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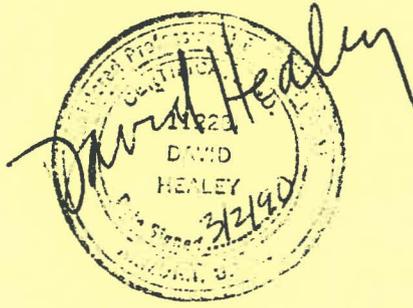
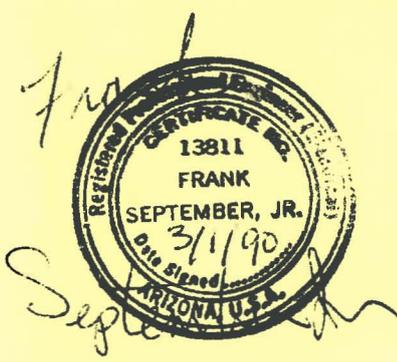
CONSTRUCTION SPECIFICATIONS
FOR

12TH STREET BRIDGE AND UTILITY RELOCATIONS
AT THE ARIZONA CANAL DIVERSION CHANNEL

FCD CONTRACT NO. 89-61

CONSTRUCTION SPECIAL PROVISIONS
Prepared By:

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.
1501 West Fountainhead Parkway
Tempe, Arizona 85285



(Engineer's Seal)

PREPARED FOR:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Recommended By: Nick Karan Date: 3-1-90
Nicholas P. Karan, P.E., Chief
Engineering Division

Approved By: Stanley L. Smith Jr. Date: 3-1-90
D.E. Sagramoso, P.E.
Chief Engineer and General Manager

SUPPLEMENTARY TO MARICOPA ASSOCIATION OF GOVERNMENTS UNIFORM STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION EDITION OF 1979 AND REVISIONS AND SUPPLEMENTS THERETO.

DATE: MARCH 26, 1990

FCD CONTRACT NO. 89-61

PAGE 1 OF 1

To Contract Documents

ENTITLED: 12TH STREET BRIDGE AND UTILITY RELOCATIONS AT THE ARIZONA CANAL DIVERSION CHANNEL

OWNER: Flood Control District of Maricopa County

The above documents are herein modified. The provisions of said documents applicable to these modifications remain unchanged unless specifically indicated otherwise herein. This addendum forms a part of the contract documents and modifies them as follows:

TO INVITATION TO BID AND BIDDING SCHEDULE:

- 1. On page 8 of 27 of the Invitation to Bid, under Item 625-1 of the Bidding Schedule, change the approximate quantity from "2" to "4".

TO CONSTRUCTION SPECIAL PROVISIONS:

- 1. On page 13 of 126, under "501 Sheet Piling", add the following sentence to the end of the first paragraph:

"The Contractor's engineer shall evaluate the traffic plating details (identified as "Transition Details" on Sheet 2 of 23 and Sheet 4 of 23 of the Construction Drawings)."

On page 13 of 126, under "501 Sheet Piling", add the following sentence to the end of the second paragraph:

"The lump sum price for Item 501-1, Sheet Piling shall also include payment for the traffic plating Transition Details shown on Sheet 2 of 23 and Sheet 4 of 23 of the Construction Drawings."

TO CONSTRUCTION DRAWINGS:

- 1. Sheet 19 of 23, eliminate the note "Jib Crane", from the Pump Station Plan shown in the upper left hand corner of the sheet. A Jib Crane is not required.

Stanley L. Smith Jr.

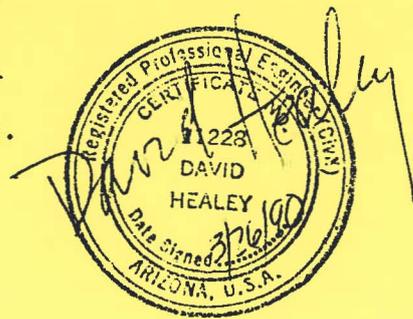
 STANLEY L. SMITH JR., P.E.
 DEPUTY CHIEF ENGINEER

D. E. Sagramoso, P.E.
 Chief Engineer and General Manager
 Flood Control District of Maricopa County

David Healey

 David Healey, P.E.
 Parsons Brinckerhoff Quade & Douglas, Inc.

RC 03.26.90
EWS



BIDDING SCHEDULE

PROJECT: 12th Street Bridge and Utility Relocations
at the Arizona Canal Diversion Channel

CONTRACT: FCD 89-61

ITEM NO.	DESCRIPTION	APPROXIMATE QUANTITY	UNIT	UNIT COST (IN WRITING) AND /100 DOLLARS	UNIT COST (NUMBERS)	EXTENDED AMOUNT
510-1	Concrete Block Masonry	1,218	SF			
515-1	Miscellaneous Metal	223	LB			
515-2	Floor Access Doors	1	LS			
520-1	Ornamental Fence	154	LF			
610-1	1" Copper Waterline	50	LF			
610-2	Plug 4" Water Line (P-1343)	1	EA			
610-3	Plug 8" Water Line (P-1343)	1	EA			
615-1	8" VCP Sanitary Sewer Line	165	LF			
615-2	DIP Discharge Section	1	EA			
615-3	6" DIP Force Main with Restrained Joints	819	LF			
615-4	8" Sanitary Sewer Drop Connection	2	EA			
615-5	Plug 8" Sanitary Sewer (Detail 427)	3	EA			
625-1	48" Sanitary Sewer Manhole	4	EA			
625-2	60" Sanitary Sewer Manhole	1	EA			
702-1	Decomposed Granite	10	TON			
1200-1	Pumps, 5 Horsepower, 208-Volt AC, 3 Phase	2	EA			

ATTENTION

ALL PROSPECTIVE BIDDERS

Some of the Bid Bonds previously received with bids for construction projects have not been in complete compliance with Arizona Revised Statutes (A.R.S.).

