid up technique or chopper gun. Chopper gun is only permitted if an automated process is used. Manual operation of chopper gun shall not be permitted.

h. Glass content shall be 25% plus or minus 5% by weight, unless otherwise noted in table above.

i. Structural layer shall be of sufficient thickness to meet minimum thickness requirements specified. Glass reinforcements shall be in accordance with the appropriate standards of construction. Structural layer shall be fabricated from using either the hand laid up, filament wound technique or approved chopper gun technique. In no case shall total thickness be less than 0.25 inches.

j. Exterior shall be reinforced using a single "A" glass veil with a layer of surfacing veil followed by a clear resin rich coating similar to the inner surface. Topcoat shall be parafinated to insure vessel cure is not air inhibited, after curing, top coat shall be sand blasted to provide a surface suitable for paint adhesion. Scrubber and exhaust stack shall be factory coated with a primer coat of paint as specified in paragraph 2.2. Factory applied pigmented gel coat will not be considered equal.

k. All vessels shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum. All design calculations must be in accordance with Paragraph 2.1.B.2.p. Vessels shall have bottom knuckle reinforcement and be designed for full hydrostatic head load as described in paragraph 3.3.

l. Each carbon tower shall be furnished with (3) three valved sample probe ports in each of the dual beds. Sample ports shall be provided in the inlet and each outlet of each carbon adsorber for the measurement of H_2S levels in the inlet and each outlet of the carbon towers.

m. Carbon tower manufacturer shall provide factory mounted pipe supports for outlet air sample ports and overflow pipe supports.

n. Scrubber manufacturer shall provide factory mounted pipe supports for recirculation piping and exhaust discharge air sample line piping.

o. All necessary connections for piping and ductwork shall be provided as shown on the Drawings, required in this specifications, or recommended by the manufacturer. All piping connections shall be flanged with bolt holes and gusseted (ANSI dimensions). Suitable gaskets shall be provided. Connections shall be provided for carbon sample probes, siphon drain, pressure gage, air sample ports, regeneration overflow and caustic regeneration connection. Carbon tower air inlet connection shall be 24 inch diameter, each air outlet connection shall be 18 inch diameter. Connections openings shall be appropriately sized for anticipated flows and service conditions. All pipe connections shall be of the same material as vessel and be gusset reinforced with strength requirements of 1,500 foot-pounds of bending and 2,000 foot-pounds of torque. Carbon tower walls shall be reinforced around <u>all</u> outlets. Carbon towers shall be considered as "tanks". Drain connection shall be siphon-drain type at low point of sloped bottom. All connections shall be properly protected from damage during shipment from factory to the site and during storage at site prior to installation. Furnish factory installed pipe supports for air sample piping and overflow piping to prevent any pipe vibration or any swaying of piping. Vessels shall be shipped empty, packing, gratings, spray nozzle headers, hardware, etc. shall be shipped separately and shall not be shipped inside any of the vessels.

p. The support system for each of the approximately three (3) feet deep carbon beds shall be as recommended by the carbon supplier and approved by the ENGINEER. The vessel walls, as designed, may not be used to transfer vertical loads to the foundations or vertically support any portion of the carbon support system. If the vessel walls are used in conjunction with the support system, the manufacturer shall redesign the vessel walls in full accordance with the adsorber vessel drawings and specifications, to be approved by the ENGINEER. The support system shall be removable and may be a system of removable columns, grating, and angle or equal. All component of the support system shall be constructed of materials resistant to the service conditions specified for corrosion and exposure to 50% sodium hydroxide for up to 48 hours. The air flow head loss through the support system shall not exceed 0.002 inches water column per foot support depth at 50 fpm superficial air velocity.

q. The structural aspects of the vessel shall be sufficient to exceed the UBC recommended seismic requirements for Zone 4 by a factor of two for all conditions. Manufacturer shall submit detailed calculations illustrating the seismic characteristics of the proposed vessels. Calculations shall be made assuming the vessel is full of 50% caustic solution to the normal level of regeneration. Failure to meet this submittal requirement shall invalidate the award. Vessel housings shall be designed for full bottom support and shall be provided with a minimum of 2 lifting lugs and a minimum of 4 hold down lugs. All supports, lifting lugs and hold down lugs shall be designed to account for all anticipated loads and shall comply with local code requirements. All anchor bolts, nuts and washers shall be Type 316 stainless steel. Scrubber housing and base shall be designed with ample supports so that whole assembly including stack shall be self-supporting in any operating condition and shall be unaffected in prevailing wind velocities up to 100 miles per hour or as required by the local code, whichever value is greater. Whole assembly shall be suitable for outdoor installation and for year round weather conditions for Glendale, Arizona. All structural computations shall be signed by an ENGINEER, Registered in the State of Arizona for record purposes and be submitted to ENGINEER. Scrubber shall be provided with a scrubbant collection sump integral with scrubber housing, which shall provide not less than three minute retention time of scrubbant solution or minimum depth as listed in schedule below whichever is greater. An overflow connection shall be provided in sump which shall prevent scrubbant level from rising above bottom of the air inlet under all anticipated liquid load conditions. Interior of the sump shall be built up and sloped to the drain at not less than 1/2-inch per foot slope.

r. Area on the back of all flanges around each bolt hole shall be the diameter of a standard washer and shall be flat and parallel to flange face. This area shall be spot faced, if necessary, to meet this requirement. Flanges shall be manufactured by hand lay-up method and shall conform to ANSI 150 lb standard dimensions for bolting. Flanges shall be checked for alignment, thickness and mating prior to shipment to field.

s. Blind flanges and access doors shall be same thickness and material as flanges to which they are attached. Tolerances and flatness shall be same as for flanges.

t. Each vessel shall be suitable for following chemical services:
   1) Sodium Hydroxide, 50% by weight @ 100 F.
   2) Sodium Hydroxide, 2% by weight @ 150 F.
   3) Chlorinated water, 100 mg/l of chlorine.

u. Certification of chemical resistance testing shall be included with submittals.

v. Provisions shall be included to adequately ground the carbon bed. Manufacturer shall supply adequate submittal details to demonstrate that the carbon bed will be adequately grounded in the form of valid past experience or calculations sufficient to demonstrate adequate grounding.

w. Activated Carbon: The activated carbon provided shall be virgin granular, derived from bituminous coal, vapor-phase type, chemically impregnated with sodium hydroxide as manufacturered

by Calgon Carbon Corporation, suitable for control of sewage treatment odors. Sufficient activated carbon shall be provided to fill the adsorbers to a bed depth of approximately three feet. A minimum of 10,800 pounds of activated carbon per adsorber is required. The carbon shall have the following performance specifications:

Carbon Substrate	
CCl_4 Number, % By Weight: (per ASTM D-3467)	60
Iodine Number, Minimum:	1000
Mean Particle Diameter, Minimum	3.6 mm
Percent Ash	8.0% Maximum
Impregnated Carbon	
Apparent Density	0.55 g/cc, Minimum
Hardness Number, Minimum	95
Moisture, Maximum	15%
Maximum Head Loss ("W.C.") @ 50 fpm Linear Velocity (through a dense packed bed)	1.9" W.C.Ft. Bed Depth

A representative sample and specification sheet of the carbon to be used shall be submitted with the submittal documents. Before final approval of submittals, a qualified laboratory of the reviewer's choice will be retained for test work required to verify H_2S breakthrough capacity and any other parameters specified, should the reviewer deem such test work necessary. Such testing will be paid for by the CONTRACTOR.

A specification sheet on the base substrate before impregnation and the impregnated carbon shall be submitted for review. The specification sheet for the base substrate shall include as a minimum total ash content, iodine number, and carbon tetrachloride activity (CCl_4).

Each lot of activated carbon delivered to the jobsite shall be accompanied by an analysis sheet of the measured characteristics of the carbon in that lot. Random samples of the delivered carbon will be selected by the ENGINEER for testing to insure product quality. The random samples will be taken under an approved sampling procedure provided by the carbon manufacturer. Testing may be made by an testing laboratory approved by the ENGINEER. All cost associated with the test work will be paid for by the CONTRACTOR. Should the carbon fail this testing, subsequent tests will be paid for by the carbon manufacturer.

The carbon supplied shall be of a type chemically regenerable in-place by the use of up to 50% sodium hydroxide. The system supplier will be responsible for any infringement of any claim of any patent due to supply, manufacture, use or regeneration of any carbons, equipment items, technologies, etc. in this Section.

x. Each adsorption system shall have three 1½" sample probes which extend into the carbon bed 6" minimum. Probes shall be adequate to provide suitable extraction of carbon samples from the carbon bed and be non-blinding. Probes shall extend outside the vessel wall and be blocked off with a ball valve. Probes and ball valve shall be of CPVC construction.

y. Inlet Dampers: Fiberglass dampers shall be installed between each fan discharge and each adsorber inlet. Fiberglass dampers shall be manufactured in accordance with Product Standard PS 15-69 for Custom Contact-Molded Reinforced Polyester Chemical-Resistant process Equipment; ASTM 2996-83 for Filament Wound Reinforced Thermosetting Resin pipe; and ASTM D-1056-78 for Celular Materials, Songe or Expanded Rubber. The design of the dampers shall be compatible with the vessels and the fans, and shall be capable of reducing fully open-position air flow by 95% when operated in a closed position.

2. Discharge Dampers: Isolation dampers shall be provided for each adsorber outlet stack. Outlet dampers shall be Ruskin/Swartwout Model 910 isolation dampers or equal. Dampers shall be of carbon steel construction with 304 stainless steel shaft and blade bolts. All carbon steel shall be lined with Plasite 7122 or equal per manufacturer's recommendation for Zone "C" exposure (commercial sandblast). Flanges shall be sized and drilled to match FRP duct sizes per Product Standard PS 15-69. Dampers shall be automatically activated to close when the fan stops and to reopen when the fan wheel begins turning. Dampers shall be provided with external locking quadrant and be adjustable from full open to full closed. Seal shall be field adjustable and replaceable. Leakage through damper in closed position shall not exceed .029 SCFM per inch of blade circumference at a pressure differential of 10" W.C. Provide chainwheel with sufficient chain for opening and closing of damper and minimum 15 feet of nylon tape to allow operation from the ground, for each damper. Provide tie-down for rope near bottom of adsorber.

a. Hydrogen Sulfide Bed Monitor: A bed monitoring system shall be furnished with each carbon vessel which will enable the operator to, at any time, check for the presence of hydrogen sulfide above, below or at any of the sample ports within the carbon bed. The monitor shall be sensitive to H_2S concentrations from 0.5 ppm to 20 ppm, and visually indicate that concentration range. The Bed Monitor shall be easy to use and require minimum operator training. The monitor shall (compliment/replace) carbon sampling as the approved method to determine H_2S capacity by permitting the operator to track the H_2S wave front, and hence breakthrough, through the bed. The bed monitor shall allow for scheduling carbon regeneration or replacement well in advance of actual need based upon hydrogen sulfide concentration.

D. Recirculation Pumps:

1. General: Chemical solution recirculation pumps complete with motors, couplings, guards, and bases shall be provided of sufficient capacity for the duty required. Recirculation pumps shall provide continuous recirculation of scrubbing liquid from scrubber sump to main packed bed spray nozzle headers.
2. Pumps shall be horizontal, single stage, base mounted, back pull-out, corrosion resistant, end suction centrifugal design manufactured in accordance with AVS standard dimensions and ANSI B 73.1 Horizontal End Suction Pumps for Chemical Process.
3. Pump casings shall be of top discharge, self venting design with fully confined gaskets. Suction and discharge connections shall be 150 lb standard ANSI flanges.

4. Pump casings shall be constructed of glass reinforced vinylester. Casings shall be designed for pressures of at least 1.5 times the shut off head of pump. Casings shall be furnished with a plugged drain connection at the low point.
5. Impellers shall be constructed of same material as casing and shall be fully open with contoured passages. Impellers shall be balanced and designed for high efficiency. The impellers shall be threaded to shafts and sealed with gaskets or O-rings.
6. Pump shafts shall be of Type 303 stainless steel and shall be designed such that deflection is minimal. Where shafts pass through stuffing box or where directly exposed to the liquid being pumped, shafts shall be protected by a readily renewable glass reinforced vinylester shaft sleeve.
7. Bearing frames shall contain bearings to take all radial and thrust loads during continuous operation. Bearings shall be anti-friction type with an Anti-friction Bearing Manufacturer's Association minimum B-10 life rating of not less than 20,000 hours. Bearings shall be oil lubricated, ANSI B73.1 and suitable provision for fill, drain, and level indication shall be provided.
8. Pumps and motors shall be directly connected through a flexible coupling. Removable coupling guards in accordance with OSHA shall be furnished.
9. Baseplates shall support the pumps and motors. Baseplates shall be fiberglass reinforced pre-drilled for ANSI pumps and NEMA motors, baseplates shall have grout holes for grouting to a concrete pad. Pumps and motors shall be assembled on the baseplates in manufacturer's shop.
10. Stainless steel nameplates giving the name of manufacturer, serial number, rated capacity, head, speed, and any other pertinent data shall be permanently attached to each pump.
11. Stainless steel nameplates shall be attached permanently to each motor as specified in Paragraph 1.10 Motors and Drives.
12. Pump manufacturer shall supply all drive units and factory mount them on a common baseplate with the pumps.
13. Shaft seal shall be water flushed mechanical type as specified below:
    a. John Crane Co. or equal 8-1-T double or durametallic RXO double.
    b. Seal face material to be silicon carbide vs. silicon carbide.
    c. Rotating metal parts to be Type 316 stainless steel.
    d. All O-rings for mechanical seals shall be EPR/EPT Duraflow, Kalrez or equal.
    e. Provide needle valve and pressure gauge on stuffing box inlet. Pipe flushing water to drain.
14. Motors:
    a. Totally enclosed, fan cooled, chemical duty, solid shaft, ball bearing, energy efficient type.
    b. Motors shall be in accordance with all current applicable standards to NEMA, IEEE, AFBMA, NEC, and ANSI.
    c. Motors shall be normal starting torque, normal slip, squirrel cage induction type.
    d. Motors shall be supplied with Class F insulation and rated for continuous duty at 55° C ambient temperature and 80C (Class B) temperature rise at a 1.0 service factor.
    e. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation from shut-off to zero head, unless otherwise specifically permitted in this Section.

f. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of pump operation from zero head to shut-off.
g. Lubrication may be grease or oil type.
h. Motor efficiencies shall be determined in accordance with NEMA Standard MG1-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MG1-12.53b.
i. Stainless steel nameplates giving the name, manufacturer, serial number and all data required in Paragraph 1.10, Motors and Drives shall be permanently attached to each motor.
j. Manufacturer: Provide products of one of the following:
   1) Reliance Electric.
   2) General Electric.
   3) Or equal.

15. Capacity: Scrubber manufacturer shall be responsible for verifying the total dynamic head required for the spray header arrangement.
16. Recirculation Pump Schedule:

a. Pump No.:	P-1&P-2	P-3
b. Service:	Odor Control	Caustic System
c. Gal/Min.:	100 gpm	325 gpm
d. Pump Head:	40 ft.	40 ft.
e. Motor HP:	3	7.5
f. Motor RPM:	1750	1750
g. Motor Volts:	460	460
h. Phase:	3	3
i. Hertz:	60	60
j. Motor Efficiency:	88.5%	90.2%
k. Pump Size:	1½" x 3" x 8"	3" x 4" x 8"

17. Pumps shall be factory prime coated as described in Paragraph 2.2 Painting.
18. Each recirculation pump and transfer pump shall be provided with a seal water system. Provide seal water system as detailed and shown on Drawings. Upon recirculation pump start-up the normally closed solenoid valve shall open. Pressure switch shall monitor seal water pressure, when pressure drops below pressure switch setting for set time period (adjustable 0 to 30 seconds) recirculation pump system shall stop. Seal water system control logic and power to solenoid valves shall be part of Odor Control Panel.
19. Vibration isolation for recirculation pumps shall be in accordance with Section 15H47.
20. Manufacturer: Provide products of one of the following:
   a. Fybroc Division, Metpro Corporation, Type 1500.
   b. Ingersoll Rand, Type GRP.
   c. Or equal.

E. Scrubber and Carbon Adsorber Fans:
1. General: Provide fiberglass reinforced plastic fire retardant fans with entire airstream surface graphite impregnated, complete with motor, drive, guard, vibration isolation and coatings of sufficient capacity for the duty required. Scrubber fans shall operate continuously, drawing odorous air from process areas and exhausting through its scrubber or carbon tower unit.
2. Type: Single width, single inlet, backward curved type impeller, centrifugal fan with fixed discharge. Fan shall be tested and rated in accordance with ASHRAE 51-75 and AMCA 210-74 Test Code, and be guaranteed by manufacturer to deliver rated performance.

3. Construction:
   a. Housing: Fan housing shall be designed so that air leakage through joints and seals is negated. All bolted pieces shall be gasketed for air tightness. Fan housing shall be corrosion resistant solid fiberglass reinforced plastic design with construction classification suitable for pressure range. Refer to paragraph 2.1B., Scrubbers above for FRP materials. All exterior surfaces of the fan shall have a factory applied primer coat as described in Paragraph 2.2 Painting. Submit color samples to ENGINEER for approval. All portions of fan housing in airstream shall be coated with graphite impregnated resin in accordance with ASTM D 4167.
   b. Fan Wheel: Fiberglass reinforced plastic or equally corrosion resistant material. Steel hub encapsulated within impeller provides connection to drive shaft. Refer to paragraph 2.1,B., Scrubbers above for FRP materials. All portions of the fan wheel in the airstream shall be coated with graphite impregnated resin in accordance with ASTM D 4167. Fan wheel shall be provided with back pressure vanes adjacent to shaft seal.
   c. Fan Shaft: Shaft shall be of Type 316 stainless steel designed to operate below first critical speed. Shaft and impeller shall be statically and dynamically balanced. Provide mechanical or teflon seal between shaft and housing.
   d. Shaft Bearing: Heavy duty, grease lubricated, sealed, self-aligning, frictionless ball bearings, B-10 minimum life rating.
   e. Fan impeller and driving pulley shall be secured to shaft with keys and set screws.
   f. Fan housing shall have flanged discharge and inlet drilled connection and companion flanges (ANSI dimensions). Fan shall be separated from ductwork at inlet and outlet by flexible connections.
   g. Stainless steel nameplates giving the name of the manufacturer, serial number, model number, rated capacity in cfm, head in inches of water gage, fan rpm, and any other pertinent data shall be permanently affixed to each fan with stainless steel hardware.
4. Motors:
   a. Totally enclosed, fan cooled chemical duty, solid shaft, ball bearing, energy efficient type.
   b. Motor shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, NEC, and ANSI.
   c. Motor shall be normal starting torque, normal slip, squirrel cage induction type.
   d. Motors shall be supplied with Class F insulation and rated for continuous duty at 55C ambient temperature and 80C (Class B) temperature rise at a 1.0 service factor.
   e. Motor shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation from shut-off to zero head, unless otherwise specifically permitted in this Section.
   f. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of fan operation.
   g. Lubrication may be grease or oil type.
   h. Motor efficiencies shall be determined in accordance with NEMA Standard MG1-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MG1-12.53b.

i. Stainless steel nameplates giving the name of the manufacturer, serial number and all data required in Paragraph 1.12, Motors and Drives shall be permanently attached to each motor.
j. Two-speed motors shall be two-winding type.
k. Manufacturer: Provide products of one of the following:
   1) Reliance Electric.
   2) General Electric.
   3) Or equal.

5. Design Criteria:

a. Fan No.:	EF-6	EF-7 and EF-8
b. CFM:	5000	3500/7000
c. *Total Static Pressure, in. W.G.:	5.0	8
d. Fan RPM:	1072	1152/1797
e. Outlet Velocity, fpm:	2415	1014/2029
f. Brake Horsepower:		2.45/9.89
g. Motor HP:	7.5	20
h. Motor RPM:	1750	1750
i. Motor Full Load Efficiency:	90.2%	92.4%
j. Volt:	460	460
k. Phase:	3	3

l. Approximate noise level on weighted scale: Less than 84 dba maximum at 5 feet

*Verify total static pressure with actual total pressure drop across the scrubber.

6. Motor Mounting: Shall be slide rail type.
7. Access Doors: Raised type, stud mounted access doors with gaskets. Studs shall be imbedded and encapsulated in FRP housing.
8. Scrubber fan mounting shall be AMCA standard arrangement 9 with top horizontal discharge and slide rail type motor mounting. Fan base shall be galvanized then painted as specified in paragraph 2.2.
9. Drains: Provide drains at low point of scroll, 1-inch pipe coupling welded to housing with threaded corrosion resistant plug.
10. Drive: V-belts and adjustable sheave pulleys shall be cast steel, sized for 1.2 service factor.
11. Belt Guard: FRP or steel construction galvanized then painted as specified in paragraph 2.2 Painting with tachometer hole, OSHA approved. Provide shaft and bearing guard.
12. Provide fan with PVC coated spring supported structural steel rails with concrete inertia base reinforced as necessary to prevent flexure as specified in Section 15H47, Vibration Isolation. Spring isolators shall be selected to obtain a maximum deflection of 0.75 inches. Paint steel frames as specified in Paragraph 2.2. Painting to match fan color.
13. Provide fans with inlet and outlet flexible connections as specified in paragraph 2.1, E. Expansion Joints and Flexible Connectors below.
14. Furnish fan with a parallel blade FRP outlet damper. Damper shall be constructed of FRP including damper linkage and quadrant. Hardware shall be Type 316 stainless steel. Damper shall be manufactured and provided by the fan manufacturer.
15. Coatings:
    a. Metal Fan Parts:
       1) Prepare metal surfaces as per Steel Structures Painting Council SSPC-SP 5-63 white metal blast cleaning.
       2) Baked epoxy phenolic or "cold set" epoxy-phenolic amine cured, brush or spray coats as per manufacturers specifications.

16. Manufacturers: Provide products of one of the following:
    a. The Ceilcote Company.
    b. New York Blower Company.
    c. Or equal.
17. Fan assembly shall be tested in accordance with Section 17892.

F. Expansion Joints, Flexible Connectors:
1. General: Pipe expansion joints and flexible connectors shall be provided in the piping and ductwork where shown as a minimum. Provide additional expansion joints where recommended by the duct or pipe manufacturer.
2. Type:
    a. Expansion Joints for Piping: Shall be arch units constructed of elastomer filler of materials listed below:
        1) Caustic Feed: Butyl.
        2) Chlorinated Water: Hypalon.
        3) Recycle Water: EPDM.

        Materials listed above shall be reinforced with steel body rings embedded in filler and strong synthetic fabric. Ends shall be flanged, with flanges conforming to ANSI B16.1, Class 125. Expansion joints shall be suitable for outdoor service, for temperature ranges from -65 F up to 250 F and pressure to 150 psig. Specially fabricated split Type 316 stainless steel retaining rings shall be supplied to prevent damage to elastomer flanges when Type 316 stainless steel bolts are tightened. Each chemical solution recirculation pump shall have a eccentric reducer expansion arch connected to suction flange and a concentric reducer expansion arch connected to the discharge flange. Concentric and eccentric reducers shall be furnished with Type 316 stainless steel Control Rods, control rod plate nuts, washers, compression sleeve and rubber washers.
    b. Flexible Connections at Scrubber Fan and Rectangular Ducts: Shall be W-design units constructed of EPDM rubber 3/8-inch thick, reinforced with a strong synthetic asbestos-free fabric suitable for corrosive service. The flexible connections shall be designed to minimize transmission of vibration from scrubber fan to the ductwork at suction and discharge connections. Ends shall be flanged, with flanges conforming to ANSI B16.1, Class 125. Corners on rectangular expansion joints shall be molded and free of patches or splices. Flexible connections shall be suitable for outdoor service and temperature ranges from -65 F up to 300 F, and pressure to 5 psig. Specially fabricated split Type 316 stainless steel retaining back-up bars shall be supplied to prevent damage to the EPDM rubber flanges when Type 316 stainless steel bolts are tightened. CONTRACTOR may substitute Darlyn 1100 by Pathway Bellows, Incorporated, or equal.
3. Accessories: Each pipe expansion joint shall be suitably harnessed against thrust for working pressure in pipeline. Harnessing shall be by control units consisting of two or more tie rods connected between flanges, set for maximum allowable elongation of the joint. Triangular plates, epoxy coated, shall be provided to connect the tie rods to flanges. Tie rods shall be of Type 316 stainless steel. Rubber washers shall be used between the triangular rods and tie rods. Control units shall be provided in accordance with recommendations of expansion joint manufacturer.
4. Hardware: All fasteners (nuts, bolts and washers) shall be Type 316 stainless steel.

5. Manufacturer: Provide products of one of the following:
   a. Holz Rubber Company.
   b. Pathway Bellows, Incorporated, Darlyn 1100. (Duct flexible connections only).
   c. Mercer Rubber Company.
   d. Or equal.

G. Level Indicator and Limit Switch (for Scrubber Sump and Chemical Storage Tank):
1. General:
   a. Provide liquid level indicators for scrubber sump and chemical tank which shall be suitable for side of vessel mounting and designed for chlorinated water and caustic service.
   b. Provide a fitted limit switch for low level alarm at scrubber. Chemical tank level indicator shall have a high level limit switch for high level alarm and a low level limit switch for low level alarm.
2. Type:
   a. The float, containing a magnet, follows the liquid level in float chamber.
   b. Level of the float shall be magnetically transmitted to limit switch which has been set at predetermined set point.
3. Required Features:
   a. Accuracy: Plus/minus 0.5 mm of measured value.
   b. Operating Pressure: 36 inches water.
   c. Temperature: -20 C to +120 C.
   d. Mounting Position: Vertical.
   e. End Construction: Flanged. Two flanged isolation ball valves shall be provided.
   f. Limit Switch: Mercury wetted power switch. Contacts 3A/120 VAC. Attached by clamp.
   g. Material of Construction:
      1) Process Wetted Parts:
         a) Chlorinated Water: Teflon lined steel.
         b) Caustic: Type 316 stainless steel.
         c) Scrubber: Teflon lined steel.
      2) Float: Hard glass.
   h. Number of Limit Switches: One for scrubber, two (high and low level alarm) for chemical storage tank.
   i. Limit switches shall be automatic reset type.
4. Manufacturer: Provide products of one of the following:
   a. Caustic Tank: Krohne America Incorporated, Model BM 26/RRK2 with (2) MS-21 limit switches.
   b. Scubber Sump: Khrone America Incorporated, Model BM 26/NRK/ PTFE/TR with (1) MS-21 limit switch.
   c. Or equal.

H. Pressure Gauges: (For Scrubber and Carbon Towers Inlet Air Pressure Indication):
1. General: Provide a pressure gauge to measure air pressure at air inlet flange of scrubber. Gauge shall be constructed of material suitable for use with 25 ppm hydrogen sulphide gaseous scrubber environment as indicated in the general operating conditions.
2. Required Features:
   a. Transmits changes in gas pressure from the diaphragm to the indicator by means of magnetic linkage.

b. Dial Size: 4-1/2 inch nominal.
c. Range: 0-12 inches water column.
d. Connections: 1/4 inch NPS.
e. Accuracy: ±2 percent of scale.
f. Housing: Polycarbonate and vinyl coated steel.
g. Appropriate fittings and connecting tubing to air inlet flange wall.
h. Gauge mounted on exterior of scrubber air inlet.