A.R.S. Sec. 34-201(A)(3) requires that every bid be accompanied by a certified check, cashier's check or surety bond for five percent (5%) of the amount of the bid.

In some cases the bond limits the five percent (5%) to the difference between the low bid and that of the next lowest responsible bidder, to whom a contract could be awarded, in the event that the low bidder failed to enter into contract within the specified time.

Bids received with limitation on the five percent (5%) will be considered as nonresponsive bids and will not be accepted or considered for award of contract.

Please take note and submit your bids accordingly.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
 FCD CONTRACT 89-61

12TH STREET BRIDGE AND UTILITY RELOCATIONS
 AT THE ARIZONA CANAL DIVERSION CHANNEL

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18. Drawings: 12th Street Bridge and Utility Relocations at the ACDC, 15 sheets	Separate



(Area to left reserved for Engineer's Seal)

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
INVITATION TO BID

BID OPENING DATE: April 3, 1990

LOCATION:

This project is located in Phoenix, Arizona on 12th Street at the Arizona Canal Diversion Channel (ACDC), approximately 1/2 mile south of Northern Avenue.

PROPOSED WORK:

The work consists of constructing a prestressed girder bridge, a pedestrian underpass, approach roadways, underground utilities modifications, and other miscellaneous items of work required for the completion of the project.

BIDS:

SEALED BIDS for the proposed work will be received by the Flood Control District of Maricopa County, 3335 West Durango Street, Phoenix, Arizona 85009 until 2:00 p.m. (Phoenix time) on the above date and then publicly opened and read at 3335 W. Durango St., Phoenix, AZ 85009. No bids will be received after the time specified for bid opening. All bids must be submitted on proposal forms furnished by the Flood Control District and included in the Proposal Pamphlet. The Board of Directors reserves the right to reject any and all bids and to waive any informality in any bid received.

ELIGIBILITY OF CONTRACTOR:

It is the policy of the Flood Control District of Maricopa County to endeavor to ensure in every way possible that minority and women-owned business enterprises have every opportunity to participate in providing professional services, purchased goods, and contractual services without being discriminated against on the grounds of race, religion, sex, age, or national origin.

The bidder shall be required to certify that it is appropriately licensed as a Contractor in the State of Arizona for performing the before-mentioned type of work. Verification shall be on the form provided herein.

The bidder may be required to furnish an affidavit as evidence of previous satisfactory performance in the above-mentioned type of work.

In order to determine if bidder is entitled to the provisions of A.R.S. Sec. 34-241, all bidders shall submit, as a part of their proposal, an affidavit stating whether or not taxes have been paid for two successive years as provided in A.R.S. Sec. 34-241. The affidavit shall be in the form provided herein.

In the event a bidder challenges compliance with the tax provision, the successful bidder will be required to provide proof of compliance.

CONTRACT TIME:

All work on this Contract is to be completed within one hundred eighty (180) calendar days after date of Notice to Proceed.

MBE/WBE PARTICIPATION:

For this project, a goal of fifteen (15) percent is desired for Minority/Women-Owned Business Enterprises. Instructions and required forms are included in the Minority and Women-Owned Business Enterprise Program Section.

PRE-BID CONFERENCE:

A pre-bid conference will be held on March 20, 1990 at 1:00 p.m. in the Flood Control District conference room, 3335 W. Durango Street, Phoenix, Arizona 85009. It is in the best interest of prospective bidders to attend the Pre-bid Conference.

Questions or items for clarification may be addressed to the Chief, Contracts Branch, in writing, at least ten (10) days prior to bid opening date. Where appropriate, any answers or clarifications affecting the cost may be addressed to all bidders in an addendum. Under no circumstances will verbal interpretations or clarifications be given to individual contractors.

PROJECT PLANS, SPECIAL PROVISIONS AND CONTRACT DOCUMENTS:

Plans and Construction Specifications may be obtained from Flood Control District of Maricopa County, 3335 West Durango Street, Phoenix, Arizona 85009 upon payment of \$40.00 by check, payable to the FLOOD CONTROL DISTRICT of MARICOPA COUNTY. This payment will not be refunded. Mail orders for project documents must include an additional \$7.50 for first class U.S. postage and handling. The total \$47.50 will not be refunded. Regardless of circumstances, we cannot guarantee mail delivery. Each bid must be accompanied by a Bid Bond, cashier's or certified check or postal money Order equal to 5 percent (5%) of the bid, made payable to the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY as a guarantee that if the work is awarded to the bidder, the bidder will within ten (10) days of receipt of the Proposal Acceptance, enter into proper contract and bond condition for the faithful performance of the work, otherwise, said amount may be forfeited to the said BOARD OF DIRECTORS as liquidated damages.

All bids are to be marked in accordance with Section 102.9 of the Uniform Standard Specifications and addressed to the Chief Engineer and General Manager, Flood Control District of Maricopa County, 3335 West Durango Street, Phoenix, Arizona 85009.

As provided for in the Agenda Information Form authorizing the Invitation to Bid.

PRINCIPLE ITEMS AND APPROXIMATE QUANTITIES

<u>QUANTITY</u>	<u>UNIT</u>	<u>DESCRIPTION</u>
127	CY	3,000 psi Concrete
177	CY	4,000 psi Concrete
31,643	LB	Reinforcing Steel
14	EA	Precast, Prestressed Concrete Box Girders
1,726	LF	Drilled Shaft 36" Dia. (incl. Conc. & Steel)
75	LF	10' x 10' Precast Concrete Underpass
165	LF	8" VCP Sanitary Sewer Line
819	LF	6" DIP Sanitary Sewer Force Main

PROPOSAL

TO THE BOARD OF DIRECTORS
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
PHOENIX, ARIZONA

Gentlemen:

The following Proposal is made for constructing FCD 89-61; 12th Street Bridge and Utility Relocations at the Arizona Canal Diversion Channel in the County of Maricopa, State of Arizona.

The following Proposal is made on behalf of

and no others. Evidence of authority to submit the Proposal is herewith furnished. The Proposal is in all respects fair and is made without collusion on the part of any person, firm, or corporation mentioned above, and no member or employee of the Board of Directors is personally or financially interested, directly or indirectly, in the Proposal, or in any purchase or sale of any materials or supplies for the work in which it relates, or in any portion of the profits thereof.

The Undersigned certifies that the approved Plans, Special Provisions, Forms of Contract, Bonds, and Sureties authorized by the Board of Directors and constituting essential parts of this Proposal, have been carefully examined and also that the site of the work has been personally inspected.

The Undersigned declares that the amount and nature of the work to be done is understood and that at no time will misunderstanding of the Plans, Construction Specifications, Special Provisions, or conditions to be overcome, be pled. On the basis of the Plans, Construction Specifications, Special Provisions, the Forms of Contract, Bonds, and Sureties proposed for use, the Undersigned proposes to furnish all the necessary machinery, equipment, tools, apparatus, and other means of construction, to do all the work and to furnish all the materials in the manner specified and to finish the entire project within the time hereinafter proposed and to accept, as full compensation therefore, the sum of various products obtained by multiplying each unit price, herein bid for the work or materials, by the quantity thereof actually incorporated in the complete project, as determined by the Engineer or Architect.

The Undersigned understands that the quantities mentioned herein are approximate only and are subject to increase or decrease and hereby proposes to perform all quantities of work, as either increased or decreased, in accordance with the provisions of the Specifications, at the unit price bid in the Bidding Schedule.

The Undersigned further proposes to perform all extra work that may be required on the basis provided in the Specifications and to give such work personal attention and to secure economical performance.

The Undersigned further proposes to execute the Contract Agreement and furnish satisfactory Bonds and Sureties within ten (10) days of receipt of Notice of Proposal acceptance, **TIME BEING OF THE ESSENCE**. The Undersigned further proposes to begin work as specified in the Contract attached hereto, and to complete the work within 180 calendar days from the effective date specified in the Notice to Proceed, and maintain at all times a Payment and Performance Bond, approved by the Board of Directors, each in an amount equal to one hundred percent of the contract amount. These Bonds shall serve not only to guarantee the completion of the work on the part of the Undersigned, but also to guarantee the excellence of both workmanship and material and the payment of all obligations incurred, said Bond to be in full force and effect until the work is finally accepted and the provisions of the Plans, Specifications, and Special Provisions fulfilled.

A Proposal Guaranty in the amount and character named in the Invitation to Bid is enclosed amounting to not less than five (5) percent of the total bid, which Proposal Guaranty is submitted as a guaranty of the good faith of the Bidder and the Bidder will enter into written contract, as provided, to do the work, if successful in securing the award thereof; and it is hereby agreed that if at any time other than as provided in the Proposal requirements and conditions the Undersigned should withdraw his Proposal, if the Proposal is accepted and there should be failure on the part of the Undersigned to execute the Contract and furnish satisfactory Bonds and Sureties as herein provided, the Flood Control District of Maricopa County in either of such events, shall be entitled and is hereby given the right to retain the said Proposal Guaranty as liquidated damages.

The Undersigned acknowledges receipt of the following addenda and has included their provisions in the proposal:

Addendum No. _____	Dated _____

The Undersigned has enclosed the required bid security to this Proposal.