3. Manufacturer: Provide products of one of the following:
   a. Dwyer Instrument Incorporated.
   b. Or equal.

I. Differential Pressure Manometers:
1. General: Provide one differential pressure manometer for wet scrubber and two for each carbon adsorber to measure the differential pressure through scrubber packed bed, carbon beds and mist eliminators. Air inlet pressure shall be measured at inlet flange and outlet pressure shall be measured at outlet flange.
2. Manometer shall be "U" type with safety traps. Tubing shall be permanently bonded to a molded, high impact acrylic plastic top. Connections shall include two rapid shut-off type molded nylon tubing connections. Each manometer shall be furnished with red gage oil 0.826 specic gravity as required, two spare 3/4 ounce bottles of red gage oil, 35 linear feet of tygon plastic tubing, magnetic mounting clips. "U" tube shall have a 24-inch water scale (12"-0"-12").
3. Manufacturer: Provide products of one of the following
   a. Dwyer Instrument, Incorporated Figure 11-1, Series 1223-24-D.
   b. Or equal.

J. Pressure Gages, (Piping):
1. Required Features:
   a. All pressure gages shall be 4-1/2-inch diameter, 270 degrees scale, 1 percent of scale accuracy, white faced, with black numerals and pointer.
   b. All gages shall be supplied with 1/2-inch NPT Type 316 stainless steel connection at the bottom.
   c. All pressure gages on chemical service lines shall be isolated from the system by a diaphragm seal.
   d. Diaphragm seal upper and lower housing shall be of 20 percent glass filled polypropylene. Diaphragms shall be teflon. Nuts, bolts and washers shall be type 316 stainless steel.
2. Range: 0-60 psig for recirculation pumps, 0-150 psig for chemical metering pumps.
3. Case: Phenolic or FRP.
4. Window: Clear acrylic plastic.
5. Body: Type 316 stainless steel.
6. Seat: Delrin.
7. Packing: Teflon.
8. Accessories: Furnish all pressure gages with stainless steel shut off cocks.
9. Provide gages as shown on the Drawings.
10. Manufacturers: Provide gages as manufactured by the following:
    a. H.O. Trerice.
    b. Albert A. Weiss and Son.
    c. Or equal.

K. Rotameters:

1. General:
   a. Furnish Rotameters on chlorinated water lines, on seal water make-up lines, on scrubber make-up water line, on caustic line, and on scrubbant recirculating solution pump discharge line to observe flow rates through respective lines.
   b. Rotameters shall be corrected for the specific gravity of fluid being measured as listed below:
      1) Clean Water Lines: Sp. Gr. = 1.00
      2) Caustic Lines (50% solution): Sp. Gr. = 1.531
      3) Chlorinated Water Lines: Sp. Gr. = 1.2265
      4) Scrubbant Solution Line: Sp. Gr. = 1.00
2. In-Line Rotameters:
   a. Rotameter for scrubber make-up water line shall have brass end fitting, tube shall be borosilicate glass with 10-inch scale length and safety enclosure, glass tube type Varea-Meter.
   b. Rotameter for chlorinated water feedline shall have PVC end fitting, tube shall be borosilicate glass with 10-inch scale length and safety enclosure, glass tube type Varea-Meter.
   c. Retainers and "O" rings shall be teflon.
   d. Float shall be Hastelloy C.
   e. Scrubber make-up water rotameter shall be graduated in gpm to provide visual measurement of flow. Chlorinated water rotameter shall be graduated in gallons per hour to provide visual measurement of flow. Graduations shall be detached from tubes.
   f. Units shall have a minimum accuracy of 2 percent of full scale.
   g. Range shall be 10 to 1.
   h. Schedule below indicates anticipated normal flow ranges, rotameter scales shall read normal flow range at midpoint to third quartile of scale.
   i. Flanged fittings, shall meet ANSI B16.1, Class 150 Specifications.
   j. Operating Temperature: 30-125 F.
3. By-Pass Rotameters:
   a. Rotameters for the scrubbant solution recirculating line shall be of the by-pass type for measuring large flows.
   b. Rotameter shall be furnished complete with Hastelloy-C orifice plates, glass tube type Varea-Meter indicating meter in the bypass, bypass piping and ball valves with ball checks to prevent leakage in the event sight glass breaks.
   c. Pipes and end fittings shall be Schedule 80 PVC.
   d. Floats and orifices shall be Hastelloy C.
   e. Tube shall be borosilicate glass.
   f. Tube retainers shall be TFE.
   g. Scale length shall be 10-inches.
   h. Rotameter shall be graduated in GPM for visual measurement of flow.
   i. Minimum accuracy shall be 4 percent of the full scale.
   j. Rotameters shall measure clean water (Sp. Gr. 1.0).
   k. Flanged fittings shall meet ANSI B16.1, Class 150 specifications.
   l. Operating temperature shall be 30 to 125 F, maximum pressure drop at design flow shall not exceed 26-inches.
   m. Approximate scrubbant solution flow will be 100 GPM, pressure rating 75 psi, main line tube size will be 3-inch diameter. Rotameter scale shall read normal flow at approximate mid-point to third quartile of scale.

4. Low Flow Rotameters:
   a. Rotameter for caustic feed line shall have Type 316 stainless steel end fittings with Type 316 stainless steel tube.
   b. Rotameter for seal water make-up line shall have Type 316 stainless steel end fittings, tube shall be borosilicate glass with safety enclosure.
   c. Retainers shall be Kynar.
   d. O-rings shall be Buna-N.
   e. Floats shall be Type 316 stainless steel.
   f. Units shall have a minimum accuracy of 2 percent of the full scale.
   g. Operating range shall be 10 to 1.
   h. End connections shall be threaded with increasers as required.
   i. Valve stem and seat shall be Type 316 stainless steel.
   j. Stem adapter, retainer and pipe plug shall be Type 316 stainless steel.
5. Provide rotameters in accordance with the following schedule. Flow rates shown are for a specific gravity of 1.0 correct rotameter scales for specific gravity tables listed above.

	Process	Nominal Capacity Flow	Pressure Rating (PSIG)	Tube Size Inches	Pressure Drop (In. H_2O)
a.	Caustic supply	0-10 gpm	150	1/2	-
b.	Scrubber make-up water	0-10 gpm	150	1/2	35
c.	Chlorinated water supply	0-15 gpm	150	1/2	8.8
d.	Seal water make-up	0-40 gph	150	1/2*	50
e.	Scrubbant solution	0-100 gpm	150	4	50

* Provide adapters as required.

   f. Manufacturer: Provide products of one of the following:
      1) Wallace & Tiernan Division of Penwalt Company.
      2) Or equal.

L. Odor Control System Panel:
1. General:
   a. Odor control panel shall be required for packed bed scrubber aeration tank odor control system.
   b. Panel shall be NEMA 4X, Type 316 stainless steel, corrosion resistant construction.
   c. Instruments, controls and other components, which will be visible on the exterior, shall be arranged in a neat and workable manner.
   d. Provide subpanels for terminal strips and internally mounted devices.
   e. Support and restrain all internally mounted components and flush mounted deep case or shelf mounted instruments to prevent any undue movement.
   f. Provide all instruments, wiring, piping and any other components necessary to make panel a complete and workable unit.
   g. Manufacturer's standard configurations will be considered for acceptance, if they fulfill all functional requirements and are approved by ENGINEER.

h. All internal wiring shall be covered plastic raceways.
i. Control circuits shall be 120 volt, single phase.
j. Refer to Odor Control System process and instrumentation diagram on Drawings for additional information.

2. Basic Construction:
   a. All materials shall be new and shall conform to the requirements of this Specification. Materials shall be of high grade, free from defects and imperfections and of recent manufacture.
   b. Access doors shall be Type 316 stainless steel pan type, not to exceed 36-inches wide and not less than 1/8-inch thick.
   c. Provide full length corrosion resistant concealed piano hinge for each door, except when otherwise specified.
   d. Provide hasp for lock with padlock and two keys.
   e. Provide 5/8-inch anchor bolt holes in the bottom of enclosure.
   f. Steel subpanels, brackets, supports, etc. shall be painted with 2 coats of semi-gloss white lacquer after proper preparation and priming.
   g. Panel shall be structurally reinforced where required to withstand the load of all appurtenances mounted thereon.
   h. No front panel device shall be mounted less than 36 inches above ground.
   i. Panel shall be furnished with at least one 40-watt fluorescent light (protected with plastic shield) and duplex convenience outlet. Lights and outlets shall be mounted within the control panel.

3. Construction Features:
   a. Provide wall mounted front access panel with all necessary mounting hardware which shall house all the instruments and devices required to make a workable unit.
   b. Frame shall be 10 gauge (0.135 inch) Type 316 stainless steel welded construction adequately braced with not less than 0.1875 inch thick Type 316 stainless steel angles and stiffened to maintain a flatness of ±1/16 inch over any two foot span.
   c. Continuously weld all seams.
   d. Provide 5/16-inch diameter copper ground studs making a clean metal contact with frame structure, which will be ground connection points for all panel equipment. A clean, 1-inch diameter area, void of any paint, shall be provided around each stud.
   e. After fabrication, enclosure shall be cleaned, surface prepared and painted in accordance with the following procedure:
      1) All areas requiring surface preparation shall be washed with either naptha, mineral spirits or lacquer thinner in order to remove all oil, grease and dirt.
      2) Exterior surfaces shall be surface ground to completely remove all corrosion and mill scale. Interior shall be wire brushed to remove all welding scale and corrosion.
      3) All external welds and seams shall also be ground smooth.
      4) All interior intermediate panels shall be zinc phosphatized prior to primer application.
      5) One coat of primer shall be applied to all interior surfaces immediately.
      6) All interior surfaces shall be painted with 2 coats of semi-gloss white lacquer.
      7) Provide one extra quart of touch-up paint of each finish color.

8) Primer coat paint shall be compatible with finish paint specified in Section 9L, Painting.

4. Identification:
   a. Provide nameplate with 1/2-inch letters to identify a given panel.
   b. Provide nameplate with 3/16-inch letters for each panel mounted device.
   c. Nameplates shall be constructed as follows:
      1) 3/32-inch thick laminated phenolic for engraving composed of core, laminated on both sides with a matte (non-glare) finish cover sheet.
      2) Core to be black; cover sheet to be white.
      3) Front face beveled edges to be 1/32 inch by 45°.
      4) Mounting holes to be centered on width and 1/4 inch from each end.
   d. Provide two stainless steel self-tapping screws per nameplate. Glueing or Dymo labels are not acceptable.
   e. Tag all instruments and components.
   f. Use terminal strips with numbered terminals.
   g. Color code wiring as required by applicable standards.
5. Electrical:
   a. Selector Switches: Heavy duty; compact.
      1) Required Features:
         a) Square.
         b) Position: 3 position.
         c) Unlighted.
         d) Maintained.
         e) Modular contacts.
   b. Pushbuttons: Heavy duty; oil tight rated.
      1) Required Features:
         a) Square.
         b) Momentary contacts.
         c) Single or dual operators as required.
         d) Lighted.
   c. Provide following switches and pushbuttons on face of panel:
      1) Recirculation pump Hand-Off-Auto, each pump.
      2) Recirculation pump lead-pump selector switch.
      3) Caustic feed pump Hand-Off-Auto, each pump.
      4) Lead-pump selector switch for caustic feed pumps.
      5) Caustic solution transfer pump start-stop pushbutton (for carbon tower regeneration).
      6) Scrubber fan EF-6 START and STOP.
      7) Carbon tower fan EF-7 Fast-Slow-Stop.
      8) Carbon tower fan EF-8 Fast-Slow-Stop.
      9) A press-to-test button to test all panel indicating lights.
      10) Annunciator "TEST" buttons.
      11) Run lights shall be green.
      12) Trouble, stop, malfunction lights shall be red.
   d. Indicating lights, heavy duty; oil tight compact. Color legend to be as follows: red: running, on Green: stop, off.
      1) Required Features:
         a) Round.
         b) Transformer type with 6 volt bulbs.
         c) All lamps to have same voltage rating.
      2) Provide the following lights on the face of the panel:
         a) Pump running light and separate off light, recirculation and caustic transfer pumps.

b) Chemical feed pumps running light and separate off light, each pump.
c) Scrubber and carbon tower fan and exhaust fan running light and separate off light, each fan.

e. Mount elapsed time meters on each panel face. Furnish a meter for each fan, each pump, and each chemical feed pump. Provide descriptive nameplates for each elapsed time meter.

f. Electrical Service:
1) A single 480 volt, 3 phase electrical service will be provided to panel under Division 16.
2) A service disconnect switch will be provided under Division 16.
3) Motor starters for single phase motors shall be included in odor control system panel. Three phase starters for scrubber sump recirculation pumps, carbon adsorber fans and scrubber fan are included in this panel.
4) Suitable size control power transformers 480/120/240 volt 3 phase shall be provided for all odor control system 120 and 240 volt power requirements. Circuit breakers shall be provided to protect each circuit. Instruments shall be on separate circuits with no more than six instruments per circuit.
5) Control and instrumentation wiring to odor control equipment shall be provided under this Section. Wire shall conform to Division 16, Electrical.

g. Miscellaneous Electrical Items:
1) Internal wiring shall be type THHN, color coded with stranded thermoplastic insulation rated for 600 volts and 90°C for single conductors, wire size shall be 14 AWG for control circuits.
2) Terminal blocks shall be 300 volt, 30 ampere, barrier type screw terminals, twenty percent of terminals on each terminal block shall be spares. Each terminal shall be identified by an engraved or painted wire number on a marking strip attached to the block. Power and control wiring shall use separate blocks from analog signal wiring. All external connections shall be to terminal blocks.
3) Manufacturer shall furnish complete wiring diagram showing as built circuitry to be placed inside the panel in a plastic pouch.
4) Panel wiring shall be run in labeled plastic wiring ducts sized for 60 percent fill. Bundling of wires except within wiring ducts shall be accomplished with plastic wrapping straps. The bundles shall be securely fastened to the steel of the cabinet using standard switchboard cleats located in suitable points between the terminal blocks and electrical devices. Lacing and twine is not acceptable. Power and signal wiring shall be run in separate wiring ducts with six inches separation.
5) Panel shall be provided with grounding lugs.
6) Lamp test circuitry and pushbuttons shall be provided.
7) Refer to Division 16 for additional requirements.

h. Control Relays:
1) Type: General purpose, plug-in type rated for continuous duty.

2) Construction Features:
   a) Coil Voltages: 24 V DC, and 120 V AC as required.
   b) Contacts:
      1. Silver cadmium oxide, gold flashed except in cases for switching low energy circuits (200 mA) where fine silver, gold flashed contacts shall be provided.
      2. Rating: Compatible with AC or DC throughout voltage and current of devices simultaneously operated by contacts but no less than the following:
         a. Silver cadmium oxide, gold flashed not less than 10 amperes resistive at 120 V DC continuous.
         b. Fine silver, gold flashed not less than 3 amperes resistive at 120 V AC or 28 V DC continuous.
   c) Relays to have clear plastic dust cover.
   d) Relays to be UL recognized.
3) Manufacturer: Provide products one of the following:
   a) Square D Company, Type R and/or Type K.
   b) Or equal.

6. Annunciators: An annunciator shall be installed in panel with ISA Sequence "A" operation.
   a. Required Features:
      1) Annunciator Mounting: Panel mounted.
      2) Annunciator Logic: Integral solid state.
      3) Assembly: Furnished with front door shatterproof glass with waterproof seals to permit viewing of annunciator windows within panel. Maintain NEMA 4X integrity.
   b. Annunciator front accessible selectors for:
      1) Normally open/normally closed field contacts.
      2) Lock-in/nonlock-in alarms.
   c. Flasher: Module mounted.
   d. Pushbuttons for Common Test and Acknowledge; NEMA-4X rated and flush panel mounted.
   e. Provide common alarm dry contact output for connection to the main status panel DAFCR control panel provided under instrumentation and control.
   f. Power: 120 VAC, 60 Hz.
   g. Single alarm points with 2 lamps per point.
   h. Windows shall be engraved for active points.
   i. Spare points shall be provided complete, including windows but without engraving.
   j. All field wiring and plug-in modules shall be serviceable from the front of each assembly.
   k. Off normal conditions:

No.	Description
1.	Scrubber Sump Low Level
2.	Caustic Tank Low Level
3.	Caustic Tank High Level
4.	Recirculation Pump Flow P-1
5.	Recirculation Pump Flow P-2
6.	Recirculation Pump Seal Water Failure P-1
7.	Recirculation Pump Seal Water Failure P-2
8.	Recirculation Pump Motor Malfunction P-1
9.	Recirculation Pump Motor Malfunction P-2
10.	Caustic Transfer Pump Flow P-3
11.	Caustic Transfer Pump Seal Water Failure P-3

12. Caustic Transfer Pump Motor Malfunction P-3
13. Scrubber Fan Motor Malfunction
14. Caustic Feed Pump Motor Malfunction P-4
15. Caustic Feed Pump Motor Malfunction P-5
16. Smoke Detector Shutdown (Crossflow Scrubber)
17. Spare
18. Spare
19. Spare
20. Spare

m. Products: Provide products of one of the following:
   1) Riley.
   2) Ronan.
   3) Or equal.

7. Control panel shall be arranged to provide control of each fan and pump in accordance with the sequence of operation specified under this section, see Paragraph L below. All required relays, timers and switches shall be provided within control panel. Provide for shut down of scrubber fan by smoke detection system in screen room. Coordinate all interface requirements with motor starters. The pH and ORP controllers specified herein shall be mounted on the face of control panel.

L. Operation and Controls:
1. Screening Room and Wet Well:
   a. Scrubber fan EF-6 shall be started through a "Start-Stop" push-button mounted on control panel.
   b. In "Start" position fan EF-6 and odor control system shall start and stop through an interlock with air supply fan SF-2.
   c. In "Auto" position selected lead recirculation pump shall start through interlock with scrubber fan EF-6.
   d. "In "Hand" position selected lead recirculation pump shall run continuously.
   f. Scrubber fan shall be stopped through smoke detectors sensing an alarm condition and as shown on HV Drawings and specified in Section 15H64, Automatic Temperature Controls.
   g. Recirculation pump shall stop when flow switch senses a no-flow condition or scrubber sump low level sensor senses a low level condition in either "Hand" or "Auto" positions.
2. The pH and ORP controller shall vary the caustic feed pump speed and remote chlorination by means of a 4 to 20 mA dc signal utilizing closed loop with proportional and integral control. Selected caustic feed pump shall start by means of an interlock with scrubber fan EF-6 specified herein. Caustic feed pump shall stop when respective chemical tank level sensor senses a low level condition or when scrubber fan stops. Caustic feed pump shall stop when flow switch on relief valve discharge line senses flow.

M. Chemical Feed System:
1. General: Chemical feed system for storing and transferring a 50 percent solution of sodium hydroxide shall be provided.
2. Components:
   a. Chemical storage tank for sodium hydroxide.
   b. Level detection and indication system.
   c. Chemical feed pumps (two required).
   d. Chemical transfer pump.
   e. Insulation and freeze protection for chemical storage tank.

3. Chemical Storage Tank:
   a. The chemical storage tank shall be fabricated of fiberglass reinforced plastic as specified in Paragraph 2.1,B., Scrubbers above.
   b. The sodium hydroxide storage tank shall be vertical, cylindrical, closed top, for above ground service and furnished as shown. Chemical Storage Tank Schedule included below:

CHEMICAL STORAGE TANK SCHEDULE

TANK NAME	SODIUM HYDROXIDE TANK
Chemical Stored:	50% NaOH Solution
Specific Gravity:	1.531
Temperature:	30-125 degrees F
Pressure:	Atmospheric (Vented)
Tank Location:	Adjacent to Operations Building
Tank Quantity:	1
Capacity:	8,000 gal
Tank Diameter:	12 foot-0 inches
Overall Height:	12 foot- 0 inches
Top:	Domed
Bottom:	Flat
Minimum Wall Thickness:	1/4-inch
Tank Material:	Fiberglass Reinforced Plastic
Chemical Fill Line:	2-inch diameter
Transfer Pump Suction Line:	4-inch diameter
Drain Line:	4-inch diameter
Level Indication Conn.:	3-inch diameter
Vent:	4-inch diameter
Manway:	20-inch diameter
Tank Overflow:	3-inch
Caustic Feed Pump Suction Line:	2-inch diameter
Relief Valve Discharge Line:	1-inch diameter
Dilution Water Line:	2-inch diameter

   c. The tank wall shall withstand the stresses caused by the conditions specified above and any stresses induced by thermal expansion and contraction.
   d. The FRP shall not contain any fillers.
   e. The tank shall be cylindrical and vertical. The finished surface shall be as free as commercially practicable from visual defects such as foreign inclusions, air bubbles, pin holes and craters.
   f. The tank diameter shall be measured internally. Tolerance on the outside diameter including out of round shall be plus or minus 1 percent. Measurement shall be taken in a horizontal position.
   g. All nozzles attached to the chemical storage tank shall be as specified in Paragraph 2.1B., Scrubber.
   h. Tank bottom shall be sloped to the drain outlet as specified in Paragraph 2.1B., Scrubber.
   i. Tank shall be provided with an identification label. Identification label shall include tank capacity and material stored (sodium hydroxide) as a minimum.

j. Chemical Storage Tank shall be furnished with OSHA approved 20-inch by 24-inch Chemical Warning sign with NFPA 704 hazard numbers for "Sodium Hydroxide" as required. Chemical sign shall include as a minimum, the name of the product stored in the tank, precautionary measures, signal word (danger, warning, caution), statement of hazard, precautionary measures, instructions in case of contact, exposure, etc. and NFPA 704 hazard numbers.

k. Level indicators shall be furnished as specified in this Section. High level limit switch shall activate alarm light.

l. Top fill connection shall extend 18 inches below overflow connection to tank supported from the interior of the tank.

m. The overflow for tank shall have a drop pipe supported from the interior of the tank extending to a point 9-inches below the tank overflow connection inlet. The overflow elbow shall be vented to prevent siphoning.

n. Chemical tank shall be insulated and heat traced as specified below.

1) Tank insulation shall be inorganic glass fibers preformed into semi rigid boards. Average compressive strength at 10 percent deformation shall be not less than 100 psf. Average density shall be 1.5 pounds per cubic foot. Thermal conductivity (k) shall be 0.24 Btu/hr/sq.ft./°F/in. at 75F. Prior to installing insulation the tank manufacturer shall install electric heating mats to prevent crystallization of the sodium hydroxide solution. Electric heating mats shall be as specified below.

2) Chemical storage tank shall have factory applied 2-inch thick insulation applied to the top and wall of the tank, rigid fiberglass segments shall be smoothly curved around tank wall. Nozzles, manhole and all other projections shall be insulated and flashed so the entire tank insulation system is waterproofed.

3) The tank manufacturer shall cover insulation with an FRP jacket to encapsulate the insulation in an air and watertight envelope. The FRP jacket shall be identical to the exterior wall of the tank and present a smooth finish, refer to ASTM D 2563. Expansion joints shall be incorporated into the outer shell to prevent cracking of the FRP outer shell. Refer to Paragraph 2.1B. in this Section for details.

4) Products: Provide products of one of the following:

a) Ceilcote Company.

b) Heil Process Equipment, Xerxes Corporation.

c) Interchem Systems Bionomics Industries.

d) Or equal.

o. Electric Heat Trace Mats:

1) Electric heat trace mats shall be furnished and installed for chemical storage tank and shall be constructed of vulcanized silicone rubber, glass fabric encasing a resistive element and a grounding grid.

2) Electric heat trace mats shall be rated at 600 volts and provided with 18-inch power leads (ground included) encased in stainless steel armor.

3) Ratings:

a) Maximum maintenance temperature shall be 250 F.

b) Maximum exposure temperature shall be 450 F (panel de-energized).

c) Minimum installation temperature shall be 250 F.
d) Service voltage shall be 115 volts, single phase, 60 Hertz.

4) Refer to table above for tank size, tank quantity, materials of construction and product in tank.
5) Caustic solution in tank shall be maintained at not less than 60 F when ambient conditions are at 20 F.
6) Electric heat trace mats shall have a watt output of 575 watts each.
7) Install mats such that minimum temperature is maintained at all levels of tank operation.
8) The following decal type sign shall be prominently fixed to the exterior of the thermal insulation every 10 feet and readily visible from ground level: ELECTRIC HEAT TRACING CAUTION.
9) Products: Provide products of one of the following:
a) Thermon Manufacturing Company.
b) Or equal.

p. Thermostats: Thermostats for chemical storage tank shall be of the dual type single-pole, single throw thermostat. One thermostat shall control the mat heaters, the other thermostat will be used as a high limit thermostat.
1) Thermostat Type: Dual (two thermostats in one enclosure) thermostat, 2 single pole-double throw switches.
2) Sensor: Remote bulb with 6-foot capillary encased in stainless steel armor.
3) Setpoint: Adjustable 35 to 250 F calibrated range dial.
4) Rating: 20 amps at 480 volts.
5) Enclosure: NEMA 4 with a PVC coating, gasket, breaker with drain.
6) Set high limit thermostat at 100 F.
7) Products: Provide products of one of the following:
a) Thermon Manufacturing Company.
b) Or equal.

q. Storage Tank Certification Label: A stainless steel nameplate mounted 5 feet-0 inch above the bottom of tank at a point accessible to view at the front of the tank shall be provided and show the following:
1) Corrosion resistant liner resin material.
2) Type of interior surface reinforcement.
3) Chemical to be stored including:
a) Concentration.
b) Specific gravity.
c) Maximum temperature.
4) Tank capacity.
5) Insulation thickness.
6) Heating Mat Watts, voltage.

4. Chemical Feed Pumps:
a. Manufacturer: Provide products of one of the following:
1) Pulsa-Feeder Division Interpace Corporation.
2) Milton Roy; MilRoyal.
3) Or equal.

b. Pumping unit shall be manufactured in accordance with Chemical Feed Pump description included herein, and as specified below.
1) Pump shall be of positive displacement pulsating piston/diaphragm type, constructed of a material fully suitable for pumping sodium hydroxide.