BIDDING SCHEDULE

PROJECT: 12th Street Bridge and Utility Relocations
at the Arizona Canal Diversion Channel

CONTRACT: FCD 89-61

ITEM NO.	DESCRIPTION	APPROXIMATE QUANTITY	UNIT	UNIT COST (IN WRITING) AND /100 DOLLARS	UNIT COST (NUMBERS)	EXTENDED AMOUNT
206-1	Structural Excavation (Bridge & Pump Station)	1,528	CY			
206-2	Structural Backfill (Bridge & Pump Station)	185	CY			
206-3	AB Slurry Backfill	351	CY			
301-1	Subgrade Preparation	1,010	SY			
310-1	Aggregate Base Course	59	TON			
315-1	Bituminous Tack Coat	0.5	TON			
321-1	C-3/4" Asphaltic Concrete	89	TON			
336-1	A.C. Pavement Replacement, MAG Std. Detail 200, Type B	24	SY			
340-1	Curb & Gutter (H=6") (Detail 220, Type A)	59	LF			
340-2	Roll Type Curb & Gutter (Detail 220, Type C)	40	LF			
340-3	Ribbon Curb (Detail 220, Type B)	46	LF			
340-4	Sidewalk (Detail P-1230)	28	SF			
340-5	Driveway (Detail P-1255)	112	SF			
340-6	Driveway (Detail P-1255, Modified)	232	SF			
350-1	Demolish & Remove Structures & Slabs	1	LS			
350-2	Remove Concrete Curb & Gutter	342	LF			

BIDDING SCHEDULE

PROJECT: 12th Street Bridge and Utility Relocations
at the Arizona Canal Diversion Channel

CONTRACT: FCD 89-61

ITEM NO.	DESCRIPTION	APPROXIMATE QUANTITY	UNIT	UNIT COST (IN WRITING) AND /100 DOLLARS	UNIT COST (NUMBERS)	EXTENDED AMOUNT
350-3	Remove Concrete Sidewalk & Driveway	1,288	SF			
350-4	Remove Asphalt Pavement	501	SY			
350-5	Miscellaneous Removals	1	LS			
401-1	Traffic Control	1	LS			
401-2	Barricade (MAG 130, Type B)	64	LF			
401-3	Uniformed, Off-Duty Law Enforcement Officer	770	MH			
420-1	Chain Link Gate (20 ft. x 7 ft)	1	EA			
501-1	Sheet Piling	1	LS			
502-1	Drilled Shaft Foundation (36 inch Diameter)	1,726	LF			
505-1	Structural Concrete (Class A, f'c=3,000 psi)	127	CY			
505-2	Structural Concrete (Class AA, f'c=4,000 psi)	177	CY			
505-3	Steel Reinforcement	31,643	LB			
505-4	PVC Pipe Sleeves	1,200	LF			
505-5	Pipe Hangers	1	LS			
505-6	10 ft. x 10 ft. Precast Concrete Box	75	LF			
506-1	Precast, Prestressed Concrete Bridge Members (Box Girders)	14	EA			

BIDDING SCHEDULE

PROJECT: 12th Street Bridge and Utility Relocations
at the Arizona Canal Diversion Channel

CONTRACT: FCD 89-61

ITEM NO.	DESCRIPTION	APPROXIMATE QUANTITY	UNIT	UNIT COST (IN WRITING) AND /100 DOLLARS	UNIT COST (NUMBERS)	EXTENDED AMOUNT
510-1	Concrete Block Masonry	1,218	SF			
515-1	Miscellaneous Metal	223	LB			
515-2	Floor Access Doors	1	LS			
520-1	Ornamental Fence	154	LF			
610-1	1" Copper Waterline	50	LF			
610-2	Plug 4" Water Line (P-1343)	1	EA			
610-3	Plug 8" Water Line (P-1343)	1	EA			
615-1	8" VCP Sanitary Sewer Line	165	LF			
615-2	DIP Discharge Section	1	EA			
615-3	6" DIP Force Main with Restrained Joints	819	LF			
615-4	8" Sanitary Sewer Drop Connection	2	EA			
615-5	Plug 8" Sanitary Sewer (Detail 427)	3	EA			
625-1	48" Sanitary Sewer Manhole	2	EA			
625-2	60" Sanitary Sewer Manhole	1	EA			
702-1	Decomposed Granite	10	TON			
1200-1	Pumps, 5 Horsepower, 208-Volt AC, 3 Phase	2	EA			

IF BY AN INDIVIDUAL:

(NAME - TITLE)

(ADDRESS)

DATE _____

(PHONE)

IF BY A FIRM OR PARTNERSHIP:

(FIRM NAME)

(FIRM ADDRESS)

BY: _____
(NAME - TITLE)

DATE _____
(PHONE)

** Name and Address of Each Member:

** The name and post office address of each member of the firm or partnership must be shown.

IF BY A CORPORATION:

(CORPORATE NAME)

(CORPORATION ADDRESS)

BY: _____

DATE: _____

(PHONE)

TITLE: _____

* Incorporated under the Laws of _____

Names and Addresses of Officers:

(PRESIDENT)

(ADDRESS)

(SECRETARY)

(ADDRESS)

(TREASURER)

(ADDRESS)

* The name of the State under which the laws of the Corporation was chartered and names, title, and business address of the President, Secretary, and Treasurer must be shown.

SURETY 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 Flood Control District of Maricopa County as Obligee, in the sum of ___ percent (___%) of the total amount of the bid of Principal, submitted by him to the Flood Control District of Maricopa County, 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 severally, firmly by these presents, and in conformance with A.R.S. Sec. 34-201(A)(3).

WHEREAS, the said Principal is herewith submitting its proposal for FCD Contract 89-61; 12th Street Bridge and Utility Relocations at the Arizona Canal Diversion Channel.

NOW, THEREFORE, if the Flood Control District of Maricopa County shall accept the proposal of the Principal and the Principal shall enter into a contract with the Flood Control District of Maricopa County in accordance with the terms of such proposal and give such Bonds and Certificates of Insurance as specified in the Standard Specifications 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 Bond and Certificates of Insurance, if the Principal shall pay to the Flood Control District of Maricopa County 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., 1990.

Principal

Title

Witness:

Surety

Title

Witness:

VERIFICATION OF LICENSE

Pursuant to A.R.S. Sec. 32-1169, I hereby state that I hold a current contractor's license, duly issued by the office of the Registrar of Contractors for the State of Arizona, said license has not been revoked, that the license number is: _____; that my privilege license number (as required by A.R.S. Sec. 42-1305) is: _____; and that, if any exemption to the above licensing requirements is claimed;

(1) The basis for the claimed exemption is: _____ and;

(2) The names(s) and license number(s) of any general, mechanical, electrical, or plumbing contractor(s) to be employed on the work are:

IT IS UNDERSTOOD THAT THE FILING OF AN APPLICATION CONTAINING FALSE OR INCORRECT INFORMATION CONCERNING AN APPLICANT'S CONTRACTOR'S LICENSE OR PRIVILEGE LICENSE WITH THE INTENT TO VOID SUCH LICENSING REQUIREMENTS IS UNSWORN FALSIFICATION PUNISHABLE ACCORDING TO A.R.S. SEC. 13-2704.

DATE: _____ SIGNATURE OF LICENSEE: _____

COMPANY: _____

MINORITY AND WOMEN-OWNED BUSINESS ENTERPRISE PROGRAM

- A. The following conditions will apply in the calculation of the percentage attainment:
1. All MBE/WBE firms used in attainment of the goal must be certified with the Maricopa County Minority Business Office which is located in the Maricopa County Highway Department building, 3325 West Durango Street, Phoenix. In addition, only those firms certified at least seven calendar days prior to the bid opening will be considered in the attainment of the goal.
 2. Prime contractor subcontracts to MBE or WBE:
The MBE/WBE amount to be applied to the goal will be based on that portion (dollar value) of the contract that the MBE/WBE performs. For example, if a prime contractor subcontracts work amounting to \$100,000 of a contract for which the total project cost is \$1,000,000. the MBE/WBE participation will be credited as 10 percent.
 3. Prime Minority Contractor:
An MBE/WBE prime contractor will be credited with the MBE/WBE participation for that portion of the contract which they themselves perform plus that portions subcontracted to other MBE/WBE firms. For example, if an MBE/WBE prime contractor proposes to perform 50 percent of a project quoted at \$1,000,000 and subcontracts 25 percent to an MBE firm and 25 percent to a non-MBE/WBE firm, MBE/WBE participation will be credited as 75 Percent, or \$750,000.
 4. Minority-Non-Minority Joint Venture:
A joint venture consisting of MBE/WBE participation and non-MBE/WBE business enterprises, functioning as a prime contractor, will be credited with minority participation on the basis of the percentage of profit accruing to the MBE/WBE firm. For example, if a MBE/WBE and non-MBE/WBE joint venture proposes to perform 50 percent of a \$1,000,000 project and 50 percent of the joint venture profits (\$500,000) are to accrue to the MBE/WBE partner in the joint venture, MBE/WBE participation will be credited at 25 percent or \$250,000.
 5. Lower Tier Non-MBE/WBE Participation:
MBE/WBE subcontractors proposing to further subcontract to non-MBE/WBE contractors shall not have that portion of subcontracting activity considered when determining the percentage of MBE/WBE participation.

6. MBE/WBE Suppliers:

Any MBE/WBE supplier that manufactures or substantially alters the material or product it supplies will have that portion of activity considered when determining the percentage of MBE/WBE participation. Any MBE/WBE Wholesaler, Distributor, or Jobber that does not manufacture or substantially alter the materials or product it sells will be limited to 20 percent of the sale price when determining the percentage of MBE/WBE participation.

B. Required forms:

An affidavit is included as part of this section. The form must be completed within seven calendar days after the Notice of Award of Contract. The low bidder is required to submit a Minority/Women-Owned Business Enterprise Program MBE/WBE Participation Affidavit listing the MBE/WBE participation by MBE/WBE firm and the related dollar value of the MBE/WBE contract.