2) Pump stroke adjustment shall be manually controlled through an external handwheel with a digital indicator, stroke length controller furnished by pump manufacturer. Stroke adjustment mechanism shall permit 0 to 100 percent capacity control while pump is in operation. Pump delivery shall be repeatable within plus or minus 1 percent over a 10:1 speed range.
3) Pump and motor shall be suitable for chemical service and continuous operation on 460 volts, three phase, 60 hertz power. Pump motor shall be totally enclosed.
4) Pump shall be provided with internal pressure relief valve with a factory set pressure of 150 psig. Pressure setting of valve shall be fully adjustable using an external adjustment screw.
5) Ball type check valves shall be provided on pump suction and discharge with replaceable ball guides. Each valve shall be removable without disconnection of any piping and shall be capable of disassembly by hand.
6) Pump shall be dry lift, self-priming and capable of indefinite operation without fluid.
7) Hydraulic system shall use hydraulic oil and shall incorporate a separate vapor bleed device in hydraulic system. Hydraulic by-pass is not acceptable.
8) Chemical Feed Pump Schedule:
   a) Normal Flow: 3.05 gph.
   b) Peak Flow: 6.10 gph.
   c) Stroke Rate: 44 spm.
   d) Pump Capacity: 6.7 gph.
   e) Specific Gravity: 1.53.
   f) Temperature: ambient.
   g) Discharge Pressure: 100 psi.
   h) Quantity: 2 each.
   i) Stroke Adjustment: Manual.
   j) Pump Head: Tube or Diaphragm.
   k) Head Material: Teflon.
   l) Motor Type: Totally enclosed chemical duty.
   m) Maximum Motor Speed: 1,725 rpm.
   n) Minimum Horsepower: 1/6 HP.
   o) Piston Diameter: 1.25 inches.
   p) Inlet and Outlet Size: 1/2-inch N.P.T.

c. Pump and motor shall be furnished such that motor will not be overloaded under any condition of operation up to 1.5 times the specified differential pressure.
d. Pump shall be supplied by same manufacturer as pumps for odor control systems, complete with motor, gear reducer, coupling, guard, pump and motor base, manual stroke adjustment mechanism, pulsation dampeners, valves and all necessary appurtenances.
e. Pump base shall be rigidly and accurately anchored into position and all necessary foundation bolts, plates, nuts, and washers shall be furnished and installed by CONTRACTOR. CONTRACTOR shall have equipment manufacturer determine number, size, and location of all anchor bolts to be set in concrete.
f. Stainless steel nameplate giving name of the manufacturer, model number, rated capacity, head, speed and any other pertinent data shall be permanently attached to pump.

g. Stainless steel nameplate giving name of manufacturer, serial number, model number, horsepower, efficiency, speed, voltage, amperes, and other pertinent data shall be attached to motor as specified in paragraph 1.10, Motors and Drives.

h. Pump manufacturer shall supply drive unit and factory mount it on a common baseplate with the pump.

i. Motor:
   1) Totally enclosed fan cooled chemical duty, solid shaft, ball bearing energy efficient type.
   2) Motor shall be in accordance with all current applicable standards to NEMA, IEFE, AFBMA, NEC, and ANSI.
   3) Motor shall be normal starting torque, normal slip, squirrel cage induction type.
   4) Motor shall be supplied with Class F insulation and rated for continuous duty at 55 C ambient temperature and 80 C (Class B) temperature rise at a 1.0 service factor.
   5) Motor shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation from shut-off to zero head, unless otherwise specifically permitted in this Section.
   6) Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of pump operation from zero head to shut-off.
   7) Lubrication may be grease or oil type.
   8) Full Load Efficiency: 81.5 percent (NEMA nominal).
   9) Motor efficiencies shall be determined in accordance with NEMA Standard MG1-12.53a and IEEE Standard 1112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MG1-12.53b.
   10) Product and Manufacturer: Motor shall be high efficiency design as manufactured by:
      a) Reliance Electric.
      b) General Electric.
      c) Or equal.

j. Pump suction and discharge connections shall be furnished with an expansion joint similar to paragraph 2.1.F. except that arches shall be filled. Expansion joints shall be full line size.

k. Pump shall be painted as described in Paragraph 2.2 Painting, in this Section.

l. Accessories:
   1) Backpressure relief/antisiphon valve shall be furnished on pump discharge to prevent flow through the pump whenever the pump is not operating. Backpressure relief/antisiphon valve shall be PVC lower body, Teflon diaphragm, teflon seat gasket and PVC seat. Upper valve body and spring shall not come in contact with the fluid. Backpressure relief/anti-siphon valve shall be product of one of the following:
      a) Pulsafeeder Division, Interpace Corporation.
      b) Milton Roy.
      c) Or equal.

2) Pump discharge line shall have a pulsation dampener of suitable size, material and pressure rating as recommended by the pump manufacturer. Pulsation dampener shall be of the air-charged type and shall be provided with an air-charging valve and a pressure gauge in air chamber.
3) Pump discharge line shall have a pressure safety valve of suitable size and pressure rating as recommended by the pressure relief valve pump manufacturer. Valve shall be PVC with teflon shafts and resilient seat of filled teflon or equal material. Pressure setting of the valve shall be fully adjustable using an external adjusting screw.
   a) Manufacturer: Provide products of one of the following:
      1. Milton Roy.
      2. Plast-O-Matic.
      3. Or equal.
4) Pump suction shall be provided with a graduated plexiglass, acrylic or ~~???~~ butyrate calibration chamber of the size recommended by pump manufacturer, for determining the discharge rate of pump.

6. Sodium Hydroxide (NaOH) Feed Control pH Monitoring System:
   a. The variable speed adjustment on the sodium hydroxide chemical feed pumps shall be controlled by a pH monitoring system comprised of the monitor and electronic indicating (single loop) controller specified below. pH monitor system shall be Model 7774-3-1-03-208 as manufactured by Leeds & Northrup, Unit of General Signal or equal, and shall consist of the following:
   b. pH Element:
      1) Type:
         a) Insertion Probe with ball valve shutoff.
         b) Differential Measurement Method.
      2) Operation:
         a) Purpose: To sense pH variations in process media when used in conjunction with an analyzer type transmitter.
         b) Operating Principle: To compare a pH electrode with a reference electrode containing a chemical pH standard and a protective intermediate solution, and produce a differential signal.
      3) Functional:
         a) Pressure Rating: 75 psi at 80 deg. C.
         b) Temperature Limits: Minus 5 to plus 95 deg. C.
         c) Temperature Compensation: Internal and automatic for 10 deg. F to 100 deg. F.
         d) Output Impedance: 580 ohms.
      4) Physical:
         a) Completely encapsulated, Type 316 stainless steel electrode housing.
         b) Wetted Materials: Derakane, ceramic, glass and titanium palladium alloy.
         c) Interconnecting Cable: Belden 8786.
         d) Mounting: Insertion mounting with Type 316 stainless steel valve assembly.
         e) To be inserted into discharge line of scrubber recirculation pump as shown on Drawings. Electrode shall be of sufficient length so that it is immersed in liquid.
      5) Performance:
         a) Range: 2-12 pH.
         b) Stability: 0.03 pH units per day, non-cumulative.

c) Sensitivity: 0.001 pH unit.

c. pH Indicating Transmitter:
   1) Type:
      a) Differential pH input.
      b) Electronic output.
   2) Operation:
      a) Purpose: To sense a differential type pH signal from a pH element and provide a standard output signal.
   3) Functional:
      a) Input: pH differential at 580 ohms.
      b) Output: 4-20 mA into 625 ohms isolated.
      c) Power requirements: 115 VAC, 60 Hz.
      d) Response Time: 0.1 to 1.0 seconds, adjustable.
      e) Stability: 0.03 pH.
   4) Physical:
      a) NEMA 4X fiberglass enclosure.
      b) Surface mounted.
      c) Meter: 6-in. scale.
      d) Mount on PVC coated Unistrut assembly adjacent to the ORP transmitter and sensors.
   5) Performance:
      a) Range: 2-12 pH.
      b) Stability: 0.03 pH units per day.

7. Chlorinated Water Feed Control ORP Monitoring System:
   a. The feed rate on the chlorinated water system shall be controlled by an ORP monitoring system comprised of the monitor and the electronic indicating (single loop) controller described below. The ORP monitor system shall be Model 7774-3-1-05-207 as manufactured by Leeds and Northrup, or equal, and shall consist of the following:
   b. ORP Element:
      1) Type:
         a) Insertion Probe with ball valve shutoff.
      2) Operation:
         a) Function: To measure the ORP value of the process fluid as specified in the Loop Diagrams.
         b) Operating Principle: To compare ORP Electrode with an ORP Standard and produce a signal.
      3) Functional:
         a) Pressure Rating: 75 psi at 80 deg C (176 Deg F).
         b) Temperature Limits: 5 to 95 Deg. C (23 Deg to 203 Deg. F).
      4) Physical:
         a) Completely encapsulated, Type 316 stainless steel electrode housing.
         b) Insertion mounted with Type 316 stainless steel valve assembly.
         c) Interconnecting Cable: Belden 8786.
         d) To be inserted into discharge line of the scrubber recirculation pump as shown on the Drawings. Electrode shall be of sufficient length so that it is immersed in liquid.
      5) Performance:
         a) Range: 0-1000 mV dc.
         b) Repeatability: 0.1 percent of SPAN.
         c) Reproducibility: 0.5 percent of SPAN.

c. ORP Indicating Transmitter:
   1) Type:
      a) ORP Input.
      b) Output: Isolated 4-20 mA dc.
   2) Operation:
      a) Purpose is to sense an ORP signal and output an isolated 4-20 mA dc signal.
   3) Functional:
      a) Input: ORP.
      b) Output: 4-20 mA dc isolated.
      c) Power Requirement: 115 VAC, 60 Hz.
      d) Response Time: 0.1 top 1.0 Seconds, Adjustable.
   4) Physical:
      a) NEMA 4X Fiberglass Enclosure.
      b) Surface Mounted.
      c) Meter - 4 inch Scale.
      d) Mount on PVC coated Uni-Strut assembly adjacent to pH indicating transmitter and sensors.

8. Electronic Indicating (Single Loop) Controllers:
   a. General: Electronic Indicating (Single Loop) Controllers shall be provided for executing stand-alone, automatic regulatory loop control and mounted on control panel and as described herein.
      1) The pH loop, consists of fluid being measured (scrubber recirculation pump discharge), sensors device - Item 6 above, controller, chemical (sodium hydroxide metering pump) to be added. pH monitor shall detect the pH of process fluid and send this information to pH controller. pH controller shall compare that pH monitor signal with desired pH (set point) and cause proper amount of sodium hydroxide to be added by sending an output to sodium hydroxide metering pump. All signal's between elements in this control loop shall be 4-20 mA. Loop power supply shall be located in single loop pH controller.
      2) ORP loop is arranged in a manner similar to the pH loop, that is to say, fluid is measured and chlorinated water is added to adjust ORP.
      3) Required setpoints will be given to the CONTRACTOR during shop drawing review.
   b. Type: Microprocessor-based controller with single loop integrity and user configuration capability.
   c. Required Design and Construction Features:
      1) Modular Construction.
      2) Front panel LED, gas-discharge or vacuum-fluorescent type, user configurable displays as follows:
         a) Two (2) vertical bar graphs with percentage scales; capability to provide direct reading scales, insertable without tools, shall be available.
         b) Digital readout display, 4 digits (minimum) with decimal point and minus sign typically for display of values associated with two vertical bar graphs.
         c) One (1) horizontal bar graph with 0 to 100% scale or an auxiliary 4 digit (minimum) digital indicator display, typically for output value.
      3) Front panel pushbuttons or membrane type keypad controls for the following:
         a) Digital display selector.
         b) Remote/Local Setpoint mode selector.

c) Automatic/Manual Output Control Selector, permitting bumpless, balanceless transfer.
d) Raise/Lower Setpoint Adjustments.
e) Increase/Decrease Manual Output Adjustments.

4) Discrete Status Indicators for the following:
   a) Indication of values displayed on digital readout display.
   b) Indication of remote or local setpoint mode.
   c) Indication of automatic or manual mode of operation.
   d) Process alarm limit indication of two separate alarm limit settings.
5) Mounting Requirements: Designed for panel mounting; suitable for single and multiple case mounting within odor control panel. Controllers shall be visible through face of panel.
6) Power Requirements: Unit shall be designed to operate on nominal 24 Vdc power provided by an external panel/instrument power supply. Provide lithium battery backup for controller memory.
7) Input/Output Capabilities:
   a) Analog Inputs:
      1) Type: 4-20 mA dc current signals and 1-5 Vdc signals.
      2) Quantity: Three (3), minimum.
      3) Resolution: 12 bit binary (±0.025%).
      4) Accessories: Provide auxiliary input signal isolators when required.
   b) Analog Outputs:
      1) Type: 4-20 mA dc.
      2) Quantity: Two (2) separate outputs, minimum.
      3) Accessories: Provide auxiliary output signal isolators when required.
   c) Digital Inputs:
      1) Type: 0-15 Vdc logic level.
      2) Quantity: Two (2), minimum.
      3) Accessories: Provide auxiliary interposing relays when required to interface higher level control/status/alarm input signals.
   d) Digital Outputs:
      1) Type: Solid state, open-collector transistor type, logic level outputs (30 Vdc maximum).
      2) Quantity: Three (3), minimum.
      3) Accessories: Provide auxiliary interposing relays when required to provide higher level control/status/alarm outputs.
8) Microprocessor Sampling and Update Rates:
   a) PID and Control Program Execution Rate: Program executed once per 0.1 seconds.
   b) Input Signal Sampling Rate: 0.1 seconds.
   c) Display Update: 0.1 seconds.
   d) Output Signal Update: 0.1 seconds.
9) Required Operational and Functional Capabilities:
   a) Processing capability for two PID control loops with analog input signal conditioning, permitting cascade loop control and dual-independent (two loop) control within a single station.
   b) Anti-reset windup.

c) Ramp setpoint capability.
d) Output limiting.
e) Alarming (absolute process and deviation).
f) Calculation Functions:
   1) Addition.
   2) Subtraction.
   3) Multiplication.
   4) Division.
   5) Square Root.
g) Ratio Control.
h) Lead/Lag.
i) Override Control via remote inputs and/or internal program logic.
j) Totalization capability.
k) Digital Logic Operations.
l) On-Off Digital Output Control.
m) Configurable power fail-auto restart in previous mode at last output or in manual at a preset output.
n) Balanceless and Bumpless control transfer between all operating modes.
o) Internal operating diagnostics to detect hardware malfunctions, memory error, loss of input and low memory battery backup voltage.

10) Communication Capability: Unit shall be designed to permit communication with other controllers and a supervisory control system and/or host computer.

11) Configuration Capability and Accessories:
   a) Controller shall be user-configurable by means of a portable, hand-held configurator terminal which provides access to all configurable parameters and controller set up functions in addition to providing controller configuration and operation diagnostics. The hand-held terminal shall plug connect directly into the front panel of the controller.
   b) The controllers shall be completely pre-configured by the instrumentation and control system supplier to perform the control functions as specified herein.
   c) Controller configuration shall be capable of being copied and transported by either of the following methods:
      1) Portable, battery-backed RAM memory module installed in controller and capable of both copying and loading the controller configuration data base.
      2) External, portable programming terminal with tape cassette or disc drive for off-line programming, editing, and copying of configurations and block downloading of configurations to the connected controller.
   d) One (1) portable configurator terminal shall be supplied with the controllers.

12) PID Control Range Adjustment:
   a) Proportional Band: 0% (off) to 1000%.
   b) Integral: 0.04 seconds to 100 minutes and off.
   c) Derivative: 0.01 minutes to 100 minutes and off.
   d) Manual Reset: 0% to 100%.

13) Connections: Provide compression type terminals for power and signal line connections.

14) NEMA 4X covers with windows.
15) Manufacturers: Provide products of one of the following:
a) Foxboro Company, 760 Series Controller.
b) Or equal.

9. Chemical Unloading Station Alarm Panel:
a. Enclosure:
1) Material of Construction: 14 Ga. Type 316 stainless steel; seams continuously welded and ground smooth; NEMA Type 4X.
2) Control Panel: Attached with stainless steel continuous hinge along one side and stainless steel screws and clamps along other three sides.
3) Finish: Brushed.
4) Required Features:
a) Oil-resistant gasket and adhesive.
b) Weld nuts for mounting subpanel and terminal strips.
5) Manufacturer: Provide products of one of the following:
a) Hoffman ENGINEERing Co. Catalog Series CHNFSS.
b) Or equal.
b. Pushbutton and Light:
1) Required Features:
a) Heavy duty.
b) Oil tight.
c) Square, modular design.
2) Light Lens: Amber.
3) Alarm Acknowledge Pushbutton: Black button to deactivate alarm light at high level. Light shall reset when high level switch resets.
4) Manufacturer: Provide products of one of the following:
a) Micro Switch.
b) Cutler-Hammer.
c) Or equal.

N. Tools, Supplies and Spare Parts:
1. General: Furnish all special tools that are required to assemble, disassemble, repair, and maintain any item of mechanical equipment, with respective equipment. Special tools shall include any type of tool that has been specifically made for use on an item of equipment for assembly, disassembly, repair, and maintenance. When special tools are provided they shall be marked or tagged, and a list of such tools shall be included with maintenance and operation instructions describing use of each marked tool. Additional requirements shall be included with individual items of equipment.
2. Furnish the following spare parts for each chemical feed pump:
a. One diaphragm assembly.
b. One check valve assemblies.
c. One sets of valve gaskets, seals, and O-rings.
3. Furnish the following spare parts for each centrifugal pump:
a. One impeller with nut and washers.
b. One complete assembly of pump bearings.
c. Two complete sets of gaskets, mechanical seals and O-rings.
d. One shaft sleeve.
e. Two sets of mechanical seals.
4. Furnish the following spare parts for horizontal crossflow scrubber:
a. Two sets of gaskets for all gasketed covers and connections.
b. One set of spray nozzles.
c. One spare set of stainless steel nut, bolt and washer assemblies for access doors and one spare set of stainless steel nut, bolt

and washer assemblies for each flanged and gussetted nozzle connection to the scrubber.

d. One set of internal bolts and fasteners for wetted service.
e. Ten percent extra scrubber packing material.

5. Furnish the following spare parts for each fan:
   a. One set of spare belts.
   b. One set of bearings.
   c. Two replacement teflon mechanical seals.
   d. One spare fan shaft.
   e. One spare inlet flexible connector.
   f. One spare outlet flexible connector.
   g. One adjustable motor mount.
   h. One set of adjustable sheaves.
6. Furnish the following spare parts for pH, ORP systems:
   a. One pH sensing element.
   b. One ORP sensing element.
7. Furnish list of solvents for cleaning dirt, grease and oil from surface of non-metalic parts.
8. Pack spare parts in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the project. Provide complete ordering information including manufacturer, part number, part name and equipment for each part to be used.

O. Portable Hydrogen Sulfide Meter:
1. General: Furnish a portable hydrogen sulfide meter and accessories as described in this Section. Meter shall be capable of drawing an air sample, analyzing the hydrogen sulfide concentration and providing a display of the results. Meter shall provide an audible alarm which is activated when a pre-set level is exceeded.
2. Required Features:
   a. Measurement and Sampling Range: 0-10 and 0-50 ppm of hydrogen sulfide in air.
   b. Power Supply: Shall operate on either 105-125 VAC, 50-60 Hertz or on rechargeable Ni/Cad batteries. All required power supply equipment for proper operation including Ni/Cad batteries, power cable, recharger, and recharger cable (if external recharger is supplied) shall be provided.
   c. Maximum Weight: 10 pounds.
   d. Operating Temperature Range: 0 to 40 C.
   e. Minimum Detectable Sensitivity: 0.5 percent full scale.
   f. Span and Zero Drift: Less than 1.0 percent full scale/day.
   g. Response Time: Less than 60 seconds to 90 percent of signal.
3. Accessories: Provide the following accessories as a minimum:
   a. Air Intake Dust Filter(s): As recommended by the meter manufacturer.
   b. 50-foot Length of Sampling Line: Either synthetic rubber or equal, as recommended by the meter manufacturer, shall be provided.
   c. Calibration Kit or Equipment: As a minimum this shall include:
      1) Calibration Gas: 10 ppm in a 100-liter disposable pressurized container.
      2) Calibration gas regulator.
      3) Sample Bags: Provide six 2-liter bags.
   d. Instruction Manual.
   e. Spare Parts:
      1) Two (2) air intake dust filters.

2) One electro chemical sensor.
3) One air pump.
4) Four intake air connectors.
5) Six fuses.
6) Two (2) circuit board batteries.

4. Manufacturer: Provide products of one of the following:
   a. Ecolyzer 2000, Energetics Science, Division of National Draeger, Incorporated.
   b. Mine Safety Appliances Company (MSA), Model 80.
   c. Or equal.

P. Flow Switch:
1. Switch shall be of the in-line type suitable for clean water caustic solution and chlorinated water.
   a. Body: Kel-F, Kynar, or PVC.
   b. Cover and Housing: NEMA 4X environment.
   c. Paddle: Teflon, Kynar, or PVC.
   d. Bearings: 440C stainless steel micro ball.
   e. Switch: DPDT 10A-125 VAC; environment-proof.
   f. Service line 2-inches and below: screw mount; above 2-inches: flange mount.
   g. Use of packing glands or stuffing boxes shall not be acceptable.
   h. Provide flow switch for scrubber recirculation pumps discharge header.
   i. Provide flow switch in each chemical feed pump pressure relief valve discharge line to shut off pump in the event of flow.
   j. Manufacturer: Provide products one of the following:
      1) PEECO.
      2) Or equal.

2.2 SURFACE PREPARATION AND SHOP PAINTING

A. All components of odor control system shall receive manufacturer's surface preparation and shop priming compatible with field painting specified under Section 9L, Painting.

B. All equipment such as, scrubber carbon adsorber towers, pumps, fans and materials specified above including FRP surfaces shall be factory prime painted with an epoxy-polyamide primer, Tnemec Series 66 Hi-Build Epoxoline 3 to 5 dry mils or equal. Primer paint used shall be compatible with final paint system specified in Section 9L, Painting. Submit paint manufacturers complete standard and custom color charts for color selection by OWNER and ENGINEER.

C. CONTRACTOR shall retain services of paint system manufacturer to instruct scrubber fabricator in proper surface preparation and proper application of paint system on the FRP surfaces. A sample FRP panel not less than 2 square feet shall be painted and allowed to dry for not less than 48 hours and then be checked for paint adhesion by paint system manufacturer and submitted to ENGINEER.

D. All odor control components including the scrubber shall be field painted in accordance with the requirements of Section 9L, Painting.

E. Machined, polished and non-ferrous surfaces shall be coated with corrosion prevention compound.

F. Moving parts shall not be painted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine pads or supports to receive scrubber, adsorbers, storage tank, fans, and pumps for:
   1. Proper anchor bolt locations.
   2. Unevenness, irregularities and incorrect dimensions.

B. Supervise installation in accordance with manufacturer's instructions and recommendations.

C. Installation shall include furnishing and applying an initial supply of chemicals as recommended by the manufacturer.

D. Provide flanged flexible connections at air inlet and discharge of fans.

E. All flexible connections with air handling equipment will be supported at free end within 18 inches of joint.

F. Test holes and air sampling tubes with cocks shall be provided at air intakes and in exhaust stacks of scrubber and adsorbers.

G. Installation of pumps shall be in complete accordance with manufacturer's instructions and recommendations.

H. Vibration isolators for fans and pumps shall be installed in accordance with Section 15H47, Vibration Isolation.

I. All pumping units shall be installed on concrete bases and secured with anchor bolts in accordance with the manufacturer's recommendations and as shown. Concrete bases shall be poured up to 1 inch below metal bases or soleplates shall then be accurately shimmed to grade and spaces between filled with an approved nonshrink grout. After grout has reached its initial set, exposed edges shall be cut back 1/2 inch and edges neatly finished with 1:2 cement mortar. Where channel baseplates are used, void inside the channel shall be filled with nonshrink mortar and open ends plastered with 1:2 cement mortar.

J. Neatly placed 1 inch Schedule 40 PVC pipe shall be provided on each pump to convey leakage to nearest drainage point.

K. Installation shall include furnishing and applying an initial supply of grease and oil, recommended by the respective manufacturer's.

L. Support piping independent of pumps.

M. Check and align all pump, motor and flexible shafting.

N. Install vibration isolators and pumps on base and anchor securely.

O. Connect all piping, valves accessories as detailed on the Drawings and approved Shop Drawings.

P. Install all conduit and wiring and complete all connections.

3.2 INSPECTION OF SCRUBBER, CARBON TOWERS AND CHEMICAL STORAGE TANK

A. ENGINEER reserves right to reject any and all items of equipment found to have following: blisters, chips, crazing, exposed glass, dry cracks, burned areas, dry spots, foreign matter, or entrapped air at the laminate surfaces which do not satisfy the tolerances specified in ASTM D 2563 Table 1 and following table:

ALLOWABLE FRP PRODUCT TOLERANCES

Defect	Inside Surface Acceptance Level I	Outside Surface Acceptance Level II	
Blisters (rounded elevations of the laminate surface over bubbles)	None	Max. dimensions: Max. density:	1/4" dia x 1/16" high 1/SF
Chips (small pieces broken from edge or surface)	None	Max. dimension of break:	1/8" dia. by 1/32" deep. max. number 3/sq.ft.
Crazing (fine resin rich surface cracks)	None	Max. length: Max. density:	1/8" 5/SF
Cracks	None	None	
Exposed Glass	None	None	
Scratches	None (coated)	None (coated)	
Sharp Discontinuity	None	None	
Burned Areas	None	None	
Surface Porosity Pinholes or Pores in the Laminate	None	None	
Foreign Inclusion	None	None if matter affects the properties of the laminate.	
Sharp Discontinuity	None	None	
Pitting	None	Max.: Max. number:	1/8" dia. x 1/16" depth 10/SF
Dry Spots	None	3/8 inch diameter maximum	

ALLOWABLE FRP PRODUCT TOLERANCES (cont'd)

Defect	Inside Surface Acceptance Level I	Outside Surface Acceptance Level II
Entrapped Air	None at surface Within laminate	Max. size and density: 1/8" dia. & 4/sq. ft. or 1/16" Max. size: dia. and 10/sq. ft. 1/16" dia.x 1/32" deep Max. density: 10/SF
Surface Porosity	None	None
Exposed Cut Edges	None	None
Sags, Wrinkles and Waves	None	Max. sag, wrinkle or wave deviation 20% of wall thickness but not to exceed 1/4 inch.

3.3 START-UP ADJUSTMENT AND TESTING

A. Lubricate bearings if required prior to starting fans and pumps.

B. Check for proper shaft rotation.

C. Adjust fans and pumps for proper alignment and flow.

D. Set volume control devices for approximate positions in preparation for final testing and balancing.

E. Balance system for CFM given on the Drawings and in accordance with this Section and as specified in Section 17892.

F. Conduct performance tests as described in Section 3.5.

G. Leave entire system in working order.

3.4 INSTALLATION AND OPERATIONAL TESTING

A. CONTRACTOR shall furnish, install, and test all mechanical equipment.

B. Equipment shall be installed as specified herein and as indicated on Drawings, and in accordance with the manufacturer's recommendation. Equipment shall be installed in such manner that connecting piping will not impose any strain whatever on any equipment. Equipment shall be set upon grouted foundations, level or perpendicular, as the case may be, so that connecting flanges, screwed connections, or flexible connections will meet without strain or distortion. Base leveling nuts shall be blocked out during grouting of foundations, the grout allowed to set for not less than three days, leveling nuts loosened and followed by grouting of block-outs, with nonshrink grout as specified in Section 3D.

C. All equipment shall be installed with Type 316 stainless steel anchor bolts as specified in Section 5G.

D. All equipment furnished under this Section shall be suitable for installation as shown on Drawings and specified herein. CONTRACTOR shall be responsible for determining the necessary clearances and headroom required to move all equipment to its final location.

E. In every case where a drive motor is connected to a driven piece of equipment by a flexible coupling, the coupling halves shall be disconnected and alignment between motor and equipment checked and corrected. Machinery shall first be perfectly aligned and leveled by means of steel wedges and shims near anchor bolts. Anchor bolts shall be tightened against shims on wedges and equipment shall again be checked for level and alignment before placing grout.

F. In general, checking and correcting the alignment shall follow procedures set up in the Standards of the Hydraulic Institute, Instructions for Installation, Operation, and Maintenance of Centrifugal Pumps. Equipment shall be properly leveled and brought into annular and parallel alignment.

G. Equipment bases shall not be grouted nor foundation bolts finally tightened until all piping connections are complete and in satisfactory alignment with no strain transmitted to the equipment.

3.5 PERFORMANCE TESTS

A. General: CONTRACTOR shall conduct performance tests on the odor control system. The performance test shall demonstrate that the off-gas from the system has an average odor concentration of no more than 100 Odor Units, that hydrogen sulfide removal efficiency is greater than 99 percent and that pressure drop through horizontal crossflow scrubber is less than 3.0 inches H_2O when the system is operated at design conditions as described herein. Additionally, the performance tests shall demonstrate that the off-gas from the carbon adsorption towers has an average odor concentration of no more than 100 Odor Units, that hydrogen sulfide removal efficiency is greater than 99.5 percent and that pressure drop through each activated carbon bed is greater than 4.5 inches minimum.

B. Horizontal Crossflow Scrubber Test Procedure: The performance test shall be conducted at such a time as when all anticipated odorous air streams are present in the scrubber inlet. The date and time of the tests and detailed test procedure shall be submitted for approval of ENGINEER two weeks prior to the testing period. In the event hydrogen sulfide levels are below anticipated levels of 25 ppm Vendor shall augment the hydrogen sulfide levels in the influent air stream so the hydrogen sulfide level is 25 ppm ± 2 ppm. Hydrogen sulfide cylinders shall be furnished with OSHA approved regulators and manifolds. At minimum, the test procedure shall consist of the following elements:
   1. The scrubber system shall be operated before, during, and after testing at design conditions. Design conditions are defined in the schedule below in Part 2 of this specification.
   2. During testing, chemical feed, scrubber overflow, recirculation and scrubber airflow rates shall be held constant. Changes in scrubber system operating conditions shall not be permitted. All fine-tuning of operating conditions shall be performed prior to testing.