C. Requests for Pay:

Each Request for Pay must be accompanied by a Maricopa County Minority/Women-Owned Business Enterprise Program MBE/WBE Participation Report. The final pay request shall include a listing of total contract MBE/WBE participation.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
MINORITY/WOMEN-OWNED BUSINESS ENTERPRISE PROGRAM

MBE/WBE PARTICIPATION ASSURANCES
AFFIDAVIT

The undersigned, fully cognizant of the Flood Control District of Maricopa County MBE/WBE Program requirements and of the goal established, hereby certifies that in the preparation of this bid,

(the entity submitting the bid)

(CHECK ONE)

_____ Will meet the established goal for participation by
Minority/Women-Owned Business Enterprises.

_____ Will provide the necessary documentation to Minority Business
Office to establish that a good faith effort was made.

_____ Will not participate in the MBE/WBE Program.

The bidder will specify its MBE/WBE participation on the Intended Participation Affidavit or provide documentation of its good faith efforts not later than 4:00 p.m., the seventh calendar day following the bid opening. The required affidavit shall be obtained by the apparent first and second low bidders from the Minority Business Office, Maricopa County Highway Department Building, 3325 West Durango Street, Phoenix, Arizona 85009, following the opening and reading of bids; a sample affidavit form for reference purposes follows.

Name of Firm

Signature

Title

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
MINORITY/WOMEN-OWNED BUSINESS ENTERPRISE PROGRAM
Actual Minority/Women-owned Participation

Name of Prime Contractor

FCD 89-61

Project Number

Contact Person

Total Amount of Contract

Street No.

City State Zip

<u>Minority/Women-owned Firm</u>	<u>Principal</u>	<u>Address</u>	<u>Type of Work</u>	<u>Subcontract Amount</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

The undersigned has entered into a formal agreement with the minority contractors/suppliers listed above in the execution of this contract with the Flood Control District of Maricopa County.

Signature

Title

Date

Copy to: Minority Business Office
Maricopa County Highway Department
3325 West Durango Street
Phoenix, Arizona 85009

MARICOPA COUNTY
MINORITY/WOMEN-OWNED BUSINESS ENTERPRISES PROGRAM

MBE/WBE PARTICIPATION REPORT
(To be attached with Request for Pay)

Date: _____

Contractor: _____

Contact Person: _____

Address: _____

Telephone: _____

Project: 12th Street Bridge and Utility

Relocations at the ACDC

Contract Number: 89-61

For Pay Period of: _____

Subcontractor: _____

Person to Contact: _____

Address: _____

Telephone Number: _____

Type of Firm: _____

Class of Work: _____

Subcontract Amount: _____

Amount Earned _____

(Commission) This Period: _____

Total Earned by This Subcontractor: _____

Total MBE/WBE Contract Goal, %: 15

Total Cumulative MBE/WBE _____

Participation on This Contract, %: _____

MBE/WBE subcontract payment made
during this reporting period (yes or no): _____

cc: Minority Business Office
Maricopa County Highway Building
3325 West Durango Street
Phoenix, Arizona 85009

CONTRACT AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 1990, by and between FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, hereinafter called the OWNER, acting by and through its BOARD OF DIRECTORS, and

_____ hereinafter called the CONTRACTOR.

WITNESSTH: That the said CONTRACTOR, for and in the consideration of the sum of _____ to be paid to him by the OWNER, in the manner and at the times hereinafter provided, and of the other covenants and agreements herein contained, hereby agrees for himself, heirs, executors, administrators, successors, and assigns as follows:

ARTICLE I - SCOPE OF WORK: The CONTRACTOR shall construct, and complete in a workmanlike and substantial manner and to the satisfaction of the Chief Engineer and General Manager, a project for the Flood Control District of Maricopa County, designated as FCD Contract 89-61; 12th Street Bridge and Utility Relocations at the Arizona Canal Diversion Channel, and furnish at his own cost and expense all necessary machinery, equipment, tools, apparatus, materials, and labor to complete the work in the most substantial and workmanlike manner according to the Plans and Construction Specifications on file with the Flood Control District of Maricopa County, 3335 West Durango Street, Phoenix, Arizona, and such modifications of the same and other directions that may be made by the Flood Control District of Maricopa County as provided herein.

ARTICLE II - CONTRACT DOCUMENTS: The Construction Specifications (Invitation to Bid, Plans, Standard Specifications and Details, Special Provisions, Addenda, if any, Proposal, Affidavits, Performance Bond, Payment Bond, Certificates of Insurance, and Change Orders, if any,) are by this reference made a part of this Contract and shall have the same effect as though all of the same were fully inserted herein.

ARTICLE III - TIME OF COMPLETION: The CONTRACTOR further covenants and agrees at his own proper cost and expense, to do all work as aforesaid for the construction of said improvements and to completely construct the same and install the material therein, as called for by this agreement free and clear of all claims, liens, and charges whatsoever, in the manner and under the conditions specified within the time, or times, stated in the proposal pamphlet.

ARTICLE IV - PAYMENTS: For and in consideration of the faithful performance of the work herein embraced as set forth in the Contract Documents, which are a part hereof and in accordance with the directions of the OWNER, through its Engineer and to his satisfaction, the OWNER agrees to pay the said CONTRACTOR the amount earned, computed from actual quantities of work performed and accepted or materials furnished at the unit bid price on the Proposal made a part hereof, and to make such payment in accordance with the requirements of A.R.S. Sec. 34-221, as amended. The CONTRACTOR agrees to discharge its obligations and make payments to its subcontractors and suppliers in accordance with A.R.S. Sec. 32-1129.

ARTICLE V - TERMINATION: The OWNER hereby gives notice that pursuant to A.R.S. Sec. 38-511(A) this contract may be cancelled without penalty or further obligation within three years after execution if any person significantly involved in initiation, negotiation, securing, drafting or creating a contract on behalf of the OWNER is, at any time while the contract or any extension of the contract is in effect, an employer agent of any other party to the contract in any capacity or a consultant to any other party of the contract with respect to the subject matter of the contract. Cancellation under this section shall be effective when written notice from the Chief Engineer and General Manager of the OWNER is received by all of the parties to the contract. In addition, the OWNER may recoup any fee for commission paid or due to any person significantly involved in initiation, negotiation, securing, drafting or creating the contract on behalf of the OWNER from any other party to the contract arising as a result of the contract.

ARTICLE VI - NEGOTIATION CLAUSE: Recovery of damages related to expenses incurred by the CONTRACTOR for a delay for which the OWNER is responsible, which is unreasonable under the circumstances and which was not within the contemplation of the parties to the contract, shall be negotiated between the CONTRACTOR and the OWNER. This provision shall be construed so as to give full effect to any provision in the contract which requires notice of delays, provides for arbitration or other procedure for settlement or provides for liquidated damages.

ARTICLE VII - COMPLIANCE WITH LAWS: The CONTRACTOR is required to comply with all Federal, State and local ordinances and regulation. The CONTRACTOR's signature on this contract certifies compliance with the provisions of the I-9 requirements of the Immigration Reform Control Act of 1986 for all personnel that the CONTRACTOR and any subcontractors employ to complete this project. It is understood that the OWNER shall conduct itself in accordance with the provisions of the Maricopa County Procurement Code.

ARTICLE VIII - MBE/WBE PROGRAM: Flood Control District of Maricopa County will endeavor to ensure in every way possible that minority and women-owned business enterprises shall have every opportunity to participate in providing professional services, purchased goods, and contractual services to the Flood Control District of Maricopa County without being discriminated against on the grounds of race, religion, sex, age, or national origin.

ARTICLE IX - ANTI-DISCRIMINATION PROVISION: The CONTRACTOR agrees not to discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, age, or handicap and further agrees not to engage in any unlawful employment practices. The CONTRACTOR further agrees to insert the foregoing provision in all subcontracts hereunder.

IN WITNESS WHEREOF: Five (5) identical counterparts of this 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 above written.

PARTY OF THE FIRST PART

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
PARTY OF THE SECOND PART

BY: _____
Printed Name

BY: _____
CHAIRMAN, BOARD OF DIRECTORS

BY: _____
Signature

DATE: _____

Title
DATE: _____

Tax Identification Number

RECOMMENDED BY:

ATTEST:

CHIEF ENGINEER AND GENERAL MANAGER
FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY

CLERK OF THE BOARD

DATE: _____

LEGAL REVIEW

Approved as to form and within the powers and authority granted under the laws of the State of Arizona to the Flood Control District of Maricopa County.

BY: _____
GENERAL COUNSEL, FLOOD CONTROL
DISTRICT OF MARICOPA COUNTY

DATE: _____

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 laws 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 Flood Control District of Maricopa County, in the 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 Flood Control District of Maricopa County, dated the ____ day of _____, 1990, for FCD Contract 89-61; 12th Street Bridge and Utility Relocations at the Arizona Canal Diversion Channel, which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall promptly pay all monies 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 was copied at length herein.

The prevailing party or any party which recovers judgement on this bond shall be entitled to such reasonable attorney's fees as may be fixed by the court or a judge thereof.

Witness our hands this _____ day of _____, 1990.

PRINCIPAL SEAL

BY: _____

AGENCY OF RECORD

SURETY SEAL

BY: _____

BOND NUMBER.

POWER OF ATTORNEY SEAL

BY: _____

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 laws 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 Flood Control District of Maricopa County, in the 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 Flood Control District of Maricopa County, dated the ____ day of _____, 1990, for FCD Contract 89-61; 12th Street Bridge and Utility Relocations at the Arizona Canal Diversion Channel, which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied 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 was 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.

Witness our hands this _____ day of _____, 1990.

AGENCY OF RECORD

AGENCY ADDRESS

BOND NUMBER

POWER OF ATTORNEY

BY:

PRINCIPAL SEAL

BY:

SURETY SEAL

BY:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

CERTIFICATE OF INSURANCE

CONTRACT FCD 89-61

PROJECT TITLE 12th Street Bridge over the ACDC

NAME AND ADDRESS OF INSURANCE AGENCY	INSURANCE COMPANIES AFFORDING COVERAGES
	Company Letter A
	Company Letter B
NAME AND ADDRESS OF INSURED	Company Letter C
	Company Letter D
	Company Letter E
	Company Letter F
	Company Letter G

THIS IS TO CERTIFY THAT POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE AND ARE IN FORCE AT THIS TIME.