SECTION 15I1

POTABLE WATER PIPING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, material, equipment and incidentals required to provide a complete and workable system of potable water piping including all hot and cold water piping, valves, and accessories as shown or specified and to the limits shown on the Drawings.

B. Related Work Specified Elsewhere:
   1. Division 2D1, Excavation and Backfill.
   2. Section 5E3, Miscellaneous Metal Fabrications.
   3. Section 15C3, Pipe Hangers, Supports and Restraints.
   4. Section 15C4, Wall Pipes, Floor Pipes and Pipe Sleeves.
   5. Section 15I7, Plumbing Fixtures and Trim.
   6. Section 15I8, Hot Water Heater.
   7. Section 15I11, Insulation, Plumbing.
   8. Section 15I12, Installation of Plumbing Piping.
   9. Section 15I15, Testing of Plumbing, Piping System.
   10. Section 15I16, Disinfection.

C. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes:
      a. Comply with applicable requirements of all governing authorities and the following codes:
         1) Uniform Building Code.
         2) Uniform Plumbing Code.
   2. Permits:
      a. CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.

B. Reference Standards:
   1. Comply with applicable provisions and recommendations of the following except as otherwise shown or specified:
      a. ANSI A13.1, Identification of Piping Systems.
      b. ANSI B16.5, Steel Pipe Flanges, Flanged Valves, and Fittings.
      c. ANSI B16.15, Cast Bronze Threaded Fittings, 125 and 250 lbs.
      d. ANSI B16.18, Cast Bronze Solder Joint Pressure Fittings.
      e. ANSI B16.22, Wrought Copper and Bronze Solder-Joint Pressure Fittings.
      f. ANSI B16.24, Bronze Flanges and Flanged Fittings, 150 and 300 lbs.
      g. ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
      h. ANSI H 23.1, Seamless Copper Water Tube, (ASTM B 88).
      i. ANSI H27.1, Seamless Red Brass Pipe, Standard Sizes (ASTM B 43).

j. ASTM A 183, Heat-Treated Carbon Steel Track Bolts and Carbon Steel Nuts.
k. ASTM A 307, Carbon Steel Externally and Internally Threaded Standard Fasteners.
l. ASTM B 32, Solder Metal.
m. ASTM D 1330, Sheet Rubber Gaskets.
n. ASTM D 2000, Elastomeric Materials for Automotive Applications, Classification System for,
o. FS O-F-506B, Flux, Soldering: Paste and Liquid.
p. FS WW-U-531C, Unions, Pipe; Steel or Malleable Iron; Threaded Connection.
q. FS WW-U-516, Unions, Brass or Bronze; 250 pound.
r. PDI WH-201,

1.3 SUBMITTALS

A. Shop Drawings:
1. Submit for approval the following:
a. Manufacturers literature, specifications, and engineering data including dimensions, size and materials for the following:
1) Pipe and Fittings.
2) Valves.
3) Backflow Preventers.
4) Strainers.
5) Water Hammer Arrestors.
6) Hose Bibbs and Wall Hydrants.
7) Dielectric Fittings.
8) Thermometers.
9) Relief Valves.
10) Other materials and equipment requested by ENGINEER.
2. Detailed 1/4-inch scale drawings showing materials and dimensions of the complete potable water piping system, in plan and in section.
3. Guarantees.

B. Record Drawings: During progress of the Work, keep an up to date set of drawings showing field and Shop Drawing modifications. Immediately upon completion of piping Work, submit cloth or mylar tracings showing the actual in-place installation of all piping and equipment installed under this Section, at a scale satisfactory to the ENGINEER. The Drawings shall show all piping on plans and in sections, with all reference dimensions and elevations required for complete "record" drawings of the piping systems. Two paper prints shall also be furnished. The tracings shall be submitted at completion of the Contract and prior to final payment.

1.4 JOB CONDITIONS

A. Protection:
1. Properly plug or cap the open ends of all pipe at the end of each days work or other stopping point throughout construction. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury.

3. Design operating conditions shall be maintained for a minimum of 6 hours. During this time, all pertinent operating parameters shall be monitored and recorded, sufficient sampling and analysis shall be conducted to demonstrate that flow rates, temperatures and solution concentrations are at design conditions.
4. Hydrogen sulfide concentration in each scrubber inlet and outlet shall be measured and scrubber pressure drop from each scrubber air inlet to exhaust shall be recorded. A minimum of 2 samples shall be collected for odor panel testing, at evenly spaced intervals over the period while each scrubber system is operating at design conditions. The samples shall be collected in either Tedlar sample bags or evacuated stainless steel cylinders. The samples shall be collected and stored so as to ensure that contamination, dilution, adsorption effects, and sample deterioration are minimized. A maximum of 24 hours shall elapse between off-gas sampling and the odor panel tests.
5. Odor panel tests shall be conducted on samples from each scrubber stack exhaust. The tests shall be conducted in accordance with the Dynamic Dilution Forced-Choice Triangle Olfactometer (IIT Research Institute) method. The odor concentration in Odor Units shall be determined for each sample.

C. Carbon Adsorption Tower Test Procedure: The performance test shall be conducted at such a time as when all anticipated odorous air streams are present in each carbon tower inlet. The date and time of the tests and detailed test procedure shall be submitted for approval of ENGINEER two weeks prior to the testing period. In the event, the hydrogen sulfide levels are below the anticipated levels of 0.25 ppm the CONTRACTOR shall augment the hydrogen sulfide levels in the influent air stream so the hydrogen sulfide level is 25 ppm. Hydrogen sulfide cylinders shall be furnished in the quantities required with OSHA approved regulators and manifolds. At minimum, the test procedure shall consist of the following elements:

1. The carbon adsorber system shall be operated before during and after testing at design conditions. Design conditions are defined in the schedule below in Part 2 of this specification.
2. During test procedure carbon tower airflow rates shall be held constant, changes in operating conditions shall not be permitted. All fine tuning of operating conditions shall be performed prior to testing.
3. Design operating conditions shall be maintained for a minimum of 2 hours. During this time, all pertinent operating parameters shall be monitored and recorded, sufficient sampling and analysis shall be conducted to demonstrate that air flow rates and concentrations are at design conditions.
4. Hydrogen sulfide in each carbon tower inlet and outlet shall be measured and carbon tower pressure drop from each carbon tower air inlet to exhaust outlet shall be recorded. A minimum of 2 samples shall be collected, for odor panel testing, at evenly spaced intervals over the 2 hour test period while each carbon tower is operating at design conditions. The samples shall be collected in either Tedlar sample bags or evacuated stainless steel cylinders. The samples shall be collected and stored so as to ensure that contamination, dilution, adsorption effects and sample deterioration are minimized. Not more than maximum of 24 hours shall elapse between off-gas sampling and odor panel tests. Samples more than 24 hours old will not be acceptable for any testing.

5. Odor panel tests shall be conducted on samples from each carbon tower effluent. The tests shall be conducted in accordance with the Dynamic Dilution Forced-Choice Triangle Olfactometer (IIT Research Institute) method. The odor concentration in odor units shall be determined for each sample.

D. Results: A description of the performance tests and the results of the odor panel tests shall be submitted to OWNER and ENGINEER. The average odor concentration (average of at least 2 tests) of each system off-gas of each odor control system shall not exceed 100 Odor Units. The hydrogen sulfide compound removal efficiency shall be greater than 99 percent. Should scrubber system performance not meet any of the above requirements, that system shall have failed the performance tests. CONTRACTOR shall make any additions or modifications to that odor control system as may be necessary at no additional cost to OWNER and the performance tests for that system shall be repeated in entirety.

3.6 CLEANING

A. Remove all loose materials and obstructions from interior of ducts and scrubber.

B. Remove debris and waste materials resulting from installation.

3.7 OPERATION SERVICES

A. Instruct plant operators in proper operation and maintenance of system.
B. Inspect scrubber system every third month for twelve months and report findings.

3.8 MANUFACTURER'S TRAINING SERVICES

A. CONTRACTOR shall furnish the services of qualified factory trained specialists from each manufacturer to instruct the OWNER'S operators and maintenance personnel in the recommended operation and maintenance of this equipment. Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 1H5 under Division 1.

+ + END OF SECTION + +

PART 2 - PRODUCTS

2.1 MATERIALS

A. Copper Water Tube:
   1. Tube:
      a. Reference: ANSI H23.1.
      b. Type: K or L.
      c. Temper: Hard-drawn or soft-annealed.
   2. Fittings:
      a. Reference: ANSI B16.22 (for hard drawn tubing).
      b. Reference: ANSI B16.26 (for soft drawn tubing).
      c. Reference: ANSI B16.18.
   3. Joints:
      a. Sweat:
         1) Solder Metal: ASTM B 32, Alloy Grade 95TA.
         2) Flux: FS O-F-506, Type 1.
      b. Flared:
         1) Reference: ANSI B16.26.
      c. Flanged:
         1) Flanges: ANSI B16.24, 150 lb. class.
         2) Gaskets: Red rubber, ASTM D1330, Grade 1, 1/8-inch thick.
         3) Nuts and Bolts: ASTM A 307.
   4. Unions:
      a. Reference: FS WW-U-516.
      b. Material: Bronze
      c. Rating: 250 pound W.O.G.

B. Chrome Plated Brass Pipe:
   1. Pipe: Red brass, ANSI H27.1.
   2. Fittings: Cast bronze, threaded, ANSI B16.15.
   3. Finish: Chrome plated.

C. Ductile Iron Pipe:
   1. Pipe: Ductile-Iron ANSI A21.51.
   2. Fittings: Ductile-Iron ANSI A21.11.
   3. Mechanical Joint (Underground):
      a. Glands, Bolts and Nuts: ANSI A21.11.
   4. Flanged: (Above ground within buildings).
      a. Reference: ANSI B16.1, Class 125 or Class 250 as required.
   5. Lining: Cement lined ANSI A21.4.

D. Dielectric Couplings:
   1. Product and Manufacturer: Provide couplings manufactured by one of the following:
      a. Watts Regulator Company.
      b. Epco Sales Incorporated.
      c. Or equal.
   2. Type: Union or flange.
   3. Rating: 250 psi at 180 F.

E. Bronze Body Gate Valves:
   1. Product and Manufacturer: Provide valves manufactured by one of the following:
      a. Stockham Valves and Fittings, Fig. No. B-124.
      b. Lunkenheimer Company, Fig. No. 3155.
      c. Or equal.

2. Type: Rising stem, union bonnet solid wedge disc.
3. Materials: Brass and bronze.
4. Rating: 150 lb. SWP.
5. End Connections: Solder joint.

F. Bronze Body Globe Valves:
1. Product and Manufacturer: Provide valves manufactured by one of the following:
   a. Stockham Valves and Fittings, Fig. No. B-24.
   b. Lunkenheimer Company, Fig. No. 126.
   c. Or equal.
2. Type: Teflon disc, union bonnet.
3. Materials: Brass and bronze.
4. Rating: 150 lb. SWP.
5. End Connections: Solder joint.

G. Bronze Body Check Valves:
1. Product and Manufacturer: Provide valves manufactured by one of the following:
   a. Stockham Valves and Fittings, Fig. No. B-309.
   b. Lunkenheimer Company, Fig. No. 2145.
   c. Or equal.
2. Type: Swing, regrinding bronze disc, screw-in cap.
3. Materials: Brass and bronze.
4. Rating: 200 lb. SWP.
5. End Connections: Solder joint.

H. Brass Body Ball Valves:
1. Manufacturer and Model:
   a. Jamesbury Corp., Fig. 21-1100TT.
   b. Or equal.
2. Construction:
   a. Body: Brass.
   b. Ball: Brass.
   c. Seat and Body Seals: TFE.
   d. Stem Seal: Spring loaded TFE.
   e. Stem: Brass.
3. Required Features:
   a. End Connections: Threaded or threaded to solder adapter as required.
   b. Valve rated for service at 400 psi and 100°F.
   c. Provide standard ball with large circular port.

I. Strainers:
1. Product and Manufacturer: Provide strainers manufactured by one of the following:
   a. Mueller Steam Specialty Company.
   b. Armstrong Steam Specialty Company.
   c. Or equal.
2. Type: Self-cleaning "Y" body with blow-off cock.
   a. Basket: Perforated metal basket.
   b. Perforations: 0.045-inches diameter, minimum.
   c. Free Area: 4 times cross sectional area of connecting pipe, minimum.

3. Construction:
   a. Body: Cast bronze.
   b. Basket: Monel.
4. Pressure Rating: 250 psi steam at 425 F temperature.
5. End Connections: Solder ends or screwed ends with adapters for screw to sweat ends.

J. Backflow Preventer: 2-1/2 inch:
1. Product and Manufacturer: Provide backflow preventer manufactured by one of the following:
   a. Watts Regulator Company - 909 Series.
   b. Cla-Val Co.
   c. Or equal.
2. Type: Reduced pressure principle.
3. Materials:
   a. Body and Cover: Cast iron, ASTM 126.
   b. Main Valve Trim: Bronze, ASTM B-61.
   c. Differential Relief Valve: Bronze ASTM B-61 with stainless steel 316 trim.
4. Maximum Working Pressure: 150 psig.
5. Fluid: Water.
6. Temperature Range: 35°F to 110°F.
7. Hydrostatic Test Pressure: 300 psig.
8. End Connections: 125 ANSI flanged.
9. Tight closing shut-off valves.
10. Accessories:
    a. Strainer.
    b. Air gap drain funnel with threaded outlet.
11. Classified by UL as to friction loss and body strength.

K. Backflow Preventers: 3/4 Inch to 2 Inches:
1. Product and Manufacturer: Provide backflow preventer manufactured by one of the following:
   a. Beeco Division, Hersey Products Inc., Aergap Model FRP-II.
   b. Febco Sales, Inc., Model 825Y.
   c. Or equal.
2. Type: Reduced pressure principle.
3. Materials:
   a. Body: Bronze.
   b. Valve Discs: EPT rubber.
   c. Diaphragm: Buna-N and nylon.
   d. Springs: Stainless steel.
   e. Screws: Stainless steel.
4. Maximum Working Pressure: 150 psi.
5. End Connection: Screwed.
6. Accessories:
   a. Air gap drain funnel with threaded outlet.
   b. Strainer with blowoff on inlet.

L. Hose Bibbs, Pipe Drains:
1. Product and Manufacturer: Provide hose bibbs manufactured by one of the following:
   a. Woodford Manufacturing Company, Model 24C.
   b. Nibco Fig. No. 74VB.
   c. Or equal.

2. Type: Backflow protected wall faucet.
3. Materials:
   a. Vacuum breaker: Nickel vacuum breaker ASSE Standard 1011.
   b. Construction: Nickel plated brass, adjustable packing nut, teflon impregnated packing. Standard size washer.

M. Wall Hydrants:
1. Exposed Hose Connection Type:
   a. Product and Manufacturer: Provide hydrants manufactured by one of the following:
      1) Jay R. Smith, Fig. No. 5607.
      2) Or equal.
   b. Type: Anti-siphon wall hydrant.
   c. Materials:
      1) Casing: Bronze.
      2) Vacuum Breaker: Integral.
      3) Threads: Standard 3/4-inch hose thread outlet.
      4) Wall Clamp: Adjustable with set screw.
      5) Key: Removable tee handle type.
   d. Connection: 3/4-inch sweat end inlet and 3/4-inch hose thread outlet, universal type.

N. Water Hammer Arresters:
1. Product and Manufacturer: Provide arresters manufactured by one of the following:
   a. Hydrotrol by Jay R. Smith Manufacturing Company.
   b. Shoktrol by Zurn Industries.
   c. Or equal.
2. Materials:
   a. Casing: Stainless steel.
   b. Bellows: Stainless steel.
   c. Bellows Contents: Nitrogen gas.
   d. Connection: Male NPT thread.
   e. Maximum Working Pressure: 250 psig.
3. Sizing and Certification: P.D.I. WH-201.

O. Pipe Labels:
1. Type: Self-adhering, temperature resistant, waterproof, corrosion resistant.
2. Marker size, marker color, legend size, and legend color shall conform to ANSI A13.1.

P. Thermometers:
1. Product and Manufacturer: Provide thermometers manufactured by one of the following:
   a. Weksler Instrument Company.
   b. H.O. Trerice Company.
   c. Or equal.
2. Range: 30 F to 240 F temperature range in maximum of 2 F increments.
3. Type: Adjustable Angle Column Type Thermometer.
   a. Construction:
      1) Scales and Lens: 9-inch high satin finish aluminum scales, black numerals, front red reading mercury tubes.

2) Wells: Insertion well with brass separable sockets.
3) Neck: 2-1/2-inch extension neck.
4) Case: Cast aluminum with bronze finish.
5) Window: Glass or clear acrylic plastic.

2.2 MATERIAL SELECTION

A. All water piping 2-1/2 inches and smaller, run within the interior of a building, shall be hard-drawn copper type "L" with solder joints and connections.

B. All underground water piping 2-1/2 inches and smaller shall be soft-annealed copper type "K" with flared joints and connections.

C. All water piping 3 inches and larger shall be mortar lined ductile iron pipe.

D. All exposed water piping and valves to plumbing fixtures shall be chrome plated brass, unless otherwise specified.

E. All valves for copper or brass piping shall be bronze bodied unless otherwise specified.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of piping shall be in accordance with Section 15I12.

B. All piping shall be pitched to facilitate draining. Pipe drain valves shall be provided at system low points.

C. Harnessed flexible couplings or pipe loops shall be provided on all piping subject to thermal expansion.

D. Harnessed flexible couplings shall be provided where piping 3 inches and larger crosses building expansion joints.

E. Unions shall be provided for all screwed piping at connections to equipment and at convenient locations to permit disassembly of piping.

F. All connections between ferrous and non-ferrous piping materials shall be made with dielectric couplings.

G. Care shall be taken so as not to leave tool marks or abrasions on plated, polished or soft metal piping.

H. Wherever changes in sizes of piping occur, changes shall be made with reducing fittings. The use of bushings is not permitted unless otherwise shown.

I. All exposed unfurred pipes, whether insulated or not, shall be identified with pipe labels and the direction of flow indicated. Labels may be omitted from piping where the use is obvious, due to its connection

to fixtures and where the appearance would be objectionable in finished rooms; as approved by the ENGINEER. Identification labels shall be placed as follows:

1. Near each valve and branch connection.
2. Wherever piping emerges or disappears from view, when viewed from the floor of the room in which it is installed.
3. At not more than 50 foot intervals.

J. All pipes passing through ceilings, floors and walls in finished rooms, and all supplies to fixtures shall have escutcheon plates.

K. All thermometers shall be legible from a standing position on the floor.

L. Pressure gage ranges shall be selected for proper sensitivity, so that the dial indicator points to the approximate center of the dial in normal operation.

M. Provide valved blow-off connections for each strainer.

N. Remove each fine mesh start-up strainer screen and replace with final stainless steel strainer screen after 30 days of operating time.

O. Conform to applicable requirements in Sections 15A1 and 15A2, Piping Installation.

P. Provide shutoff valves to each piece of equipment furnished.

Q. Pipe backflow preventer waste to closest floor drain, mop receptor or service sink.

R. Provide strainers on inlets to all backflow preventers.

S. Every section of branch supply and return piping and all risers of all services shall be controlled by a valve at the main.

T. Make final connections to all laboratory equipment requiring hot and cold water.

3.2 PREPARATION

A. Disinfection: Conform to Section 15I16.

3.3 FIELD QUALITY CONTROL

A. Tests: Pressure test all systems in conformance with Section 15I15.

3.4 CLEANING

A. Remove all debris, dirt and waste materials resulting from installation.

B. Remove dirt, dust, rust, etc. from piping in preparation for painting, testing and insulating.

C. Clean lenses on thermometers, pressure gauges, etc. where required.

+ + END OF SECTION + +

SECTION 15I2

WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide a complete waste and vent piping system including all floor, equipment and trench drains and all soil, waste, drain and vent piping as shown or specified and to the limits designated on the Drawings.

B. Related Work Specified Elsewhere:
1. Division 2D1, Excavation and Backfill.
2. Section 15C3, Pipe Hangers, Supports and Restraints.
3. Section 15C4, Wall Pipes, Floor Pipes and Pipe Sleeves.
4. Section 15I12, Installation of Plumbing Piping.
5. Section 15I15, Testing of Plumbing, Piping System.

C. Coordination:
1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
   a. Uniform Building Code.
   b. Uniform Plumbing Code.
2. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.

B. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified:
1. ANSI A21.6, Cast-Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids.
2. ANSI A21.11, Rubber Gasket Joints for Case-Iron and Ductile-Iron Pressure Pipe and Fittings.
3. ANSI A21.50, Thickness Design of Ductile-Iron Pipe.
4. ANSI A21.51, Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
5. ANSI A112.5.1, Cast Iron Soil Pipe and Fittings.
6. ANSI B16.12, Cast-Iron Threaded Drainage Fittings.
7. ANSI B125.2, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses.
8. ASTM C 564, Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
9. ASTM D 1248, Polyethylene Plastics Molding and Extrusion Materials.
10. ASTM D 1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
11. ASTM D 2466, Socket-Type Poly (Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
12. ASTM D 2467, Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

13. CISPI 301-78, Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary System.
14. CISPI 310-78, Cast Iron Soil Pipe Institute's Patented Joint for Use in Connection with Hubless Cast Iron Sanitary System.
15. FS QQ-C-40, Federal Specification for Calking: Lead Wool and Lead Pig.
16. FS HH-P-117, Federal Specification for Packing, Jute Twisted.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturers literature, specifications, and engineering data including, dimensions, size and material of the following:
      a. Floor, equipment and trench drains.
      b. Floor and wall cleanouts.
   2. Pipe and fittings.
   3. Drawings on a 1/4-inch scale showing materials and dimensions of the complete waste and vent piping system, in plan and in section.

B. Record Drawings: During progress of the Work keep an up to date set of Drawings showing field and Shop Drawing modifications. Immediately upon completion of piping Work submit cloth or mylar tracings showing the actual in-place installation of all piping and equipment installed under this Section, at a scale satisfactory to the ENGINEER. The Drawings shall show all piping on plans and in sections, with all reference dimensions and elevations required for complete "record" drawings of the piping systems. Two paper prints shall also be furnished. The tracings shall be submitted at completion of the Contract and prior to final payment.

1.4 JOB CONDITIONS

A. Protection: Properly plug or cap the open ends of all pipe at the end of each days work or other stopping point throughout construction. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Waste and Vent Piping:
   1. Cast Iron Soil Pipe and Fittings:
      a. Pipe and Fittings: ANSI A112.5.1.
      b. Weight: Service.
      c. Joints:
         1) Calked:
            a) Lead: FS QQ-C-40, Type I, Grade AA.
            b) Jute Packing: FS HH-P-117, Type I.
         2) Compression:
            a) Gasket: Rubber, ASTM C 564.
            b) Lubricant: As recommended by pipe manufacturer.
   2. Hubless Cast Iron:
      a. Pipe and Fittings: CISPI Standard No. 301.
      b. Joints: CISPI Standard No. 310.

3. Steel Pipe and Fittings:
   a. Pipe: ANSI B125.2.
   b. Weight: Schedule 40.
   c. Finish: Galvanized.
   d. Fittings: ANSI B16.12 threaded so as to allow 1/8-inch or 1/4-inch per foot grade, as needed.
4. Poly (Vinyl Chloride) Pipe and Fittings:
   a. Pipe: ASTM D 2665.
   b. Weight: DWV.
   c. Fittings: ASTM D 2665, drainage type.
   d. Joints:
      1) Chemical weld with manufacturers recommended solvent.

B. Floor Drains:
1. Floor Drain and Shower Drain: Toilets, Laboratory and Showers: Type 1:
   a. Product and Manufacturer: Provide drains manufactured by one of the following:
      1) Jay R. Smith, Fig. 2010-B.
      2) Zurn Industries, Fig. Z-415 with "Y" strainer.
      3) Or equal.
   b. Materials:
      1) Body: Cast iron.
      2) Collar: Cast iron, reversible, threaded for strainer heads, enamel coated.
      3) Strainer Head: Square nickel bronze grate with bronze body, heel proof grate, and vandal proof screws.
   c. Outlet Connection: Threaded or inside calk as required.
2. Floor Drain: General Purpose: Type 2:
   a. Product and Manufacturer: Provide drains manufactured by one of the following:
      1) Jay R. Smith, Fig. 2340.
      2) Zurn Industries, Fig. Z-520.
      3) Or equal.
   b. Materials:
      1) Body: Cast iron.
      2) Collar: Cast iron.
      3) Top: Enameled cast iron adjustable 10-inch or 12-inch diameter.
      4) Grate: Ductile iron.
   c. Accessories:
      1) Sediment bucket.
      2) Vandal proof.
   d. Rating: Heavy duty.
   e. Outlet Connection: Threaded or inside caulk as required.

C. Cleanouts:
1. Floor Cleanouts:
   a) Product and Manufacturer: Provide cleanouts manufactured by one of the following:
      1) Jay R. Smith, Fig. 4021.
      2) Zurn Industries, Fig. Z-1400.
      3) Or equal.
   b) Materials: Cast iron body and adjustable bronze top.
   c) Outlet Connection: Standard spigot.

d) Accessories:
   1) Flashing flange with flashing device and 1/4-inch diameter weep holes.
   2) Round heavy duty nickel bronze top.
   3) Square heavy duty nickel bronze top with tile recess.
   4) Plug: Cast bronze taper thread plug.

2. Riser Cleanout:
   a) Product and Manufacturer: Provide cleanouts manufactured by one of the following:
      1) Jay R. Smith, Fig. 4402.
      2) Zurn Industries, Fig. No. Z-1440-1.
      3) Or equal.
   b) Materials: Cast bronze taper thread plug.
   c) Accessories:
      1) Stainless steel round shallow wall plate.
      2) Cast iron calked ferrule.

2.2 MATERIAL SELECTION

A. All exposed gravity waste and vent piping run within the interior of a building shall be threaded steel or hubless cast iron. Concealed gravity soil, waste and vent piping lines in chases may be threaded steel or hubless cast iron.

B. All gravity waste and vent piping located in concrete slabs or underground to exterior limits as shown shall be hub and spigot cast iron pipe and shall be coated with two 6 mil coats of asphaltum or coal tar pitch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of drains and cleanouts shall be in accordance with manufacturers instructions and recommendations.

B. Installation of piping shall be in accordance with Section 15I12.

C. All waste and vent piping in chases shall pitch uniformly at a 1/4- inch per foot grade, otherwise waste and vent piping shall pitch uniformly at 1/8-inch per foot grade unless otherwise shown.

D. Traps shall be furnished and installed where shown and as required by local building codes.

E. Accessible cleanouts shall be furnished and installed as shown and as required by local building codes.

3.2 FIELD QUALITY CONTROL

A. Tests: Water or smoke test in accordance with Section 15I15.

+ + END OF SECTION + +

SECTION 15I7

PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, tools and incidentals required to furnish, install, clean, test and adjust all plumbing fixtures and trim as shown and specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

C. Related Work Specified Elsewhere:
   1. Section 15I1, Potable Water Piping Systems.
   2. Section 15I2, Waste and Vent Piping.
   3. Section 15I15, Testing of Plumbing, Piping Systems.
   4. Section 15I16, Disinfection.
   5. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Uniform Building Code.
      b. Uniform Plumbing Code.
   2. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections, by authorities having jurisdiction.

B. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified:
   1. FS WW-P-541b, Plumbing Fixtures-Land Use.

1.3 SUBMITTALS

A. Shop Drawings: Submit the following for approval with manufacturers data, dimensions, sizes, materials of construction and accessories:
   1. Water closets, flush valve, seat and carrier.
   2. Lavatories, faucets, trim, drain and carrier.
   3. Service sink, faucet and accessories.
   4. Electric water cooler.
   5. Shower valves and shower base.
   6. Electric water heater.
   7. 1/4-inch scale drawings, prepared by the CONTRACTOR showing the layout, dimensions and mounting heights of all plumbing fixtures.
   8. Assembly of parts lists for all faucets, shower valves, flush valves and electric water cooler.

B. Operation and Maintenance Manuals: Submit complete manuals including:
   1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.

1.4 JOB CONDITIONS

A. Protection: At the end of each day's work or other stopping point throughout the construction, the CONTRACTOR shall provide temporary covering over all plumbing fixtures and trim as required to prevent damage due to moisture, dirt, plaster, concrete or other material. As each fixture is installed, it shall be protected with temporary wood crating and the chromium-plated brass trim shall be covered with vaseline. Chipped, cracked, dented or damaged fixtures or trim will not be accepted in the finished installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Water Closet: WC-1:
   1. Product and Manufacturer: Provide one of the following:
      a. Eljer, Fig. No. 111-1405.
      b. Or equal.
   2. Type: Flush-valve, siphon jet, watersaver and wall hung.
   3. Style: Elongated bowl.
   4. Standards: Conform to applicable requirements of Federal Specification WW-P-541/1A, Type IIk, Style D, Class 9.
   5. Accessories:
      a. Flush Valve and Vacuum Breaker:
         1) Product and Manufacturer: Provide valves manufactured by one of the following:
            a) Sloan, "Royal" Model No. 110-35.
            b) Coyne & Delany "Flushboy" Model No. F402.
            c) Or equal.
      c. Seat and Cover:
         1) Product and Manufacturer: Provide seats manufactured by one of the following:
            a) Beneke Corporation, Model GP-18.
            b) Kohler, Fig. No. K-4560.
            c) Or equal.
         2) Standards: Conform to applicable requirements of Federal Specification WW-P-541/1, Type IV, Class 2.
         3) Type: Solid plastic, elongated, open front with cover.
   6. Closet Supports:
      a. Product and Manufacturer: Provide supports manufactured by one of the following:
         1) Jay R. Smith, Hi-Set, Fig. 175 Series as required.
         2) Zurn Industries, Fig. ZER-1204 Series as required.
         3) Or equal.
      b. Provide one support for each water closet complete with all necessary hardware and gaskets, suitable for specified floor construction.

B. Lavatory:
   1. Product and Manufacturer: Provide products of one of the following:
      a. Eljer, Model 051-2964.
      b. Kohler, Model K-12636.
      c. Or equal.
   2. Type: Wheelchair flat slab, front overflow for concealed arm support.

3. Material: Vitreous china.
4. Size: 20-inch wide by 27-inch deep.
5. Faucets:
   a. Product and Manufacturer: Provide products of one of the following:
      1) Moen Group, Stanadyne Incorporated Model 4400.
      2) Delta Faucet Company, Model 511 HGM HDF.
   b. Description: Single control, extended lever handle lavatory faucet, 4-inch centerset exposed deck mounting.
   c. Materials: Chrome plated brass.
   d. Inlets: 1/2-inch IPS inlets.
   e. Flow Restrictor: 3/4 gpm flow controllers.
6. Supplies:
   a. Product and Manufacturer: Provide products of one of the following:
      1) Eljer, Model 490-3782 straight tail piece; 802-0950 wall supplies with loose key stops next to wall.
      2) Kohler, Model K-7622 offset tail piece; K-13711 extended supply pipes with loose key stop.
   b. Finish: Chrome plated.
   c. Accessories: 1/2-inch coupling nuts for tailpiece connection to faucet inlets.
7. Drain Plug:
   a. Product and Manufacturer: Provide products of one of the following:
      1) Eljer, Model 803-0530.
      2) Kohler, Model K-13885.
   b. Description: Cast grid strainer with 1-1/4-inch offset drain assembly, chrome plated.
8. Trap:
   a. Product and Manufacturer: Provide products of one of the following:
      1) Eljer, Model 804-1185.
      2) Kohler, Model K-9000.
   b. Description: Adjustable cast brass "P" trap with cleanout. Slip joint inlet and 17 gauge tubing outlet to wall with escutcheon, 1-1/4-inch by 1-1/2-inch outlet, chrome finish.
9. Carrier:
   a. Product and Manufacturer: Provide products of one of the following:
      1) Jay R. Smith, Fig. No. 700-27-M31.
      2) Zurn Industries, Fig. No. Z-1231-79 Series.
   b. Description: Floor mounted concealed arm carrier for wheelchair lavatories.

C. Urinals:
1. Product and Manufacturer: Provide fixtures manufactured by one of the following:
   a. Eljer, Fig. No. 161-1090.
   b. Kohler, Fig. No. K-4985-T.
2. Type: Wall-hung, siphon jet water saver.
3. Inlet and Outlet Connections: 3/4-inch top spud inlet and 2-inch threaded outlet.
4. Flush Valve and Vacuum Breaker:
   a. Product and Manufacturer: Provide valves manufactured by one of the following:

1) Sloan, "Royal" Model No. 186.
2) Coyne & Delany, "Flushboy" Model No. 451 VB.

5. Urinal Supports:
   a. Product and Manufacturer: Provide supports manufactured by one of the following:
      1) Jay R. Smith, Fig. No. 637.
      2) Zurn Industries, Fig. No. Z-1222.
   b. Description: Floor mounted urinal support with hanger and bottom bearing plates.
   c. Provide one support for each urinal complete with all necessary hardware and gaskets.

D. Electric Water Cooler (EWC):
   1. Type: Barrier-free wall hung with high back.
      a. Product and Manufacturer: Provide cooler manufactured by one of the following:
         1) Sunroc Corporation Model HCWC-8.
         2) Or equal.
      b. Type: Water cooler.
      c. Capacity: 8 gallons per hour of 50 F drinking water at 80 F inlet water and 90 F ambient room temperature.
      d. Materials:
         1) Fountain: Satin-finish stainless steel.
         2) Ventilation Panel: Louvered satin finish stainless steel.
      e. Refrigeration Unit:
         1) Compressor: Hermetically sealed, thermal overload protection, vibration eliminators.
      f. Electrical Characteristics: 110 volt, 60-cycle, single-phase operation, 1/5 horsepower compressor.

E. Service Sink:
   1. Product and Manufacturer: Provide sink manufactured by one of the following:
      a. Eljer, "Rollins" Fig. No. 242-0125.
      b. Kohler, Bannon Fig. No. K-6718.
      c. Or equal.
   2. Type: Enameled cast iron service sink, wall hanger, plain back.
   3. Accessories:
      a. Rim Guard:
         1) Product and Manufacturer: Provide rim guards manufactured by one of the following:
            a) Eljer, Fig. No. 805-0190.
            b) Kohler, Fig. No. K-8936.
            c) Or equal.
      b. Trap Standard:
         1) Product and Manufacture: Provide traps manufactured by one of the following:
            a) Eljer, Fig. No. 804-1060.
            b) Kohler, Fig. No. K-6673.
            c) Or equal.
         2) Materials:
            a) Cast iron body with cleanout.
            b) Acid resistant enamel interior coating.
            c) Painted outside.
            d) Cleanout plug.
            e) Chrome strainer.
            f) 3-inch IPS outlet.

c. Faucet:
   1) Product and Manufacturer: Provide faucets manufactured by one of the following:
      a) Eljer, Fig. No. 749-1200.
      b) Kohler, Fig. No. K-8908 Model C.P.
      c) Or equal.
   2) Description: Exposed service sink faucet with vacuum breaker, integral stops, lever or four arm handles, spout with pail hook and hose end, top single brace, 1/2-inch I.P.S. female couplings and renewable seats.

F. Shower Head, Valve and Spray Handle:
   1. Product and Manufacturer: Provide shower assemblies manufactured by one of the following:
      a. Symmons Safetymix Visu-Temp, Model 1-117VT-FS-2.
      b. Or equal.
   2. Type: Pressure balanced mixing valve, with integral thermometer, shower head with adjustable spray, head bracket, hand spray unit with flexible hose, wall hook, wall connection, in-line vacuum breaker and diverter with volume control for shower head and hand spray.
   3. Materials and Construction:
      a. Shower Valve:
         1) Single bronze stem.
         2) Body: Bronze.
         3) Valve Seat: Stainless steel renewable.
         4) Thermometer: Bi-metallic, dial type with shatterproof case and white against black background.
         5) All Metal Trim: Triple chrome plated.
         6) Temperature Stops: Adjustable.
      b. Shower Head:
         1) Chrome plated brass.
         2) Description: Adjustable spray, self-cleaning, ball joint.
         3) Flow Restrictor: 3 gpm maximum.
      c. Hose: Flexible hose, wall hook, wall connection and in-line vacuum breaker all chrome plated.
      d. Diverter Valve: Double outlet with volume control for shower head and hand spray.
   4. Accessories:
      a. Integral service stops.
      b. 3 gpm flow restrictor on shower head and hand spray.

G. Shower Base:
   1. Product and Manufacturer: Provide bases manufactured by one of the following:
      a. Powers-Fiat, Gibraltar.
      b. Or equal.
   2. Type: Precast terazzo shower floor.
   3. Materials:
      a. Terazzo: Marble chips cast in white portland cement compressive strength of 3000 psi in 7 days. Terazzo surface shall be ground and polished. Color shall be white marble chips in white cement.
      b. Drain: Cast integrally in shower floor for caulk outlet. Strainer shall be stainless steel.

c. Size: 36-inches by 42-inches by 6-inches high with flanged top on 3 sides for tiled wall.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All fixtures shall be installed in accordance with manufacturers printed instructions and recommendations.

B. Each fixture shall have wheel handle control stops or integral screw-driver stops for hot and cold water.

3.2 ADJUSTMENT AND CLEANING

A. Upon completion of the Work, all labels shall be removed, fixtures and trim shall be cleaned of all dirt, grease and markings and all valves properly adjusted.

+ + END OF SECTION + +

SECTION 15I8

HOT WATER HEATER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, tools and incidentals necessary to provide hot water heating equipment as shown or specified.

B. Related Work Specified Elsewhere:
   1. Section 5E3, Miscellaneous Metal Fabrications.
   2. Section 15I1, Potable Water Piping System.
   3. Section 15I11, Insulation, Plumbing.
   4. Division 16, Electrical.

C. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Uniform Plumbing Code.
   2. Certifying Agency: Certified by Underwriters' Laboratories Inc.

B. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.
   1. ASME Boiler Construction Code, Section VIII, Unfired Pressure Vessels.
   2. ANSI Z21.22, Relief Valves including Addenda Z21.22a and Z21.22b.
   3. ASHRAE Standard 90-75.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Catalog Data: Manufacturer's literature and illustrations showing the following:
      a. Dimensions and weights.
      b. Details of construction, including control systems, safety devices, cathodic protection and type of tank insulation.
      c. Material.
      d. Heating capacity.
      e. Code construction.
      f. Voltage and amperage draw.
      g. Temperature and pressure relief valve.
      h. Vacuum breakers.
      i. Pressure relief valve.
      j. Structural supports for hot water generator.
   2. Installation: Manufacturer's installation instructions.
   3. Operating Instructions: Written operating instructions including startup and shutdown procedures.

4. Maintenance Data:
   a. Written instructions on items requiring periodic maintenance.
   b. Parts list.
5. Test Results: Certified copies of shop pressure tests.

1.4 GUARANTEE

A. Guarantee tank against leakage due to corrosion for 3 years from date of project acceptance.

B. Repair or replace all faulty equipment within guarantee period, at no expense to the OWNER.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Domestic Water Heater:
   1. Product and Manufacturer: Provide one of the following:
      a. A. O. Smith, Model DSE-50.
      b. Or equal.
   2. Heater Type: Electric.
   3. Heater Style: Standard Vertical.
   4. Materials:
      a. Tank: Welded steel, ASME construction.
      b. Tank Lining: Glass.
      c. Outer Shell: Steel with baked enamel finish.
      d. Insulation: Blanket type glass fiber.
      e. Cathodic Protection Anode: High density magnesium.
      f. Water Connections: Brass.
      g. Base and Legs: Steel or cast iron.
   5. Heaters to be free of:
      a. Sharp edges.
      b. Scratches on enameled surfaces.
      c. Loose screws.
      d. Loose panels.
      e. Dents on outer jacket.
   6. Service Conditions:
      a. Nominal Capacity: 50 gallons.
      b. Minimum Recovery Rate: 25 gallons per hour at 100 F temperature rise.
      c. Working pressure: 150 psig.
   7. Electric Heat Source:
      a. Heating Element and Operation: Immersion type, one immersion heater with 3 electric elements.
      b. Voltage: 240 volt, 60 Hz, 1 phase.
      c. KW: 4.5.
   8. Thermostat: 95 F to 190 F water temperature range.
   9. Water Connections: 3/4 inch pipe nipples for connection to hot and cold water piping system.
   10. Drain Valve: Manufacturer's standard drain valve on tank bottom or lower side to completely drain tank.
   11. Shop Tests: Subject heater tank to two repeated pressure tests at 355 psig.

2.2 ACCESSORIES

A. High limit energy cut-off on electric hot water heater thermostat to interrupt electrical current on both sides of thermostat in the event water temperature inside of tank exceeds 190 F.

B. Temperature and Pressure Relief Valve:
   1. Type: ASME Temperature and Pressure Relief Valve in conformance with ANSI Z21.22.
   2. Capacity and size of valve to relieve heater capacity at specified temperatures and pressure setting.
   3. Settings:
      a. Temperature Relief Setting: 210 F.
      b. Pressure Relief Setting: 150 psig.

C. Cathodic Protection: Rigidly supported anode rods in heater tank.

D. Vacuum Relief Valve:
   1. Product and Manufacturer: Provide one of the following:
      a. Watts, No. 36A.
      b. Or equal.
   2. Type: Vacuum relief valve for water heater service.
   3. Size: 1/2 inch.
   4. Opens at less than 1/2 inch vacuum.
   5. Reference: ANSI Z21.22, A.G.A. listed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hot water heater and accessories in accordance with manufacturer's installation instructions.

B. Provide all supporting steel, brackets, saddles, etc. required to support hot water heater.

C. Install temperature and pressure relief valves in accordance with ANSI Z21.22.

D. Pipe all relief valve drain lines to nearest funnel drain, floor drain, service sink or mop receptor.

3.2 TESTING AND FLUSHING

A. Flushing: After piping, valves and accessories are connected, but prior to startup and testing, flush heater under full system pressure.

B. Startup and Testing:
   1. Startup: After flushing, drain heater, refill and startup unit in accordance with manufacturer's operating instructions.
   2. Operations Test:
      a. Test heater after field adjustments have been made.
      b. Retest until specification requirements have been met.

3.3 ADJUST AND CLEAN

A. Adjust:
   1. Adjust thermostat to desired water outlet temperature.

B. Clean: Upon completion of testing and adjusting, clean all parts of heater unit to remove grease, sludge and foreign matter.

+ + END OF SECTION + +

SECTION 15I11

INSULATION, PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals to provide insulation for all potable water with all accessories as shown and specified.

B. Related Work Specified Elsewhere:
   1. Section 15C3, Pipe Hangers, Supports and Restraints.
   2. Section 15C4, Wall Pipes, Floor Pipes and Pipe Sleeves.
   3. Section 15I1, Potable Water Piping System.

C. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes.
      a. Uniform Building Code.
      b. Uniform Plumbing Code.
   2. Certifying Agency: Certified by Underwriters' Laboratories, Incorporated.
   3. Permits: CONTRACTOR shall obtain and pay for all required permits, fees, inspections and approvals by authorities having jurisdiction.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. Federal Specification HH-1-558B, Insulation Blocks, Boards, Blankets, Felts, Sleeving, Pipe Fitting Covering.
   2. ASTM C 547, Mineral Fiber Preformed Pipe Insulation.

C. Field Measurement: Take field measurements where required prior to installation to ensure proper fitting of Work.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturers literature, specifications, engineering data and samples.
   2. Fabrication instructions for pipe fitting and valve insulation and coating.
   3. Installation instructions for pipe and pipe fitting insulation.

1.4 JOB CONDITIONS

A. Protection:
   1. All material applied in one day shall have the vapor barrier applied the same day and exposed ends shall be temporarily protected with a moisture barrier and sealed to the pipe.

2. Insulating materials shall, at all times, be protected from moisture.
3. Material shall be warehoused on or near the job site and drawn from this protected area as used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fiberglass Insulation:
   1. Product and Manufacturer: Provide insulation manufactured by one of the following:
      a. Owens-Corning Fiberglass Corporation Fiberglass ASJ/SSL.
      b. Certain Teed Products Corporation.
      c. Or equal.
   2. Type: Heavy density sectional pipe insulation with vapor barrier with self-sealing lap.
   3. Fire Hazard Classification:
      a. Flame Spread: 25.
      b. Fuel Contributed: 50.
      c. Smoke Developed: 50.
   4. Fittings: Molded fiberglass.
   5. Jointing Materials: Manufacturers recommended adhesives and tape.
   6. Valve Insulation: Miter cut nesting size covering segments of same thickness as pipeline, for insulation of valves.

PART 3 - EXECUTION

3.1 GENERAL

A. Insure that surfaces of pipes, valves, and fittings are clean and dry before applying insulation.

B. Insure that piping and equipment has been inspected and released for application of insulation.

C. Insure that insulation is dry when installed, and before and during the application of any finish.

D. Install insulation so as to make surfaces smooth, even, and substantially flush with adjacent pipe insulation.

E. Follow manufacturer's application instructions for all materials used.

F. Provide insulation protection shields for insulated piping supported by pipe hangers.

G. Install and coat insulation in accordance with the manufacturer's recommendations.

H. Pipe insulation shall be continuous through walls and floor openings except where walls or floors are required to be firestopped or required to have a fire resisting rating.

I. Where hangers are in direct contact with low temperature piping the hanger and supporting rod shall be wrapped with foil-faced blanket insulation and vapor sealed. Hanger rod insulation and vapor barrier shall extend up to the rod a minimum distance equal to the diameter of the pipe.

J. The following piping systems shall be insulated:
   1. All hot and cold piping, valves and fittings.

K. See schedule below for minimum thicknesses:

Pipe Size	Minimum Insulation Thickness
1/2" thru 1-1/2"	1 inch
2" thru 4"	1-1/2 inch

+ + END OF SECTION + +

SECTION 15I12

INSTALLATION OF PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to install all plumbing piping as shown and specified.

B. Related Work Specified Elsewhere:
   1. Section 15I1, Potable Water Piping System.
   2. Section 15I2, Waste and Vent Piping.

C. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Uniform Building Code.
      b. Uniform Plumbing Code.
   2. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ANSI B13.1, Code for Pressure Piping.
   2. ANSI B31.1, Power Piping.
   3. AWS D10.9, Standard for Qualifications of Welding Procedures and Welders for Piping and Tubing.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval detailed 1/4-inch scale Drawings showing materials and dimensions of piping system. See applicable piping systems in other Sections under this Contract for additional required submittals.

B. Record Drawings: During progress of the Work, keep an up to date set of drawings showing field and Shop Drawing modifications. Immediately upon completion of piping Work, submit cloth or mylar tracings showing the actual in-place installation of all piping and equipment installed under this Section, at a scale satisfactory to the ENGINEER. The Drawings shall show all piping on plans and in sections, with all reference dimensions and elevations required for complete "record" drawings of the piping systems. Two paper prints shall also be furnished. The tracings shall be submitted at completion of the Contract and prior to final payment.

1.4 JOB CONDITIONS

A. Sequencing: Obtain approval of Shop Drawings and layout drawings before placing concrete and installing any piping.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials for piping system shall be specified under applicable Sections of Division 15, Plumbing.

PART 3 - EXECUTION

3.1 BEFORE INSTALLATION

A. General: Thoroughly plan the installation of piping systems prior to placing concrete so that inserts, openings, sleeves, supports and blocking will be correctly located.

B. Defective Materials: Examine piping, fittings, valves, and accessories to be installed and reject those which are defective or in poor condition.

C. Cleaning: Thoroughly clean all piping, fittings, valves and accessories.

3.2 INSTALLATION

A. General:
   1. Install all items as shown, specified, and as recommended by the manufacturer.
   2. Request instructions from the ENGINEER when there is a conflict between the manufacturer's recommendations and the Drawings or Specifications.
   3. Present conflicts between piping systems and equipment or structures to the ENGINEER who will determine corrective measures to be taken.
   4. Do not modify structures to facilitate installation of piping unless specifically approved by the ENGINEER.

B. Piping:
   1. Install straight runs true to line and elevation.
   2. Install vertical pipe truly plumb in all directions.
   3. Install piping parallel or perpendicular to building walls. Piping at odd angles and 45 degrees runs across corners will not be accepted unless specifically shown.
   4. Install small diameter piping generally as shown on the Drawings when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, etc.
   5. Unless otherwise approved by ENGINEER provide temporary caps or plugs over all pipe openings at the end of each days work, or when otherwise required or directed, to prevent foreign material from entering the piping systems.

6. Cutting: Cut pipe from measurements taken at site, not from Drawings.

C. Joints:
1. General:
   a. Make joints in accordance with the pipe manufacturer's recommendations and the supplemental specifications below.
   b. Cut piping accurately and squarely and install without forcing or springing.
   c. Ream out all pipes and tubing to full inside diameter after cutting.
   d. Remove all cuttings and foreign matter from the inside of pipes and tubing before installation.
2. Threaded Joints: Use standard, right hand tapered full depth threads on steel piping and apply an approved joint compound to the male threads only, before installation. Leave not more than three pipe threads exposed at each connection.
3. Solder Joints:
   a. Ream or file pipe to remove burrs.
   b. Clean and polish contact surfaces of joints.
   c. Apply flux to both male and female ends.
   d. Insert end of tube into fittings full depth of socket.
   e. Heat joint evenly.
   f. Form continuous solder bead around entire circumference of joint.
4. Flanged Joints: Assemble flanged joints with approved full face gaskets and gasket compounds and draw up flange bolts evenly.
5. Plastic Pipe Joints: Make joints in plastic piping in accordance with the manufacturer's recommendations.
6. Welded Joints: ANSI B31.1 latest revision and requirements of the American Welding Society for pipe welding.
7. Flared Joints:
   a. Cut the tube to the required length.
   b. Remove all burrs. This is very important to assure metal-to-metal contact.
   c. Slip the coupling nut and sleeve over the end of the tube.
   d. Clamp the tube in the flaring block so that the end of the tube is slightly above the face of the block.
   e. Place the yoke of the flaring tool on the block so that the beveled end of the compressor cone is over the tube end.
   f. Turn the compressor screw down firmly, forming the flare between the chamber in the flaring block and the beveled compressor cone.
   g. Remove the flaring tool.
   h. Assemble the joint by placing the fitting squarely against the flare. Engage the coupling nut with the fitting threads. Tighten with two wrenches, one on the nut and one on the fitting.

D. Unions:
1. Install dielectric unions wherever dissimilar metals are connected except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.
3. Provide screwed or flanged unions where shown on the Drawings and to provide for ready dismantling of piping.

E. Eccentric Reducers: Use eccentric reducers where shown and where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

F. Valves and Accessories:
   1. Provide supports for large valves, backflow preventers, flow meters and other heavy items as shown or otherwise required.
   2. Install floor stands as shown on the Drawings and as recommended by the manufacturer.
   3. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by the manufacturer.

G. Provide chrome plated escutcheons with set screws for all piping passing through floors, walls or ceilings.

3.3 AFTER INSTALLATION

A. Remove and replace any items which are found to be defective after installation.

B. Repair damaged mortar pipe lining as recommended by the manufacturer and approved by the ENGINEER.

C. Clean all debris out of piping systems.

D. Maintain all piping, fittings, valves and accessories in clean undamaged condition until accepted by the OWNER.

+ + END OF SECTION + +

SECTION 15I15

TESTING OF PLUMBING PIPING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all tests necessary to demonstrate compliance with the Specifications, codes and regulations, which include water tests, air tests, and smoke tests as specified.

B. Related Work Specified Elsewhere:
   1. All Sections pertaining to Section 15I, Plumbing Piping Systems.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Uniform Building Code.
      b. Uniform Plumbing Code.

1.3 SUBMITTALS

A. Submit a description of proposed testing methods, procedures, and apparatus to the ENGINEER for approval at least 48 hours in advance of testing.

B. Submit a test report for each test to the ENGINEER certifying the test pressure, duration of the test, and test performance of all installed piping.

C. Valve Charts:
   1. Two required, 1/8-inch sheet acrylic in 8-1/2 by 11-inch extruded aluminum frame.
   2. Charts: Typed or inked on mylar with the following information for each valve.
      a. Valve identification number.
      b. Valve location.
      c. Valve use.
      d. Valve size.
      e. Manufacturer's name and model number.
   3. Submit sample valve with lettering.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all necessary equipment and materials, including gages and pumps, to perform the testing operations.

2.2 VALVE TAGS

A. Product and Manufacturer: Provide tags manufactured by one of the following:
   1. Seton Name Plate Corporation.
   2. New York Stencil Works.
   3. Or equal.

B. Construction:
   1. Material: Brass.
   2. Size: 1-1/2-inch diameter.
   3. Chain: Brass.
   4. Lettering Size: 1/4-inch black filled letters over 1-inch high black filled numbers.

C. Legend:
   1. H.W. - Hot Water
   2. C.W. - Cold Water
   3. N.P.W. - Non-potable Water
   4. PW - Potable Water.

PART 3 - EXECUTION

3.1 GENERAL

A. Conduct water, air and smoke tests as required, on all piping systems as specified below.

B. Conduct all tests in the presence of, and in a manner approved by the ENGINEER all state and local authorities having jurisdiction. Repeat test for these authorities if requested by them.

C. Repair and retest all lines which do not pass the tests as specified herein.

D. Inspect all valves, joints, and specialties for tightness and for proper operation while under test pressure.

3.2 WATER TEST

A. Drainage and Vent System Piping:
   1. Perform tests either on the entire system or on successive sections of the system.
   2. Tightly close all openings except the highest opening of the system or section to be tested.
   3. Fill the system or section with water to the point of overflow.
   4. Test with a head of at least 10 feet of water, except for the uppermost 10 feet of the system.
   5. Allow water to stand in the system for at least 15 minutes before inspecting.
   6. Inspect the system or section for leaks, and repair any leaks found.

B. Cold and Hot Piping:
   1. Water piping shall be tested and proved tight under a pressure not less than 1-1/2 times the working pressure under which it is to be used.

2. Potable water shall be used for testing potable water systems. Non-potable water shall be used for testing non-potable water systems.

3.3 SMOKE TEST

A. Finished Plumbing: Final test for gas and water tightness of the completed drainage and vent system:
   1. Fill all traps with water.
   2. Introduce a pungent thick smoke, produced by one or more smoke machines, into the system.
   3. When the smoke appears at stack openings on the roof, close the system.
   4. Maintain a pressure in the system equivalent to a one inch water column for the period of the inspection.
   5. Inspect the system for leaks and repair any leaks found.

+ + END OF SECTION + +

SECTION 15I16

DISINFECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall be responsible for the disinfection of all potable water lines with compliance to codes and regulations as specified.

B. Related Work Specified Elsewhere:
   1. Section 15I1, Potable Water Piping System.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Uniform Building Code.
      b. Uniform Plumbing Code.
   2. Permits: CONTRACTOR shall obtain and pay for all required permits, fees, and inspections by authorities having jurisdiction.

B. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified:
   1. AWWA C601, Standard for Disinfecting Water Mains.

C. Testing: Bacteriological tests as specified below will be provided by Contractor.

1.3 SUBMITTALS

A. Submit a description of the forms of chlorine, dosages, and proposed methods of application to the ENGINEER for approval.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all necessary equipment and materials, including chemicals, to perform the disinfecting operations.

PART 3 - EXECUTION

3.1 DISINFECTION

A. General: The method to be followed shall be that prescribed by the local authorities or, in accordance with the procedures recommended by

AWWA C601, except as specified below:

1. Before application of chlorine, flush the piping system at a velocity of not less than 2.5 feet per second. Do not flush the system if the tablet method, as specified in the above standard, is used.
2. After the applicable retention period, flush the system using potable water.

B. Testing: Perform bacteriological tests in accordance with AWWA C601-68.

+ + END OF SECTION + +

SECTION 16A

GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to complete the electrical Work.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the formwork, walls, partitions, ceilings and panels.
   2. CONTRACTOR shall be responsible for the installation of all conduits, inserts and other items to be embedded in the concrete, or built into walls, partitions, ceilings or panels constructed by other contractors. CONTRACTOR shall provide other contractors with detailed plans or sketches of the location of said conduits and other built-in items as may be required. CONTRACTOR shall keep himself fully informed of the construction where conduits and other built-in items are to be installed. CONTRACTOR shall install said conduits and other built-in items in such a manner and within such time periods as will not unnecessarily delay the Work of the other contractors.

C. General:
   1. Interpretation of Drawings:
      a. Dimensions shown on the Drawings that are related to equipment are based on one manufacturer's equipment. Coordinate the dimensions of the equipment furnished with the space allocated for that equipment.
      b. The Drawings show the principal elements of the electrical installation. They are not intended as detailed working drawings for the electrical Work but as a complement to the Specifications to clarify the principal features of the electrical systems.
      c. It is the intent of this Section that all equipment and devices, furnished and installed under this and other Sections, be properly connected and interconnected with other equipment so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.

D. Related Sections:
   1. Section 2D1, Excavation and Backfilling.
   2. Section 3D, Cast-In-Place Concrete.
   3. Section ____, Shop Painting and Surface Preparation.
   4. Section ____, Anchor Bolts and Other Fasteners.

E. Utilities:
   1. CONTRACTOR shall furnish and install an underground pull section, transformer pad, empty conduits from pad to pull section, and full metering details for main power service.
   2. CONTRACTOR shall furnish and install empty conduits for telephone company service. Plywood backboards shall be furnished and installed for regular telephone service and a dedicated leased line. CONTRACTOR shall make all arrangements for the telephone lines and pay all fees.

F. Temporary Power:
   1. Temporary light and power for construction purposes shall be provided in accordance with Section 1G2, Temporary Electricity.
   2. Temporary power shall be provided for the existing pump station, including Well No. 8 during replacement of the existing Arizona Public Service electric service the station.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Permits: Obtain all permits required to commence work and, upon completion of the Work, obtain and deliver to the Engineer a Certificate of Inspection and Approval from the State Board of Fire Underwriters or other authority having jurisdiction.
   2. Codes: Material and equipment shall be installed in accordance with the current standards and recommendations of the National Electrical Code, the National Electrical Safety Code and with local codes which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply.
   3. Tests by Independent Regulatory Agencies: Electrical material and equipment shall be new and shall bear the label of the Underwriters' Laboratories, Inc., or other nationally-recognized, independent testing laboratory, wherever standards have been established and label service regularly applies.
   4. Utilities:
      a. Electric Utility: Arizona Public Service.
      b. Telephone Company: Midwest Communications.
      c. Power Company: Work in connection with the electric service and utility metering shall be done in strict conformance with the requirements of the Power Company.
      d. Telephone Company: Work in connection with the telephone lines for the telephone service shall be done in strict conformance with the requirements of the Telephone Company.

B. Reference Standards: Electrical material and equipment shall conform in all respects to the latest approved standards of the following:
   1. National Electrical Manufacturers Association (NEMA).
   2. The American National Standards Institute (ANSI).
   3. The Institute of Electrical and Electronic Engineers (IEEE).
   4. Insulated Power Cable Engineers Association (IPCEA).
   5. National Electrical Code (NEC).
   6. National Electrical Safety Code (NESC).

1.3 SUBMITTALS

A. General:
   1. Conform to requirements of Section 1E4 and the General Conditions.

B. Shop drawings shall include the following information to the extent applicable to the particular item:
   1. Manufacturer's name and product designation or catalog number.
   2. Electrical ratings.
   3. Conformance to applicable standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEC, NEMA, NFPA, OSHA, UL, or other organizations.
   4. Dimensioned plan, section, and elevations showing means for mounting, conduit connection, and grounding.
   5. Materials and finish specification, including paints.
   6. List of components including manufacturer's names and catalog numbers.
   7. Internal wiring diagram indicating all connection to components and numbered terminals for external connections.

1.4 PRODUCT DELIVERY

A. Operation and Maintenance Data:
   1. Conform to requirements of Section 1E3 and the General Conditions.

B. Record Drawings:
   1. In addition to the requirements of Section 1I2 and the General Conditions, record drawings shall include the following:
      a. One line wiring diagram of the distribution system.
      b. Actual in place conduit and cable layouts with schedule of conduit sizes and number and size of conductors.
      c. Layouts of the grounding system and lighting arrangement.
      d. Control wiring diagrams with terminal numbers and all control devices identified.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: CONTRACTOR shall instruct the manufacturers and vendors as to the maximum shipping sizes of equipment that can be accommodated at the site.

B. Storage of Materials: Conform to the requirements of Section 1G17, Storage of Materials.

C. Handling of Materials: Conform to the requirements of Section 1H1, Transportation and Handling of Materials and Equipment.

1.6 JOB CONDITIONS

A. CONTRACTOR shall examine the site and existing facilities in order to compare them with the Drawings and Specifications with respect to the conditions of the premises, location of and connection to existing facilities and any obstructions which may be encountered.

B. CONTRACTOR is cautioned to perform his work with due regard to safety and in a manner that will not interfere with the existing equipment or in any way cause interruption of any of the functions of the plant.

C. Work shall be carried out with a minimum amount of disruption to the operation of the existing pump station and No. 8 well pump and with prior approval of OWNER. CONTRACTOR shall submit, for approval by OWNER, a detailed written procedure for work which affects operation of the existing pump station, a detailed procedure for modifying any existing electrical equipment, and anticipated time required to complete the work and the required shutdown time, if any.

D. Where the work of CONTRACTOR ties in with existing installations, CONTRACTOR shall take prior precautions and safeguards in connecting the new work with the existing operating circuits so as to prevent any interruption to the existing operating circuits. The tying-in of new work, installed under this Contract, with the existing circuits shall be performed only in the presence of OWNER. Advance notice will be required before any equipment is removed from service. CONTRACTOR shall notify OWNER in writing of his intention to do such work, giving full details.

1.7 AREA CLASSIFICATIONS

A. Wet Locations: The following areas shall be considered wet locations:
1. All outdoor areas.
2. All indoor areas below grade unless otherwise specified.
3. Indoor areas above grade where designated on the Drawings.

Materials, equipment and incidentals in areas identified as wet locations shall meet NEC and NEMA requirements for wet locations. Enclosures installed in wet locations shall meet NEMA 4 requirements as a minimum and NEMA 4X requirements where specified or indicated on the Drawings. Conduits shall be terminated at enclosures with watertight, threaded hubs.

4. The following specific areas in addition to the general requirements above shall be considered wet locations:
   a. Screening Room in the Operations Buildings.
   b. ??? 1171 Room of existing pump station.
   c. The RAS/WAS and Blower Room.

B. Corrosive Locations: The following areas shall be considered corrosive locations:
1. Chlorine and Chlorination Rooms in the Operations Building.
2. Caustic storage tank area at wet scrubber.
3. Wet well at the existing influent pump station.

Materials, equipment and incidentals in areas identified as corrosive shall meet NEC and NEMA requirements for corrosive locations. Conduit systems shall be PVC coated galvanized steel and enclosures shall meet NEMA 4X requirements. Conduits shall be terminated at enclosures with watertight, threaded hubs.

C. Hazardous Locations: The following areas shall be considered hazardous locations:
1. Existing influent pump station wet wells.
2. Screening Rooms in the Operations Building.

Materials, equipment and incidentals in areas identified as hazardous locations shall meet NEC requirements for the Class and Division designated.

+ + END OF SECTION + +

SECTION 16B1

RIGID CONDUIT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install conduit and fittings to form complete, coordinated and grounded raceway systems.
   2. The types of conduit required include the following:
      a. Rigid steel or intermediate metallic conduit for exposed indoor conduit runs in non-corrosive areas.
      b. PVC coated rigid steel for exposed conduit runs in corrosive areas and in all outdoor areas.
      c. Schedule 40 PVC for concrete encased duct bank runs.
      d. Rigid steel for individual conduit runs direct buried in earth.
      e. Rigid steel, intermediate metallic, schedule 40 PVC or fiberglass for conduit runs embedded in structural concrete slabs.

B. Coordination:
   1. Conduit runs shown are diagramatic.
   2. Coordinate conduit installation with piping, ductwork, lighting fixtures and other systems and equipment and locate so as to avoid interferences.

C. Related Sections:
   1. Section 16B2, Flexible Conduit.
   2. Section 16B4, Sealing Fittings.
   3. Section 16B5, Expansion Fittings.
   4. Section 16F2, Underground Ductbanks.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 346, Rigid Metal Conduit.
   2. NEC Article 347, Rigid Nonmetallic Conduit.
   3. UL Standard No. 6, Rigid Metal Electrical Conduit.
   4. UL Standard No. 514, Electrical Outlet Boxes and Fittings.
   5. UL Standard No. 651, Schedule 40 and 80 PVC Conduit.
   6. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
   7. UL Standard 1242, Intermediate Metallic Conduit.
   8. ANSI C80.1, Specification for Zinc Coated Rigid Steel Conduit.
   9. ANSI C80.4, Specification for Fittings for Rigid Metal Conduit and Electrical Metallic Tubing.
   10. NEMA TC2, Electrical Plastic Tubing, Conduit and Fittings.
   11. NEMA TC3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts and technical information for the conduit, fittings and supports proposed for use.
   2. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete and conduits directly buried in earth. Drawings shall show locations of pull and junction boxes and all penetrations in walls and floor slabs.

B. Record Drawings: Include the actual routing of exposed and concealed conduit runs on record drawings.

PART 2 -PRODUCTS

2.1 MATERIALS

A. Rigid Steel Conduit, Elbows and Couplings:
   1. Material: Rigid, heavy wall, mild steel, hot dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
   2. Manufacturer: Provide rigid steel conduit and fittings of one of the following:
      a. Allied Tube and Conduit Corporation.
      b. Republic Steel Corporation.
      c. Triangle PWC Incorporated.
      d. Or equal.

B. PVC Coated Rigid Steel Conduit, Elbows and Couplings:
   1. Material: Rigid, heavy wall, mild steel, hot dip galvanized, smooth interior, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with a factory coating of 40 mil thick polyvinyl chloride.
   2. Color: Color of coating shall be the same on all conduit and fittings.
   3. Manufacturer: Provide PVC coated rigid steel conduit and fittings of one of the following:
      a. Robroy Industries.
      b. Republic Steel Corporation.
      c. Or equal.

C. Intermediate Metallic Conduit, Elbows and Couplings:
   1. Material: Rigid-type steel, work-hardened, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
   2. Couplings: Same as for rigid steel conduit.
   3. Elbows: Factory formed of same material specification as for intermediate metallic conduit.
   4. Manufacturers: Provide intermediate metallic conduit of one of the following:
      a. Allied Tube and Conduit Corporation.
      b. Republic Steel Corporation.
      c. Or equal.

D. Metallic Conduit Fittings and Outlet Bodies:
   1. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers. Outdoor units to be gasketed and water-tight. Gaskets to be of an approved type designed for the purpose. Improvised gaskets not acceptable. All units to be threaded type with five full threads. Material to conform to ANSI C80.4 and be listed by UL. Fittings and bodies in or on PVC coated conduit runs to have a factory-applied coating of 40 mil thick polyvinyl chloride. The use of "LB" fittings shall be avoided and type "LBD" fittings applied wherever the use of fittings is unavoidable.
   2. Manufacturer: Provide metallic conduit fittings and outlet bodies of one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or equal.

E. Non-metallic Conduit:
   1. PVC Plastic:
      a. Material: Schedule 40 PVC plastic, NEMA Type EPC-40-PVD, 90°C rated, conforming to UL No. 651.
      b. Manufacturer: Provide non-mettalic conduit of one of the following:
         1) Amoco Chemicals Corporation.
         2) Carlon, Division of Indian Head, Incorporated.
         3) Or equal.
   2. Fiberglass Conduit:
      a. Description: UL listed fiberglass-reinforced epoxy system of 68 percent glass content encapsulated in an epoxy matrix.
      b. Provide protection against ultraviolet light deterioration via impregnation with carbon black throughout.
      c. Include integral insert type expanded coupling with an integral urethane gasket for sealing.
      d. Dielectric Strength: 500 volts/mil using test method ASTM D 149.
      e. Coefficient of Thermal Expansion: 1.25×10^{-5} in./in/°F using test method ASTM D 696.
      f. Thermal Conductivity: 2 Btu/hr/ft^2/°F/in.
      g. Tensile Strength (Axial): 11,000 psi.
      h. Continuous Service Temperature: 230°F.
      i. Coefficient of Friction: 0.233 while pulling cross linked polyethylene cable.
      j. Impact Resistance: 80 ft lbs at room temperature and 72 ft-lbs at minus 40°F and plus 140°F for 4" diameter.
      k. Wall Thickness: 0.066" up to 4" diameter and 0.096" above 4" diameter.
      l. Inside Diameter: Not less than the internal diameter published in Table 4, Chapter 9 of the NEC.
      m. Manufacturer: Provide fiberglass conduit of one of the following:
         1) Canadian General Electric.
         2) Kock Fiberglass Products.
         3) Fiberglass Pipe and Conduit Company.
         4) A.O. Smith Corporation.
         5) Or equal.
   3. Non-metallic Fittings: Form elbows, bodies, terminations, expansions and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.

F. Conduit Hubs:
   1. Material: Threaded conduit hub, vibration proof, weather proof with captive O-ring seal, zinc metal with insulated throat. Hubs used on PVC cated conduit systems shall have a factory applied PVC coating.
   2. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures located in areas designated as set locations.
   3. Manufacturer: Provide material manufactured by Myers Electrical Products Company or equal.

G. Conduit Tags:
   1. Material: 19 gauge, 1-1/2-inch diameter round brass with backfilled legend, Style #250-BL as manufactured by Seton Nameplate Corporation or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in conformance with National Electrical Code requirements.

B. Supports:
   1. Rigidly support conduits by clamps, hangers or Unistrut channels.
   2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers with steel horizontal members and threaded hanger rods, Kindorff or equal. Rods shall be not less than 3/8-inch diameter, and shall be cadmium coated.
   3. For PVC coated rigid steel conduit runs, supports and hardware shall be PVC coated or stainless steel.

C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures by the following methods:
   1. To Wood: Wood screws.
   2. To Hollow Masonry Units: Toggle bolts.
   3. To Brick Masonry: Price expansion bolts, or equal.
   4. To Concrete: Phillips; Hilti Corporation; or equal, anchors.
   5. To Steel: Welded threaded studs, beam clamps or bolts with lockwashers or locknuts.

D. Exposed Conduit:
   1. Install parallel or perpendicular to structural members or walls.
   2. Wherever possible, run in groups. Provide galvanized conduit racks of suitable width, length and height and arranged to suit field conditions. Provide support at every ten feet minimum.
   3. Install on structural members in protected locations.
   4. Locate clear of interferences.
   5. Maintain 6 inches from hot fluid lines and 1/4 inch from walls.
   6. Install vertical runs plumb. Unsecured drop length not to exceed 12 feet.

E. Conduit Embedded in Concrete:
   1. Separation: Three times outer diameter of larger conduit center to center.

2. Minimum Slab Thickness:
   a. With no crisscrossing of conduit, three times outer diameter of conduit.
   b. With crisscrossing of conduits, four times outer diameter of larger conduit.
3. Run conduit in center of slab.
4. Before concrete is placed, make the necessary location measurements of the conduit to be embedded so that the information is available to prepare record drawings.

F. Underground Conduits:
1. Install individual underground conduits a minimum of 20 inches below grade unless otherwise indicated.
2. Perform all excavation, bedding, backfilling and surface restoration including pavement replacement where required.
3. Make conduit connections watertight.
4. Protect metallic conduits from corrosion by one of the following means:
   a. Provide three inches of concrete all around conduits.
   b. Tape conduits with an all-weather polyvinyl chloride plastic tape with a high tack adhesive formulated to resist corrosion, Scotchrap Brand 50 or equal.
   c. Apply 2 coats of a bitumastic coating.

G. Empty Conduits:
1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.
2. Identify each empty conduit with a durable tag showing the conduit number indicated on the Drawings.

H. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at any bend.

I. Joints:
1. Apply conductive compound to all joints before assembly.
2. Make up joints tight and ground thoroughly.
3. Use standard tapered pipe threads for conduit and fittings.
4. Cut conduit ends square and ream to prevent damage to wire and cable.
5. Use full threaded couplings. Split couplings not permitted.
6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where the base metal is exposed.

J. Terminations:
1. Install insulated bushings on conduits entering boxes or cabinets, except threaded hub types.
2. Provide locknuts on both inside and outside of enclosure for grounding.
3. Bushings not to be used in lieu of locknuts.

K. Moisture Protection:
1. Plug or cap conduit ends at time of installation to prevent entrance of moisture or foreign materials.

2. Make underground and embedded conduit connections watertight.
3. Thruwall Seals: Install for conduits passing through new exterior subsurface walls or base slabs of buildings and for conduits passing through existing exterior walls. For individual exposed conduits passing through interior walls, install non-metallic sleeves to protect the conduit against action of akaline substances which may be present.
4. Drainage: Pay particular attention to drainage for conduit runs. Wherever possible, install conduit runs so as to drain to one end and away from buildings. Avoid pockets or depressions in conduit runs.

L. Corrosion Protection:
1. Conduit Curb:
   a. In concrete slabs or floors, provide a two inch high curb extending two inches from the outer surface of the conduit penetrating the floor, to prevent corrosion.
   b. Terminate conduit stub-ups in couplings, slightly above the finished concrete curb.
   c. Paint the stub-up with Scotch-Clad Protective Coating #1706 or equal, a minimum of 6 inches above and below the finished surface of the concrete.
2. Dissimilar Metals:
   a. Take every action to prevent the occurrence of electrolytic action between dissimilar metals.
   b. Do not use copper products in connection with aluminum work, and do not use aluminum in locations subject to drainage of copper compounds on the bare aluminum.
   c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.
3. PVC Coating: Field apply a 40 mil thick polyvinyl chloride coating to supports and fasteners for PVC coated conduit runs.

M. Reused Existing Conduits:
1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
2. Repeat swabbing until all foreign material is removed.
3. Pull mandrel through conduit, if necessary, to remove obstructions.

N. Core drill for individual conduits passing through existing concrete slabs. Obtain authorization from OWNER prior to core drilling. Seal spaces around conduit with epoxy grout.

O. Non-metallic Conduit:
1. Install in accordance with manufacturer's recommendations.
2. Join sections in accordance with manufacturer's installation procedures for push-fit, bell and spigot type joints, if applicable or with manufacturer's recommended cement.
3. During installation provide expansion fittings for expansion and contraction to compensate for temperature variations. Expansion fittings shall be watertight and of the type suitable for direct burial.
4. Make transition to intermediate or rigid steel conduit before making turn up to enclosures.
5. Provide watertight expansion/deflection fittings at all wall and floor penetrations of all buildings and equipment concrete pads.

3.2 TESTING

A. Test conduits by pulling through each conduit a cylinderical mandrel not less then two pipe inside diameters long, having an outside diameter equal to 90 percent of the inside diameter of the conduit.

B. Maintain a record, by number, of all conduits testing clear.

3.3 IDENTIFICATION

A. Tag all conduits at the ends and in all intermediate boxes, chambers, handholes and other enclosures. Fasten tags to conduits with No. 14 AWG insulated copper wire. Where this method is not practical, fasten to the adjacent masonry by means of expansion bolts.

B. Use numbers on all conduits as designated in the cable and conduit list and record the conduit numbers and the cable content by cable designation, size, quantity, origin of conductors, and name of equipment served.

+ + END OF SECTION + +

SECTION 16B2

FLEXIBLE CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install flexible metallic conduit and fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified.
   1. NEC Article 351, Liquid-Tight Flexible Metal Conduit.
   2. UL Standard No. 360, Liquid-Tight Flexible Steel Conduit.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts and technical information for flexible conduit and fittings proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flexible Conduit (Non-hazardous Areas):
   1. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1-1/4 inch. Material shall be UL listed.
   2. Product and Manufacturer: Provide one of the following:
      a. Sealtite UA by Anaconda Metal Hose Division, Anaconda American Brass Company.
      b. Liquatite Type L.A. by Electric-Flex Company.
      c. Or equal.

B. Flexible Conduit (Hazardous Areas):
   1. Material: Flexible brass inner core with bronze outer braid and protective vinyl plastic coating. Steel end fittings. Suitable for use in Class 1, Group D, Division 1 hazardous area. Minimum of 12 inches in length.
   2. Product and Manufacturer: Provide one of the following:
      a. Type ECGJH or ECLK by Crouse Hinds Company.
      b. Type EXGJH or EXLK by Appleton Electric Company.
      c. Or equal.

C. Flexible Conduit Fittings:
   1. Material and Construction: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
   2. Manufacturer: Provide flexible conduit fittings of one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install at motors and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to three feet maximum.

B. Install in conformance with National Electrical Code requirements.

+ + END OF SECTION + +

SECTION 16B3

PULL AND JUNCTION BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install pull and junction boxes.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 370, Outlet, Switch and Junction Boxes, and Fittings.
   2. UL Standard No. 50, Electrical Cabinets and Boxes.
   3. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for pull and junction boxes proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Junction and Pull Boxes:
   1. Material and Construction:
      a. Cast gray iron alloy or cast malleable iron bodies and covers. Cadmium finish.
      b. Neoprene gaskets. Gaskets to be of an approved type designed for the purpose. Improvised gaskets not acceptable.
      c. Stainless steel cover screws.
      d. External mounting lugs.
      e. Drilled and tapped conduit holes.
      f. Boxes where conduits enter a building below grade shall have 1/4-inch drain hole.
   2. Manufacturer: Provide pull and junction boxes of one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or equal.
   3. Large boxes not generally available in cast construction may be fabricated of copper-free aluminum alloy or stainless steel code gage sheet metal.
   4. Boxes for installation in areas classified as hazardous locations shall be explosion proof and shall comply with UL886.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided.

B. Securely fasten boxes to walls or other structural surfaces on which they are mounted. Provide independent galvanized steel supports where no walls or other structural surface exists.

C. Install pull boxes in runs containing more than three 90 degree bends, runs exceeding 200 feet, where indicated on the Drawings and where required to conform with the National Electrical Code.

D. Size junction and pull boxes in accordance with the requirements of the National Electrical Code.

E. Provide terminal blocks in junction boxes where cable terminations or splices are required.

+ + END OF SECTION + +

SECTION 16B4

SEALING FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install conduit sealing fittings.

1.2 QUALITY ASSURANCE

A. Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 500, Hazardous (Classified) Locations.
   2. UL Standard 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class 1, Groups A, B, C and D and Class II, Groups E, F and G.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for sealing fittings proposed for use.
   2. Listing of locations where fittings are to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and Construction:
   1. Cast gray iron alloy or cast malleable iron bodies with zinc electroplate and lacquer or enamel finish.
   2. Ample opening with threaded closure for access to conduit hub for making dam.

B. Sealing fiber for forming the dam within the hub and the sealing compound shall be approved for use with the fittings furnished.

C. Product and Manufacturer: Provide one of the following:
   1. Series EYS by Crouse Hinds Company.
   2. EYS by Appleton Electric Company.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install for hazardous and corrosive locations as required by the National Electrical Code and where shown on the Drawings.

B. Select a fitting for the proper use in respect to the mounting position.

+ + END OF SECTION + +

SECTION 16B5

EXPANSION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install conduit expansion and deflection fittings.

1.2 QUALITY ASSURANCE

A. Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 300, Wiring Methods.
   2. UL Standard 514, Electrical Outlet Boxes and Fittings.
   3. UL Standard 467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for expansion and deflection fittings proposed for use.
   2. Listing of locations where fittings are to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast gray iron alloy or bronze end couplings, malleable iron or hot dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting to be watertight, corrosion-resistant UL listed and compatible with the conduit system.

B. Product and Manufacturer: Provide one of the following:
   1. Type DX for expansion/deflection or AX for expansion only by O-Z Gedney Company.
   2. Type XD for expansion/deflection or XJ for expansion only by Crouse Hinds Company.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fittings in conformance with the National Electrical Code where necessary to compensate for thermal expansion and contraction.

B. Install expansion/deflection fittings where conduits cross structural expansion joints.

C. Where required in non-metallic conduit and duct systems, provide necessary couplings to make transition to the threaded metallic fitting.

+ + END OF SECTION + +

SECTION 16C1

600 VOLT CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install 600 volt cable.
   2. The types of cable required include the following:
      a. Insulated cable for installation in raceways.

B. Related Sections:
   1. Section 16C4, Instrumentation Cable.
   2. Section 16E, Grounding Systems for ground cable.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Codes: Cable shall be installed in accordance with the standards and recommendations of the National Electrical Code and with local codes which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply.
   2. Tests by Independent Regulatory Agencies: Cable shall bear the label of the Underwriters' Laboratories, Inc.

B. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. ASTM B 3, Soft or Annealed Copper Wire.
   2. ASTM B 8, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-hard or Soft.
   3. IPCEA S-66-524, NEMA WC7-1971, Cross-linked-thermosetting-polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   4. National Electrical Code.
   5. UL Standard No. 44, Wires and Cables, Rubber-Insulated.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, specifications, and engineering data for 600 volt insulated cable.

B. Test Records: Submit for review copies of written records of field insulation resistance test results.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Insulated Cable In Raceways:
   1. Material: Single conductor copper cable conforming to ASTM B 3 and B 8 with flame-retardant, moisture and heat resistant cross- linked polyethylene or thermoplastic insulation rated 90C in dry locations and 75C in wet locations and listed by UL as Type XHHW or THHN/THWN.
   2. Application: Use XHHW for #4 and larger and THHN/THWN or XHHW for #6 and smaller.
   3. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120 volt control circuits.
   4. Stranding: All 600 volt cable shall be stranded except that solid cable, size 10 and smaller may be used for lighting circuits.
   5. Manufacturer: Provide cable of one of the following:
      a. Pirelli Cable Corporation.
      b. Triangle PWC, Incorporated.
      c. Or equal.

B. Cable Connectors, Solderless Type:
   1. For wire sizes up to #6 AWG, use compression type.
   2. Product and Manufacturer: Provide one of the following:
      a. T & B Sta-Kon.
      b. Burndy Hylug.
      c. Or equal.
   3. For sizes #4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
   4. For sizes #250 MCM and larger, use connectors with at least 2 cable clamping elements or compression indents and provision for at least 2 bolts for joining to apparatus terminal.
   5. Properly size connectors to fit fastening device and wire size.

C. Cable Markers:
   1. Product and Manufacturer: Provide one of the following:
      a. Omni-Grip by W.H. Brady Company.
      b. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.

B. Pulling:
   1. Use insulating types of pulling compounds containing no mineral oil.
   2. Pulling tension shall be within the limits recommended by the wire and cable manufacturer.
   3. Use a dynamometer where mechanical means are used.
   4. Cut off section subject to mechanical means.

C. Bending Radius: Limit to 6 times cable overall diameter.

D. Slack: Provide maximum slack at all terminal points.

E. Splices:
   1. Where possible, install cable continuous, without splice, from termination to termination.
   2. Where required, splice in junction box using terminal boards.
   3. Splices in conduits not allowed.
   4. Splices in below grade pull boxes or manholes not allowed without specific written approval from the ENGINEER for method in each instance.

F. Identification: Identify all conductors by circuit number and phase at each terminal or splice location.

G. Color code power cables in accordance with OWNER's standards:

3.2 TESTING

A. Test each electrical circuit after permanent cables are in place to demonstrate that the circuit and connected equipment perform satisfactorily and that they are free from improper grounds and short circuits.

B. Individually test 600 volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service with a Megger whose rating is suitable for the tested circuit. Tests shall meet with the applicable specifications of IPCEA S-66-524 and NEMA WC7-1971.

C. The insulation resistance for any given conductor shall not be less than the value recommended by the IPCEA or a minimum of 1 megohm for 600 volt and less service, if not IPCEA listed. Any cable not meeting the recommended value or which fails when tested under full load conditions shall be replaced with a new cable for the full length.

+ + END OF SECTION + +

SECTION 16C4

INSTRUMENTATION CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install instrumentation cable.
   2. The types of cable include the following:
      a. Twisted shielded instrument cable.

1.2 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for shielded instrumentation cable proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Single Shielded Pair Instrument Cable:
   1. Tinned copper, stranded conductors, #18 AWG minimum, twisted with aluminum-polyester shield, stranded tinned 20 AWG copper drain wire and overall chrome vinyl jacket. Rated for 300 volts minimum.
   2. Manufacturer: Provide shielded cable of one of the following:
      a. Okonite Company.
      b. Belden Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.

B. Multipaired Shielded Instrument Cable:
   1. Tinned copper, 7 strand XLPE insulated conductors, #18 AWG minimum, twisted in pairs with aluminum-mylar shield over each pair, silicone rubber fiberglass fire barrier tape, tinned copper drain wire, aluminum mylar overall shield, Hypalon outer jacket.
   2. Manufacturer: Provide shielded cable of one of the following:
      a. Okonite Company.
      b. Dekoron Wire and Cable Company.
      c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in conduit separate from power cables unless otherwise noted.

B. Ground shield an shielded cables at one end only and as recommended by instrument manufacturer.

C. Terminate stranded conductors with pre-insulated crimp type spade or ring torque terminals properly sized to fit fastening device and wire size.

D. Install and terminate vendor furnished cable in accordance with vendor equipment requirements.

E. Install in conformance with the National Electrical Code.

3.2 TESTING

A. Test all 600 volt wiring in conformance with the requirements of Section 16C1, 600 Volt Cable.

B. Test shielded instrumentation cable shields with an ohmeter for continuity along the full length of the cable and for shield continuity to ground.

C. Connect shielded instrumentation cables to a calibrated 3-20 milliamp DC signal transmitter and receiver. Test at 4, 12, and 20 milliamp transmitter settings.

+ + END OF SECTION + +

SECTION 16D1

OUTLET BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install outlet boxes for mounting wiring devices and lighting fixtures.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 370, Outlet, Switch and Junction Boxes and Fittings.
   2. UL Standard No. 514, Electrical Outlet Boxes and Fittings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Device Boxes:
   1. Material: Cast gray iron alloy, or cast malleable iron, with zinc electroplate finish in damp, wet or exterior locations and zinc-coated sheet steel in dry locations.
   2. Device Cover Plates:
      a. Stainless steel Type 302 alloy for indoor finished areas.
      b. Gasketed spring door type for devices designated as weather proof.
      c. Integral with device for hazardous locations.
      d. Stainless steel screws and hardware.
   3. Manufacturer: Provide device boxes of one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten boxes rigidly and neatly to supporting structures.

B. For units mounted on masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.

C. Leave no open conduit holes in boxes. Close unused openings with capped bushings.

D. Label each circuit in boxes and identify with durable tag.

E. Install in conformance with National Electrical Code.

+ + END OF SECTION + +

SECTION 16D2

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install snap switches for lighting and other systems.

B. Related Sections:
   1. Section 16D1, Outlet Boxes.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified.
   1. National Electrical Code.
   2. UL Standard #20, General Use Snap Switches.
   3. UL Standard #894, Switches for Use in Hazardous Locations.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches for Non-Hazardous Locations:
   1. Single pole AC toggle switch, quiet type, 120/277 volt AC, 20 ampere, Ivory, specification grade.
      a. Product and Manufacturer: Provide one of the following:
         1) Cat. #1221-I, by Harvey Hubbel Incorporated.
         2) Cat. #1991-I, by Arrow-Hart Incorporated.
         3) Or equal.
   2. Single pole, 3-way AC toggle switch, quiet type, 120/277 volt AC, 20 ampere, Ivory, specification grade.
      a. Product and Manufacturer: Provide one of the following:
         1) Cat. #1223-I, by Harvey Hubbell Incorporated.
         2) Cat. #1993-I, by Arrow-Hart Incorporated.
         3) Or equal.
   3. Two pole AC toggle switch, quiet type, 120/277 volt AC, 20 ampere, Ivory, specification grade.
      a. Product and Manufacturer: Provide one of the following:
         1) Cat. #1222-I, by Harvey Hubbel Incorporated.
         2) Cat. #1992-I, by Arrow-Hart Incorporated.
         3) Or equal.

B. Switches for Hazardous Locations:
   1. Material: Factory sealed tumbler switch suitable for installation in Class I, Group D hazardous locations. Cast gray iron alloy or cast malleable iron body and cover with zinc electroplate finish. Switch rated at 20 amperes, 120/277 volt AC.
   2. Product and Manufacturer: Provide one of the following:
      a. Series EDS by Crouse-Hinds Company.
      b. Type EDS by Appleton Electric Company.
      c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wiring devices in outlet or device boxes in accordance with Section 16D1 in non-hazardous locations.

B. Install switches in rigid metallic conduit systems in hazardous locations.

C. Mount wall switches 4 feet-6 inches above finished floor unless otherwise noted.

D. Install switches in conformance with National Electrical Code.

+ + END OF SECTION + +

SECTION 16D3

RECEPTACLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install receptacles.

B. Related Sections:
   1. Section 16D1, Outlet Boxes.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. National Electrical Code.
   2. UL Standard #1010, Electrical Receptacle - Plug Combinations for Use in Hazardous Locations.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for receptacles proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Receptacles for Non-Hazardous Locations:
   1. Duplex grounding receptacle, two pole, three wire, 125 volt AC, 20 ampere.
      a. Product and Manufacturer: Provide one of the following:
         1) Cat. #53CM62, by Harvey Hubbell Incorporated.
         2) Cat. #5362-CR, by Arrow-Hart Incorporated.
         3) Or equal.
   2. Single grounding receptacle, corrosion resistant, two pole, three wire, 125 volt AC, 20 ampere.
      a. Product and Manufacturer: Provide one of the following:
         1) Cat. #53CM61, by Harvey Hubbell Incorporated.
         2) Cat. #5361-CR, by Arrow-Hart Incorporated.
         3) Or equal.

B. Receptacles for Hazardous Locations:
   1. Material: Factory sealed receptacle suitable for installation in Class I, Group D hazardous locations. Copper-free alumimum receptacle and cover with cast gray iron alloy or cast malleable iron mounting box with zinc electroplate finish. Receptacle rated at 20 amperes, 125-250 volt AC, 2 wire, three pole.

2. Product and Manufacturer: Provide one of the following:
   a. Series CPS by Crouse-Hinds Company.
   b. Type CPS by Appleton Electric Company.
   c. Or equal.

C. Welding Receptacles:

????

D. Power and Special Receptacles: Provide receptacles with number of poles and voltage and current rating as shown on the Drawings. Coordinate with equipment plugs. Provide matching plug for each receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wiring devices in outlet ordevice boxes in accordance with Section 16D1 in non-hazardous locations.

B. Install receptacles in rigid metallic conduit systems in hazardous locations.

C. Install receptacles with ground pole in the down position.

D. Mount receptacles 18 inches above finished floor in non-hazardous locations and 4 feet-6 inches above finished floor in hazardous or wet locations and process areas unless otherwise noted.

E. Install in conformance with National Electrical Code.

+ + END OF SECTION + +

SECTION 16D4

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install disconnect switches.

B. Related Sections:
   1. Section 16D2, Snap Switches for disconnect switches on 120 volt, single phase circuits.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. National Electrical Code.
   2. UL #98, Enclosed Switches.
   3. NEMA KS-1, Enclosed Switches.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for disconnect switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Service Disconnect Switches:
   1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in OFF position and safety handle.
   2. Rating: Voltage, number of poles and short circuit rating as shown on the Drawings. Switch shall bear a UL label and shall be suitable for use as service equipment.

B. Single Throw, Circuit Disconnect Switches:
   1. Type: Unfused, horsepower rated, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in the OFF position and safety handle.
   2. Rating: Voltage and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label.

C. Double Throw Safety Switches:
   1. Type: Unfused, double throw with center OFF position, quick-make, quick-break mechanism, visible blades in the OFF position and safety handle.
   2. Rating: Voltage and number of poles as required for the circuits being disconnected.

D. Enclosure:
   1. NEMA 12 for dry, non-corrosive areas.
   2. NEMA 4X for wet or corrosive locations and all outdoor locations.
   3. NEMA 7 for areas classified as hazardous locations.
   4. Nameplate identifying equipment for which switches serve as the disconnecting means.

E. Manufacturer: Provide disconnect switches of one of the following:
   1. Square D Company.
   2. General Electric Company.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other structural surfaces on which they are mounted. Provide independent galvanized steel supports where no wall or other structural surface exists.

C. Install in conformance with National Electrical Code.

+ + END OF SECTION + +

SECTION 16E

GROUNDING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install complete grounding for the electrical systems.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 250, Grounding.
   2. UL Standard #467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for grounding materials proposed for use.
   2. Listing of grounding connector types identifying where they are to be used.
   3. Layouts of each structure ground grid.
   4. Test point construction details.
   5. Results of ground resistance tests at each test point.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Bare Ground Cable:
   1. Material: Annealed, bare, stranded copper, No. 8 AWG minimum size.
   2. Manufacturer: Provide ground cable of one of the following:
      a. Cablec Corporation.
      b. General Cable Corporation.
      c. Rome Cable Company.
      d. Or equal.

B. Ground Rods:
   1. Material: Copperclad rigid steel rods, 3/4-inch diameter, 10 feet long.
   2. Manufacturer: Provide ground rods of by one of the following:
      a. Copperweld, Bimetallics Division.
      b. ITT Blackburn Company.
      c. Or equal.

C. Grounding Connectors:
   1. Material: Pressure connectors shall be copper alloy castings, designed specifically for the items shall be connected, and assembled with Durium or silicone bronze bolts, nuts and washers. Welded connections shall be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.
   2. Product and Manufacturer: Provide grounding connectors of one of the following:
      a. Pressure Connectors:
         1) O.Z./Gedney, Division of General Signal Corporation.
         2) Burndy Corporation.
         3) Or equal.
      b. Welded Connections:
         1) Cadweld by Erico Products, Incorporated.
         2) Therm-O-Weld by Burndy Corporation.
         3) Or equal.

PART 3 - EXECUTION

3.1 STRUCTURE GROUND SYSTEM

A. Provide ground grids around the following structures:
   1. Operations Building (note southward future expansion of Electric and Chlorine Rooms. Grid cable shall clear future work).
   2. Carbon Adsorber Pad.
   3. Standby Generator Pad.

B. Install #4/0 bare copper cable around the exterior perimeter of structures, minimum 2 feet-6 inches below grade, unless otherwise shown on Drawings.

C. Install sufficient ground rods (minimum of 4) to provide a resistance to ground of less than 5 ohms for each ground grid.

D. For structures with steel columns, install #4/0 ground cable from grid to each column around the perimeter of the structure. Connect cable to steel using exothermic welds.

E. Connect grids to a continuous underground water pipe system when practical.

F. Provide accessible test points for measuring the ground resistance of each grid, as shown on the Drawings.

G. Weld all buried connections except for test points.

3.2 EQUIPMENT GROUNDING

A. Ground all electrical equipment in compliance with the National Electrical Code.

B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where necessary for mechanical protection.

C. Connect ground conductors to conduit with copper clamps, straps or with grounding bushings.

D. Connect to piping by welding or brazing. Use copper bonding jumpers on all gasketed joints.

E. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use holddown bolts. Where grounding provisions are not included, drill suitable holes in locations designated by ENGINEER.

F. Connect to motors by bolting directly to motor frames, not to sole plates or supporting structures.

G. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on all gasketed joints.

H. Scrape bolted surfaces clean and coat with a conductive oxide- resistant compound.

3.3 TESTING

A. Test the completed ground systems for continuity and for resistance to ground using an electrical ground resistance tester.

+ + END OF SECTION + +

SECTION 16F1

UTILITY SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all materials, labor, equipment and incidentals as shown, specified and required to furnish and install underground ducts, transformer pad, underground pull section pad, grounding, metering details and structure in complete accordance with Arizona Public Service (APS) Rules and Regulations:

B. Coordination: CONTRACTOR shall comply with APS requirements for submission for approval or all APS related equipment, material and installation work.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the NEC, The National Electrical Safety Code and APS Rules and Regulations.

1.3 SUBMITTALS

A. Shop Drawings: Submit to APS for approval the following:
1. Underground pull section and metering section.
2. Main switchboard and electric room layout.
3. Underground service conduit layout.
4. Transformer pad location, layout and details.
5. All other requirements necessary for APS approval.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be in conformance with APS requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All Work shall be in conformance with APS Requirements.

B. Obtain approvals from APS at all stages of the Work.

+ + END OF SECTION + +

SECTION 16F2

UNDERGROUND DUCT BANKS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install underground duct banks.

B. Coordination: Duct bank routing on the Drawings is diagrammatic. Coordinate installation with piping and other underground systems and structures and locate clear of interferences.

C. Related Sections:
1. Section 2D1, Excavation and Backfill.
2. Section 3C, Concrete Reinforcement.
3. Section 3D, Cast-In-Place Concrete.
4. Section 16B1, Rigid Conduit.
5. Section 16F3, Manholes and Handholes.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the National Electrical Code and National Electrical Safety Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Layouts showing the proposed routing of duct banks and the locations of manholes, handholes and areas of reinforcement.
2. Profiles of duct banks showing crossings with piping and other underground systems.
3. Typical cross sections.
4. Installation procedures.

B. Record Drawings: Include the actual routing of underground duct runs on record drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Duct: Schedule 40 PVC conduit and fittings in accordance with Section 16B1.

B. Backfill: Select backfill in accordance with Section 2D1.

C. Concrete: In accordance with Section 3D.

D. Reinforcement: In accordance with Section 3C.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide excavation and backfilling required for ductbank installation.

B. Make duct bank installations and penetrations through foundation walls watertight.

C. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 3-inch minimum concrete separation between the outer surfaces of the ducts.

D. Provide a 3-inch minimum concrete covering on both sides, top and bottom of concrete envelopes around conduits. Add red dye to concrete used for envelopes or trowel a coloring on the concrete for easy identification during subsequent excavation.

E. Firmly fix ducts in place during pouring of concrete. Carefully spade and vibrate the concrete to insure filling of all spaces between ducts.

F. Make bends with sweeps of not less than 48-inch radius or 5 degree angle couplings.

G. Make a transition from non-metallic to rigid steel conduit where duct banks enter structures or turn upward for continuation above grade. Continue ducts inside buildings with rigid steel conduit.

H. Reinforce duct banks under roadways and in areas subject to soil settlement.
   1. Unless otherwise noted on the Drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 18 inches on centers, and No. 3 tie-bars transversely placed at 18-inch maximum longitudinal intervals.
   2. Maintain a maximum clearance of one inch from bars to the edge of the concrete encasement.

I. Where ducts enter structures such as manholes, handholes, pullboxes, transformer and switchgear compartments, or buildings, terminate the ducts in suitable end bells, insulated bushings or couplings on steel conduits.

J. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material or other materials which can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.

K. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3 inches per 100 feet.

L. Install a bare stranded copper duct bank ground in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system and connect to switchgear and MCC ground buses and to steel conduit extensions of the underground duct system.

M. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately one-fourth inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand or gravel have been left in the duct.

N. Install a warning ribbon approximately 12 inches below finished grade over all underground duct banks carrying cables of 480 volts and higher. The identifying ribbon shall be a PVC tape, 3-inches wide, yellow color, permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW" in black letters.

O. Plug and seal watertight all empty spare ducts entering buildings and structures. Seal watertight all ducts in use entering buildings and structures.

P. Install duct banks in conformance with National Electrical Code and National Electrical Safety Code.

+ + END OF SECTION + +

SECTION 16F3

MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install manholes and handholes.

B. Coordination: Coordinate manhole and handhole installation with piping, sheet piling and other underground systems and structures and locate clear of interferences.

C. Related Sections:
1. Section 2D1, Excavation and Backfill.
2. Section 3C, Concrete Reinforcement.
3. Section 3D, Cast-In-Place Concrete.
4. Section 16F2, Underground Duct Banks.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
1. National Electrical Code.
2. National Electrical Safety Code.
3. ASTM A 48, Gray Iron Castings.
4. ANSI A14.3, Safety Requirements for Fixed Ladders.
5. OSHA.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's technical information for manholes, handholes and accessories proposed for use.
2. Drawings showing interior and exterior dimensions and details of openings, jointing, inserts and reinforcing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material and Construction:
1. Precast or cast-in-place type of reinforced concrete.
2. Minimum interior dimensions as indicated on the Drawings.
3. Duct entrances sized and located to suit duct banks.

B. Accessories:
1. Frames and Covers:
   a. Material: Cast iron conforming to ASTM A 48, Class 30A.
   b. Covers: Watertight, sealed type marked "ELECTRICAL" in raised two inch letters.

c. Frame shall be grouted on the manhole or handhole.
d. Manufacturer: Provide frames and covers of one of the following:
   1) Neenah Foundry Company.
   2) Flockhart Foundry Company.
   3) Campbell Foundry Company.
   4) Or equal.

2. Pulling Irons:
   a. Material: Galvanized steel.
   b. Cast in the wall opposite to the centerline of each incoming duct bank and 12 inches below centerline of bottom line of ducts.
   c. Product and Manufacturer: Provide one of the following:
      1) Cat. No. DU2T3 by McGraw Edison Company.
      2) Cat. No. 8119 by A.B. Chance Company.
      3) Or equal.
3. Cable Racks:
   a. Material: Galvanized steel.
   b. Cable racks shall adequately support cables with space allowed for future cables.
   c. Each rack shall be a vertical assembly of 24 inch cable racks extending from within 6 inches of the manhole roof slab to within 6 inches of the manhole floor.
   d. Product and Manufacturer: Provide one of the following:
      1) Cat. No. J-5125 by Joslyn Manufacturing and Supply Company.
      2) Cat. No. 2125 by Hubbard and Company.
      3) Or equal.
4. Cable Hooks:
   a. Material: Galvanized steel.
   b. Length: 7-1/2-inch minimum.
   c. Product and Manufacturer: Provide one of the following:
      1) Cat. No. J-5132 by Joslyn Manufacturing and Supply Company.
      2) Cat. No. 2132 by Hubbard and Company.
      3) Or equal.
5. Insulators:
   a. Material: Porcelain.
   b. Product and Manufacturer: Provide one of the following:
      1) Cat. No. J-5122 by Joslyn Manufacturing and Supply Company.
      2) Cat. No. 2120 by Hubbard and Company.
      3) Or equal.
6. Manhole Steps:
   a. Material: Extruded aluminum.
   b. Steps spaced evenly at approximately twelve to sixteen inch centers and shall project evenly from manhole walls.
   c. Manufacturer: Provide manhole steps of one of the following:
      1) Flockhart Foundry Company.
      2) Neenah Foundry Company.
      3) Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install manholes and handholes where shown on Drawings. Verify final locations in field. Contractor shall be responsible for all excavation and backfilling required for installation.

B. Complete installation of manholes and handholes so that structures are watertight.

C. Cable Racks:
   1. Attach with 3-inch by 3/8-inch diameter "tamp-in" studs mounted in 1-inch holes drilled into walls of manholes in the absence of inserts.
   2. Provide cable hooks to support each cable on each rack along the cable run within the manholes.
   3. Individually support each cable at each hook on porcelain insulators.
   4. In the manhole securely tie each cable in place at each insulator block to prevent excessive movement of insulators, cables, or fireproof tape. Tie cables with non-metallic 3/4-inch strapping tape as manufactured by 3M or tie down with nylon straps.

D. Grounding: Install a 3/4-inch by 10-foot copper-clad ground rod for each manhole. Bond all exposed metal manhole accessories and the concrete reinforcing rods with No. 4 AWG minimum bare copper wire and connect to the ground rod and to the ductbank ground cable.

E. Sump: Provide a 12" x 12" x 6" sump in manhole floor.

F. Provide grading rings or brick stacks for manholes when required to adjust manhole cover to proper grade. Stacks shall be minimum of 12 inches in height, constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the stack shall be such as is necessary to bring the manhole frame to the proper grade.

+ + END OF SECTION + +

SECTION 16F8

LIGHTING AND DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting and distribution panelboards.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 384, Switchboards and Panelboards.
   2. UL Standard #50, Electrical Cabinets and Boxes.
   3. UL Standard #67, Electric Panelboards.
   4. NEMA PB1, Panelboards.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for panelboards proposed for use.
   2. Listing of the panelboards to be furnished with their proposed location and number of branch circuit breakers identified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Panelboards:
   1. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles shall be as indicated on the Drawings.
   2. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.
   3. Branch circuit interrupting capacity to exceed the maximum fault current available at the panelboard bus.
   4. Bus Bars: 98 percent conductivity copper. All 4 wire panelboards shall have a solid neutral bar. All panels shall have ground bus.
   5. Main: All panelboards shall have a main circuit breaker unless Drawings specifically call for main lugs only.
   6. Branch circuit breakers connected for sequence phasing.
   7. Construction: Code grade steel, ample gutter space, flush door, flush snaplatch and lock.
   8. Trim: Surface or flush as required.
   9. Directory: Typed card, with glass cover in frame on back of door giving the circuit numbers and the area or equipment served.
   10. Identification: Nameplate identifying the panel number and voltage.

11. Manufacturer: Provide panelboards of one of the following:
    a. General Electric Company.
    b. Westinghouse Electric Corporation.
    c. Square D Company.
    d. Or equal.

B. Mini-Power Centers:
1. General: Mini-power center shall consist of an encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.
2. Transformer Rating: KVA, primary voltage, secondary voltage, frequency and number of phases shall be as indicated on the Drawings.
3. Branch Circuits: Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.
4. Enclosure: Weatherproof.
5. Product and Manufacturer: Provide mini-power centers of one of the following:
    a. Mini-Power Zone by Square D Company.
    b. Mini-Power Center by Westinghouse Electric Corporation.
    c. Panel Tran by Acme Electric Corporation.
    d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting: Install panelboards at locations shown on Drawings. Set cabinets so that top branch circuit breaker is not over 6 feet from the floor.

B. Directory: Complete typewritten directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.

C. Arrange circuits to balance the loads on the panelboards.

+ + END OF SECTION + +

SECTION 16F9

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install dry type transformers.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. ANSI C89.1, Specialty Transformers.
   2. ANSI C89.2, Dry-Type Transformers for General Applications.
   3. UL Standard #506, Specialty Transformers.
   4. National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for transformers proposed for use.
   2. Listing of the transformers to be furnished with their ratings and proposed locations identified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Type: General purpose, dry type.
   2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as indicated on the Drawings.
   3. Taps: Full capacity, two 2-1/2 percent primary taps above normal and two 2-1/2 percent primary taps below normal.
   4. Sound Level: ANSI C89.1 standard.
   5. Enclosure: UL listed for either indoor or outdoor use.
   6. Insulation: Class 185 C, 115 C rise.
   7. Identification: Nameplate identifying the transformer number and voltages.

B. Manufacturer: Provide transformers of one of the following:
   1. General Electric Company.
   2. Westinghouse Electric Corporation.
   3. Sorgel by Square D Company.
   4. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install transformers on walls or floors. Provide sufficient access and working space for ready and safe operation and maintenance.

B. Mount transformers so that vibrations are not transmitted to the structural parts of the building or to other equipment.

C. Adjust tap settings to provide proper voltage at panelboards.

D. Ground transformer properly and install in conformance with the National Electrical Code.

+ + END OF SECTION + +

SECTION 16G1

LIGHTING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting fixtures.

B. Coordination:
   1. Coordinate location of fixtures with piping, ductwork, openings and other systems and equipment and locate clear of interferences.
   2. Coordinate fixtures to be mounted in hung ceilings with the ceiling suspension system proposed for use.

C. Related Work Specified Elsewhere:
   1. Section 16D1, Outlet Boxes.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. National Electrical Code.
   2. UL Standard #57, Electric Lighting Fixtures.
   3. UL Standard #844, Electric Lighting Fixtures for Use in Hazardous Locations.
   4. UL Standard #1570, Fluorescent Lighting Fixtures.
   5. UL Standard #1571, Incandescent Lighting Fixtures.
   6. UL Standard #1572, High Intensity Discharge Lighting Fixtures.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog costs and technical information for lighting fixtures proposed for use.
   2. Fixture construction details.
   3. ETL photometric and isocandle curves for each fixture proposed.
   4. Verification that recessed fixtures which are to be mounted in hung ceilings are compatible with the ceiling suspension system proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Type: Lighting fixtures are noted in the Fixture Schedule. Fixtures to be complete with supports, ballasts, lamps and incidentals as required.

B. Lamps:
   1. Fluorescent: Cool white, energy efficient type.
   2. High Pressure Sodium: Clear.

3. Mercury Vapor: Color corrected.
4. Metal Halide: Phosphor coated.
5. Incandescent: Inside frosted.
6. Spare: Ten percent spare lamps of each type and wattage.

C. Ballasts:
1. Fluorescent: High power factor, energy efficient type, equipped with thermal protectors (Type "P" ballast), compatible with the lamps installed.
2. High Intensity Discharge: High power factor, constant wattage, stabilized autotransformer with line starting current the same or less than operating current.
3. Ballasts to have "C" sound rating (min.) and be ETL/CBM certified.
4. Spare: Ten percent spare ballasts of each type.

D. Fixtures located in an area which is identified as a hazardous location shall be approved as a complete assembly for the hazardous location classification indicated on the Drawings, shall be clearly marked to indicate maximum wattage of lamps for which they are approved, and shall be protected against physical damage by suitable guards.

E. Hardware: All necessary hangers, supports, conduit adaptors, reducers, hooks, brackets and other hardware required for safe fixture mounting shall be furnished. Hardware shall have a protective, non-corrosive finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision in the field where necessary to clear conflicts and obstructions.

B. Suspended Fixtures: Pendant mount using 1/2-inch conduit stems. Ground to outlet box. Attach mounting to building structure with expansion anchors. Fixtures shall not be dependent on the outlet box cover screws for support.

C. Surface Mounted Fixtures: Attach to appropriate outlet box.

D. Boxes and Fixtures:
1. For units mounted against masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.
2. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers or Unistrut.
3. No boxes shall be installed with open conduit holes.
4. Cable each circuit and identify with tag.

E. Mounting Heights: Mounting heights or elevations are to bottom of the fixture or to centerline of device.

F. Relamp all fluorescent fixtures with new lamps at end of construction period, prior to final acceptance of the new facilities by OWNER.

G. Install fixtures in conformance with the National Electrical Code.

+ + END OF SECTION + +

SECTION 16G3

LIGHTING CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting controls.

B. Related Sections:
   1. 16H6, Contactors.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. UL Standard #917, Clock-Operated Switches.
   2. National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for lighting controls proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Time Switch:
   1. Type: Astronomic dial time switch with day-omitting device.
   2. Timing Motor: Heavy duty, synchronous, self-starting, high torque, 120 volt, 60 cycles.
   3. Capacity: 40 Amps per pole at 277 volts.
   4. Dial: 24 hour rotation, with gear to provide one revolution per year which automatically raises the ON and OFF settings each day according to seasonal changes of sunset and sunrise for the Glendale Arizona area, latitude __° ___.
   5. Reserve Power: Spring driven reserve sufficient to operate time switch contacts for a minimum of 30 hours after power failure. On restoration of power, time switch shall transfer to synchronous motor drive and automatically rewind reserve.
   6. Product and Manufacturer: Provide one of the following:
      a. Z Series by Tork Time Controls, Incorporated.
      b. Series CR 121JB by General Electric Company.
      c. Or equal.

B. Photocell:
   1. Cadmium sulphide hermetically sealed cell, fully temperature compensated, with time delay of at least 15 seconds to prevent false switching.

2. Built-in fail safe light level selector, adjustable within limits of 2 to 50 foot candles and factory set at 25 foot candles.
3. Product and Manufacturer: Provide one of the following:
   a. Model No. 2102 by Tork Time Controls, Incorporated.
   b. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Mount photocell in appropriate outside location and adjust footcandle setting for proper dusk and dawn photo control. Provide wiring in conduit from the photocell to controls.

C. Securely fasten equipment to walls or other surfaces on which they are mounted.

D. Install in accordance with the National Electrical Code.

+ + END OF SECTION + +

SECTION 16H1

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install motor control centers.

B. Coordination: Obtain motor nameplate data on equipment being furnished for properly sizing circuit breakers, starters and overloads.

C. Related Sections:
1. Section 3D, Cast-In-Place Concrete for concrete pad.
2. Section 16H7, Automatic Transfer Switches.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
1. UL Standard #845, Electric Motor Control Centers.
2. NEMA ICS2-322, AC General Purpose Motor Control Centers.
3. National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's technical information for motor control centers proposed for use.
2. Outline and summary sheets with schedules of equipment in each unit.
3. Unit control schematic and elementary wiring diagrams showing numbered terminal points and interconnections to other units.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Motor control center lineups shall be provided as shown on the Drawings.
1. Service: Voltage rating and number of wires shall be as shown on the Drawings. MCC shall operate from a 3 phase, 60 hertz system.
2. Wiring: NEMA Class II, Type B.
3. Enclosure: NEMA I.

B. Construction:
1. Totally enclosed structure, dead front, consisting of nominal 20-inch deep, 20-inch wide, 90-inch high vertical sections bolted together to form a unit assembly.
2. Removable lifting angles for each shipping section.
3. Two removable floor sills for mounting.

4. Horizontal wireways top and bottom, isolated from horizontal bus and readily accessible.
5. Isolated vertical wireways with cable supports, accessible through hinged doors, for each controller section.
6. All metal non-conducting parts electrically continuous.

C. Bus System:
1. Rating: Bus bracing and bus current capacities as indicated on the Drawings.
2. All bus bars tin plated copper rated UL heat rise standards.
3. Bus bar connections easily accessible with simple tools.
4. Main Horizontal Bus: Continuous edge mounted, and isolated from wireways and working areas.
5. Vertical Bus: Continuous, and isolated by a glass polyester barrier.
6. Grounding Bus: Full length mounted across the bottom, drilled with lugs of appropriate capacity as required.

D. Unit Compartments:
1. Individual front door for each unit compartment with engraved nameplate identifying equipment. Nameplates to be 1 inch by 3 inches minimum, secured to unit door with two screws.
2. Starter and feeder-unit doors interlocked mechanically with the unit disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while door is open, with provisions for releasing the interlock for intentional access and application of power.
3. Padlocking arrangement permitting locking the disconnect device in the OFF position with at least three padlocks with the door closed or open.
4. NEMA 1 minimum motor starter size. Starter units completely drawout type in Sizes 1 and 2 and drawout type after disconnecting power leads only in Sizes 3 and 4.
5. Motor starters shall include a magnetic contactor, NEMA rated with encapsulated magnet coils. Wound coils not acceptable.
6. Reversing Starters: Single speed full voltage with two contactors and extra interlocking contacts.
7. Reduced Voltage Starters: Part winding, closed-transition type, adjustable time interval.
8. Overload Relays: Three melting alloy type, manually reset from outside the enclosure by means of an insulated button with normally open auxilliary contact for remote alarm purposes and separate heater elements sized for the full load amperes and service factor of the actual motors furnished.
9. Individual control power transformers for all starters, capacity as required for all control circuit devices, 100VA minimum, Class A insulation, two primary fuses, 120 volt secondary, one secondary fuse and the other secondary leg grounded.
10. Separate Control: Where control power to starter is provided by a separate power source, a control power fuse shall be provided in the unit and the main disconnect shall be equipped with a normally open contact to isolate the control circuit from the source when the controller disconnect is open.
11. Motor horsepowers shown are preliminary. Circuit breaker trips and starter overload heaters to be coordinated with the actual equipment installed.

12. Auxiliary contacts, relays, timers as required for specified control functions and those shown on the Drawings.
13. All starter devices, including spare contacts wired to numbered terminal blocks.
14. Control devices shall be 600 volt heavy duty, NEMA A600. Relays shall have convertible contacts. Pilot devices shall be oiltight, push-to-test.
15. Feeder Circuit Breakers: Thermal magnetic type.
16. Motor Starter Circuit Breakers: Magnetic trip only motor circuit protectors.
17. Each starter shall be provided with one N.D. and one N.C. auxiliary contact.
18. Provide the following diagrams and tables on the inside of the door for each compartment:
    a. Elementary wiring diagram.
    b. Table of overload heater sizes with the correct heater highlighted.
    c. Table of the motor circuit protector settings with the correct setting highlighted.
19. Integral automatic transfer switch as specified in Section 16H7.

E. Spare Parts:
1. Provide the following spare parts for each motor control center lineup:
    a. Two fuses of each size and type used.
    b. One auxiliary control relay with at least two normally open and two normally closed contacts.
    c. One control transformer of each size used.
    d. Twelve indicating lamps.
2. Package spare parts in suitable containers bearing labels clearly indicating the contents and equipment with which they are to be used. Deliver spare parts at the same time as the motor control centers.

F. Product and Manufacturer: Provide motor control centers of one of the following:
1. 8000 Line by General Electric Company.
2. Model 4 by Square D Company.
3. Centerline by Allen Bradley Company.
4. Unitrol by Cutler Hammer.
5. System 89 by Furnas Electric.
6. Series 2100 by Westinghouse Electric Corporation.
7. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install on raised concrete base at locations shown on the Drawings. Install support channels in concrete per manufacturer's recommendations.

B. For installations against masonry walls, provide an insulation board, 1/4 inch minimum thickness, between motor control center and wall for corrosion protection. Trim board neatly within outline of unit.

C. Provide no openings in top or side of units not required for conduit.

D. Cable circuits together within enclosures and identify with durable tag secured to cabling twine.

E. Set motor circuit protectors at lowest setting which permits motor starting without nuisance tipping.

F. Field test all motor control center components.

G. Verify that wiring diagrams on inside of door of each compartment reflects the "as-built" circuitry and that the correct overload heater size and motor circuit protector setting are noted.

H. Install in conformance with the National Electrical Code.

3.2 MANUFACTURER TRAINING SERVICES

A. CONTRACTOR shall furnish the services of qualified factory trained specialists from the manufacturer to instruct OWNER'S operations and maintenance personnel in the recommended operation and maintenance of this equipment.

+ + END OF SECTION + +

SECTION 16H2

MAGNETIC MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install magnetic motor starters.

B. Related Sections:
   1. Section 16H1, Motor Control Centers for starters furnished as part of motor control centers.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable, provisions, and recommendations of the following except where otherwise shown or specified.
   1. NEMA Standard ICS2-110, General Standards for Manual and Magnetic Controllers.
   2. NEMA Standard ICS2-321 AC General Purpose Class A Controller for Squirrel Cage Induction Motors, 600 volts and less.
   3. UL Electrical Construction Materials Directory (NLDX).
   4. National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for magnetic motor starters proposed for use.
   2. Listing of the motor starters to be furnished with their location and equipment to be controlled identified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Type: Magnetic coil operated, horsepower rated with thermal overload protection.
   2. Combination starter with magnetic only motor circuit protector.
   3. Enclosures: NEMA 1 for dry, indoor locations and NEMA 4X for outdoor and damp, wet or corrosive indoor locations.
   4. Functional Type: Full voltage, single speed, nonreversing unless otherwise noted on Drawings.
   5. Control power transformer fused and grounded on low voltage (120 V) side for each starter.
   6. Auxiliary contacts for remote status signals and interlocks as shown on Drawings.
   7. Overload relays of the temperature compensated type and overload heaters sized to coordinate with actual motors being controlled.

8. Start and stop control stations, selector switches, pilot lights and other devices as shown on Drawings.
9. Nameplate identifying the equipment controlled.

B. Product and Manufacturer: Provide one of the following:
1. Type A 206 by Westinghouse Electric Corporation.
2. Type CR287 by General Electric Company.
3. Bulletin 512 by Allen Bradley Company.
4. Class 8539 by Square D Company.
5. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount controller so that sufficient access and working space is provided for safe operation and maintenance.

B. Securely fasten enclosure to wall or other mounting surfaces. Where local wall is not available, provide galvanized steel supports to rigidly support equipment reasonably close to motor.

C. Install in conformance with the National Electrical Code.

+ + END OF SECTION + +

SECTION 16H4

CONTROL STATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install pushbuttons, selector switches and other control stations.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified.
   1. NEMA Standard ICS2-216, Pushbuttons, Selector Switches, Indicating Lights and Pushbutton Stations.
   2. National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for control stations proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Control Stations:
   1. Type: Industrial, heavy duty, oiltight construction with clearly marked legend plates.
   2. Lockout Stop: Maintained contact type with provisions for locking.
   3. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
   4. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position.
   5. Indicating Lights: 110V lamps, push to test. Lens color red for running, green for stopped or ready and amber for failure.
   6. Enclosures: NEMA 12 for dry indoor non-hazardous locations, NEMA 7 for Class I hazardous locations, NEMA 9 for Class II hazardous locations and NEMA 4X for outdoor and damp, wet or corrosive indoor locations. NEMA 4X stations shall have 316 SS or non-metallic bezels, locking rings, nameplates, and all external hardware and components.
   7. Nameplates identifying equipment controlled if not readily apparent.
   8. Products and Manufacturers: Provide control stations of one of the following:
      a. Westinghouse Electric Corporation.
      b. General Electric Company.
      c. Allen Bradley Company.
      d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which they are mounted. Provide independent galvanized steel supports where no wall or other surface exists.

C. Install in conformance with National Electrical Code.

+ + END OF SECTION + +

SECTION 16H6

CONTACTORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install contactors.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. UL Standard #508, Electric Industrial Control Equipment.
   2. National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for contactors proposed for use.
   2. Listing of the contactors to be furnished with their location and equipment to be controlled identified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lighting Contactor:
   1. Type: Single coil, electrically operated, mechanically held.
   2. Contactor shall be 4 pole, single throw, 60 ampere 600 volt industrial duty, suitable for continuous duty with all types of lighting loads.
   3. Main Contacts: Silver alloy, removable.
   4. Coil Voltage: 120 volts.
   5. Enclosure: NEMA 1 for dry, indoor locations; NEMA 4X for outdoor and damp, wet or corrosive indoor locations; open when located in motor control centers or panelboards.
   6. Accessories: Coil clearing contacts.
   7. Nameplates identifying equipment controlled.
   8. Products and Manufacturers: Provide one of the following:
      a. Class 8903 by Square D Company
      b. Type A202 by Westinghouse Electric Corporation.
      c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which they are mounted.

C. Install in conformance with the National Electrical Code.

+ + END OF SECTION + +

SECTION 16H7

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish an automatic transfer switch integral with the motor control center in Section 16H1.

B. Related Sections:
   1. Section 16H1, Motor Control Centers.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. UL Standard #1008, Automatic Transfer Switches.
   2. NEMA 1CS2-447, AC Automatic Transfer Switches.
   3. NEMA 1CS1-109, Tests and Procedures.
   4. IEEE Standard 472-1974, Guide for Surge Withstand Capability Tests.
   5. National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for automatic transfer switches proposed for use.
   2. Listing of the transfer switches to be furnished with their ratings and locations identified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rating:
   1. Switches shall be capable of switching all classes of loads and shall be rated for continuous duty when installed in a non-ventilated enclosure.
   2. Ampere rating and number of poles shall be as indicated on the Drawings.
   3. Switches shall withstand the magnitude of fault current indicated on the Drawings without welding of contacts.

B. Operation:
   1. Switches shall be double throw and operated by a single, non-fused, momentarily energized operating mechanism.
   2. Operating mechanism shall prevent a sustained neutral position.
   3. Main contacts interlocked to prevent simultaneous closing.
   4. Mechanical locking of main contacts in each direction shall be accomplished without the aid of latching solenoids, toggle mechanisms or gear arrangements.

5. An overload or short-circuit shall not cause the switch to go to a neutral position.
6. Inspection of all movable and stationary contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The maintenance handle shall permit the operator to stop the contacts at any point throughout the entire travel to properly inspect and service the contacts when required.

C. Accessories: A separately mounted control panel with adjustable solid-state or programmable microprocesser sensing and timing functions shall provide the following operational characteristics:
1. Time delay on momentary dips in normal source (0.5-6.0 seconds), factory set at 1 second.
2. Time delay on transfer to emergency for controlled loading of generator (0-1 minute), factory set at 0 minutes.
3. Time delay on retransfer to normal (0-30 minutes), factory set at 30 minutes.
4. Time delay on engine shutdown after retransfer to normal (0-5 minutes), factory set at 5 minutes.
5. Close differential voltage sensing of all normal source phases (pickup adjustable from 85-100 percent of nominal and dropout adjustable from 75-98 percent of pickup), factory set to pickup at 90 percent and dropout at 85 percent of nominal.
6. Independent voltage (85-100 percent pickup) and frequency (90-100 percent pickup), sensing of the emergency source to prevent premature transfer, factory set to pickup at 90 percent of nominal voltage and 95 percent of nominal frequency.
7. Test switch (momentary type) to simulate failure of normal source.
8. Two sets of gold-plated single pole, double throw contacts, which operate when the normal source fails. One set to be used for engine starting and the second set to be spare.
9. Pilot lights to indicate switch position.
10. Auxiliary contacts (one closed on "Normal" and one closed on "Emergency") rated 10 amps, 480 VAC.
11. An inphase monitor to control transfer and retransfer operations between live sources so that closure on the alternate source will occur only when the two sources are approaching or near synchronism (within 15 electrical degrees maximum) so that inrush currents do not exceed normal starting currents. The monitor shall function over a frequency difference range of up to ±2.0 Hz with a maximum operating transfer time of one-sixth of a second. If the voltage of the load-carrying source drops below 70 percent, the inphase function shall be automatically bypassed. The monitor shall not require interwiring with the generator controls, or active control of the governor.
12. All time delay and sensing functions shall be field adjustable over the ranges indicated and shall operate with minimum drift (not to exceed ±1 percent of set frequency, ±2 percent of set voltage, and ±10 percent of set time delay) over the temperature range of -20 C to +70 C. The control panel shall be provided with a protective cover and an isolation plug in the wiring harness to disconnect all the control wires between the control panel and the main transfer panel.

D. Electrical and Mechanical Performance: Comply with UL Standard 1008 and NEMA Standard ICS2-447. In addition, performance must meet or exceed the following requirements and, if so requested, be verified by certified laboratory test data:
   1. Temperature Rise: Measurements shall be made after the overload and endurance tests.
   2. Withstand: UL listed to withstand the magnitude of fault current available at the switch terminals when coordinated with respective protective devices as shown on the Drawings at an X/R ratio of 6.6 of less. The main contacts shall not trip open or weld when subjected to fault currents.
   3. Dielectric: Measurements shall be made at 1960 VAC rms minimum following the withstand current rating test.
   4. Transient Withstand: Control panel shall pass the voltage surge withstand test per IEEE Standard 472-1974 and the voltage impulse withstand test per NEMA ICS-1-109.

E. Product and Manufacturer: Provide one of the following:
   1. Bulletin 940 by Automatic Switch Company.
   2. Type RMT by Russelectric Incorporated.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which they are mounted.

C. Install in conformance with National Electrical Code.

+ + END OF SECTION + +

SECTION 16I1

STANDBY POWER GENERATOR

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install an outdoor, enclosed engine generator set complete with all appurtenances.

B. In order to centralize responsibility, it is required that all equipment and services provided under this Section be furnished by a single supplier or manufacturer who shall assume full responsibility for the completeness of the system.

C. Related Work Specified Elsewhere:
   1. Section 9L, Painting (surface preparation and shop painting are under Section 16I1.)
   2. Division 15.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The manufacturer shall have experience in producing similar equipment, and shall show evidence of installations in satisfactory operation. The manufacturer shall have complete parts and service facilities and a factory trained serviceman available on a 24 hour basis.

B. Requirements of Regulatory Agencies:
   1. Local Ordinances: The manufacturer shall submit proof that the engine generator sets meet all requirements with respect to noise control and exhaust emissions.

C. Source Quality Control:
   1. All materials, equipment and parts comprising the unit specified shall be new, of current manufacture and of the highest grade.
   2. The engine generator set shall be factory assembled and tested to determine that it is free from electrical or mechanical defects and to assure that it meets design specifications.

D. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEMA MG1, Motors and Generators.
   2. NEMA MG2, Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators.

E. Performance Tests:
   1. Factory Tests: Standard production tests shall be performed at the factory after assembly to verify proper operation and performance.
   2. Field testing shall be performed by a factory trained serviceman as coordinated by the CONTRACTOR.

1.3 SUBMITTALS

A. Submit for approval the following:
   1. Preliminary outline drawings including overall dimensions of the unit and enclosure.
   2. Engine data sheet including, as a minimum, type, make and model of engine, fuel consumption at rated load, maximum horsepower at rated RPM, piston displacement, rated revolutions per minute and number of engine cycles.
   3. Generator data sheet including, as a minimum, design type, continuous and standby rating in kw, voltage, phase, frequency, winding insulation class and temperature rise, coupling and voltage regulation capability.
   4. Additional manufacturer's literature, specifications, and engineering data necessary to fully describe engine-generator set and all appurtenances and to substantiate compliance with the Specifications.
   5. Standard published curves of engine-generator set rating. Special or maximum ratings not acceptable.
   6. Calculations confirming motor starting capability.
   7. Guaranteed noise level in db within 10 feet of the unit.
   8. Weight of the unit (including all components).
   9. A list of any and all instances where equipment proposed deviates from the Specifications.

B. Operation and Maintenance Manual: Submit complete manual including:
   1. Copies of all shop drawings, test reports, maintenance data and schedules, description of operation and spare parts information.
   2. Furnish operation and maintenance manual in conformance with requirements of Section 1I3.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following generator set is required:

1. Number Required	-	1
Rating	-	Minimum 150 KW, 187.5 KVA, 0.8 power factor, 480 volt, 3 phase, 4 wire, 60 Hz when equipped with all accessories.
Cooling System	-	Radiator Type

B. The set shall be rated for continuous 24-hour per day operation, without deration, for the duration of any normal utility outage up to a maximum of 30 days.

C. Ambient Conditions:
   1. Temperature: 125 F.
   2. Altitude: 1250 feet above sea level.

2.2 ENGINE-GENERATOR UNIT

A. Engine Type: Radiator cooled diesel, 1800 rpm.

B. Engine Construction:
   1. Steel backed bearings.
   2. Crank Case: Reinforced cast iron.
   3. Crank Shaft: Forged alloy steel with hardened journals, finished and dynamically balanced.
   4. Cylinder Head: Cast iron.
   5. Pistons: Aluminum alloy with chrome faced rings.
   6. Replaceable cylinder liners and valve seat inserts.

C. Cooling System:
   1. Cooling system shall employ an engine-mounted radiator capable of cooling the engine when operating under full load conditions in an ambient temperature not exceeding 125 F.
   2. Engine shall be provided with a thermostatic valve placed in the jacket water outlet between the radiator and the engine to maintain proper jacket water temperature. Engine driven circulating pump shall be provided to circulate water through the engine cooling system.
   3. Coolant: System shall be filled with a 50 percent solution of ethylene glycol.
   4. High engine temperature shutdown.
   5. Loss of coolant shutdown.
   6. Jacket Water Heater:
      a. 1500 watts maximum, thermostatically controlled to keep the jacket water at a suitable temperature for trouble-free starting.
      b. Suitable for operation on 280 volt, single phase current. Automatically disconnected when engine is started.

D. Lubrication System: Force feed to all bearings with gear type pump, full-flow filters, oil level indicator, oil temperature and pressure gages.

E. Fuel System: Suitable for operation on No. 2 fuel oil. System to include day tank, fuel filters, dry element air cleaners, and an electronic governor.
   1. Day Tank: 25 gallon capacity, insulated epoxy coated inside, 2 gpm high lift pump, solenoid valve on pump inlet, float switches for control of pump and low level alarm, level gage, control panel with "Press-to Test" feature; Simplex Model SFT 25A, or equal. The entire day tank assembly shall be weather proof.
   2. Governor: Electronic, speed droop externally adjustable, isochronous to 5 percent.
   3. Fuel/Water Separator:

F. Exhaust System: Flexible stainless steel exhaust connector and critical silencing muffler, Cowl TXS, Maxim M51, or equal. Include condensate drain valve.

G. Starting System: DC system complete with batteries, charger and connecting cables between batteries and engine.
   1. Batteries: Lead acid engine cranking type, rated in accordance with engine manufacturer's requirements for a minimum of three 15 second cranking cycles at firing speeds without recharging. Batteries to be sized to accommodate DC power requirements of the control panel and any other accessories requiring DC power.

2. Charger: Automatic float charger, current limited, with DC ammeter and voltmeter, equalizing timer and capable of recharging the batteries to full charge in not more than six hours after three crank cycles, La Marche Model A-46, or equal. The charger shall be mounted in the generator weatherproof enclosure.

H. Alternator: Revolving field, 4-pole, brushless excitation, open drip-proof self ventilated enclosure, class F insulation, skewed stator, dynamically balanced rotor, full amortisseur windings, epoxy coating on rotor and stator for abrasion and humidity protection, solid state voltage regulator.
1. Voltage Regulation: ±1 percent from no load to full load.
2. Voltage Adjustment: ±5 percent with rheostat in generator control panel.
3. Voltage Wave Form Deviation: Per NEMA MG1-22.43.
4. Telephone Influence Factor: Per NEMA MG1-22.43.
5. Overload: Capable of sustaining a 10 percent overload for 2 hours.
6. Short Circuit: Include a permanent magnet pilot exciter, in addition to the standard exciter, to increase fault current to 3 times full load rating.

I. Control Panel: Panel unit mounted inside generator housing on vibration isolators containing the controls, instruments, lights, main line circuit breaker and other devices necessary to manually and automatically start, stop and protect the diesel engine-generator unit. Controls and alarms shall operate from battery power. Panel shall include the following:
1. Run-Stop-Remote selector switch with terminals for two-wire remote start-stop signal.
2. AC voltmeter and ammeter with phase selector switch.
3. Frequency meter.
4. Running time meter.
5. Voltage adjusting rheostat.
6. Cyclic cranking and over crank protection.
7. Overspeed control independent of the governer.
8. Cooldown timer.
9. Shutdown without cooldown and alarm annunciation for:
   a. High coolant temperature.
   b. Low oil pressure.
   c. Overspeed.
   d. Overcrank.
   e. Low coolant level.
10. Alarm annunciation without shutdown:
    a. Low fuel level on day tank.
    b. Pre-alarm conditions recommended by manufacturer.
11. Lamp test momentary push button controls and wiring.
12. Common dry contact closing on alarm for remote alarm and dry contact for remote run indication.
13. Reset Control: Manual or remote restarts shall not be permitted and alarm lamps shall remain in the alarm state until manual reset is accomplished even if the alarm condition has been corrected.
14. Emergency stop switch for shutdown independent of cooldown timer.
15. Main circuit breaker, manually operated, insulated case type, UL listed, with shunt trip and sized as required to protect the unit furnished. Breaker shall be mounted in the control panel or in a separate NEMA I enclosure inside the housing.

J. Generator Enclosure and Base: An outdoor nonwalk-in weatherproof housing shall completely enclose the engine generator set and appurtenances:
   1. Welded and bolted reinforced sheet steel, 14 gauge.
   2. Weatherproof, tamperproof construction.
   3. Hinged doors on sides and one door in rear for easy access and servicing. Door handles key lock design.
   4. Shuttered air openings on front and sides with mesh screens on side shutters. Shutters sized for engine air requirements,
   5. All ventilation and other openings shall have 316 SS rodent and bug proof screening.
   6. Base shall be a structural steel frame of adequate rigidity for generator and engine alignment.

K. Nameplate: In accordance with the requirements of NEMA MG1-22.61.

L. Painting:
   1. All ferrous metal surfaces shall be cleaned and painted with a rust inhibiting primer and manufacturer's standard finish paint.
   2. Color of finish paint to be manufacturer's standard color.

2.3 MANUFACTURER

A. Provide one of the following:
   1. Kohler.
   2. Onan Corporation.
   3. Or equal.

PART 3 - EXECUTION

3.1 CONTRACTOR'S SERVICES

A. Install the engine generator set in accordance with the Drawings, approved Shop Drawings and the manufacturer's recommendations.

B. Engine-Generator Set Mounting:
   1. Vibration Isolators: Steel springs in combination with rubber pads. Vibration Eliminator #23W95, 6 pcs per set, Korfund #LKE-68, 4 per set, or equal.
   2. Anchor Bolts: Type 316 stainless steel or silicon bronze.
   3. A template shall be furnished by the manufacturer for setting anchor bolts, pipe sleeves, and nuts for mounting the spring type isolators specified to the concrete foundation. Bolts and nuts shall be furnished for bolting the isolators to the channel frame base of the engine-generator set.
   4. Vibration Isolation: Provide flexible connections between engine-generator set and fuel lines, exhaust system, conduit containing power or control cables and other externally connected support systems.

C. Silencer: Horizontal mounted within enclosure.

D. Vibration Isolation: Provide flexible connections between engine-generator set and fuel lines, exhaust system, conduit containing power or control cables and other externally connected support systems.

3.2 FIELD QUALITY CONTROL

A. Required Manufacturer's Services: A qualified factory trained serviceman shall perform the following services:

1. Supervise installation of the equipment specified herein.
2. Inspect and adjust the equipment after installation and insure that it operates properly.
3. Instruct OWNER'S personnel in the operation and maintenance of the equipment.

B. Field Tests:
1. Field testing to be by a factory trained serviceman.
2. Apply the actual plant loads available:
3. Verify the following:
   a. That the entire installation has been made in accordance with the approved manufacturer's drawings, and that the units and all auxiliaries are ready for operation.
   b. That fuel and lubrication systems are complete, clean and filled with the proper grades of fuel and lubricants.
   c. That the units and all all subsystems start, operate, and shutdown as specified herein and in accordance with manufacturer's specifications.
   d. That all safeties, alarms and shut-downs function at the correct set point and sequence.
   e. That the units accept load, govern speed and regulate voltage as specified.
4. Provide all equipment, lubricants and material required for the field testing.
5. Adjust and leave equipment in proper working order.
6. Fuel supplied by Owner.

+ + END OF SECTION + +