COMPANY LETTER	TYPE OF INSURANCE	POLICY NUMBER	EXPIRATION DATE	LIMITS OF LIABILITY IN \$1,000 MINIMUM each occurrence	
	COMMERCIAL GENERAL <input checked="" type="checkbox"/> LIABILITY FORM <input checked="" type="checkbox"/> PREMISES OPERATIONS <input checked="" type="checkbox"/> CONTRACTUAL <input checked="" type="checkbox"/> BROAD FORM PROPERTY DAMAGE <input checked="" type="checkbox"/> EXPLOSION & COLLAPSE <input checked="" type="checkbox"/> PRODUCTS/COMPLETED OPERATIONS HAZARD <input checked="" type="checkbox"/> UNDERGROUND HAZARD <input checked="" type="checkbox"/> INDEPENDENT CONTRACTORS <input checked="" type="checkbox"/> PERSONAL INJURY			BODILY INJURY per person PROPERTY DAMAGE each occurrence	Combined Single Limit 5,000
	COMPREHENSIVE AUTO <input checked="" type="checkbox"/> LIABILITY & NON-OWNED			SAME AS ABOVE	
	<input type="checkbox"/> EXCESS LIABILITY			NECESSARY IF UNDERLYING NOT ABOVE MINIMUM	
	<input checked="" type="checkbox"/> WORKERS' COMPENSATION AND EMPLOYERS' LIABILITY			STATUTORY each accident	\$100
	<input checked="" type="checkbox"/> ENGINEERS PROFESSIONAL LIABILITY			EACH CLAIM AND ANNUAL AGGREGATE	
	<input checked="" type="checkbox"/> OTHER In addition to the Flood Control District of Maricopa County, the City of Phoenix, Maricopa County, and Parsons Brinkerhoff Construction Services, Inc. shall be named additional insureds.				

Except for Professional Liability Insurance and Workers Compensation Insurance, the Flood Control District of Maricopa County is added as an additional insured in respect to liability arising in any manner out of the performance of any contract entered into between the insured and the Flood Control District or liability arising out of any services provided or duty performed by any party as required by statute, law, purchase order, or otherwise required. It is agreed that any insurance available to the named insured shall be primary of other sources that may be available. It is further agreed that no policy shall expire, be cancelled, or materially changed to effect the coverage available to the District without thirty (30) days written notice to the District. THIS CERTIFICATE IS NOT VALID UNLESS COUNTERSIGNED BY AN AUTHORIZED REPRESENTATIVE OF THE INSURANCE COMPANY.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
 3335 West Durango Street
 Phoenix, Arizona 85009

DATE ISSUED _____

AUTHORIZED REPRESENTATIVE _____

It is further agreed that:

The Contractor hereby agrees to indemnify and save harmless the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, CITY OF PHOENIX, MARICOPA COUNTY, AND PARSONS BRINKERHOFF CONSTRUCTION SERVICES, INC. or any of its departments, agencies, officers or employees, from and against all loss, expense, damage or claim of any nature whatsoever which is caused by any activity, condition or event arising out of the performance or nonperformance of any of the provisions of this Agreement. The Flood Control District of Maricopa County, City of Phoenix, Maricopa County and Parsons Brinkerhoff Construction Services, Inc. shall in all instances be indemnified against all liability, losses and damages of any nature for or on account of any injuries to or death of persons or damages to or destruction of property arising out of or in any way connected with the performance or nonperformance of this Agreement, except such injury or damage as shall have been occasioned by the negligence of the Flood Control District of Maricopa County, City of Phoenix, Maricopa County and Parsons Brinkerhoff Construction Services, Inc. The above cost of damages incurred by the Flood Control District of Maricopa County, City of Phoenix, Maricopa County and Parsons Brinkerhoff Construction Services, Inc. or any of its departments, agencies, officers or employees, or others aforesaid shall include in the event of an action, court costs, expenses for litigation and reasonable attorney's fees.

Firm

Date

Principal

Title

SUBCONTRACTOR LISTING

Following is a listing of Subcontractors and material suppliers that are to be used in the event the undersigned should enter into contract with the Owner. This is not an exhaustive or inclusive list.

(Signature) _____

**CONSTRUCTION SPECIAL PROVISIONS
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
TWELFTH STREET BRIDGE AND UTILITY RELOCATIONS
AT THE
ARIZONA CANAL DIVERSION CHANNEL**

LOCATION OF THE WORK

The proposed work is located in the vicinity of 12th Street and Orangewood Avenue, along the Arizona Canal, Phoenix, Arizona.

PROPOSED WORK

The work consists of constructing a prestressed girder bridge, a pedestrian underpass, approach roadways, a sanitary sewer pump station, underground utilities modifications, and other miscellaneous items of work required for the completion of the project.

STANDARD SPECIFICATIONS

The work embraced herein and as shown on the plans for the construction of this project shall be done in accordance with the Maricopa Association of Governments Uniform Standard Specifications for the Public Works Construction dated 1979 and the current revisions thereto, and the Construction Special Provisions contained herein the City of Phoenix 1986 Supplement to the MAG Uniform Standard Specifications.

PRECEDENCE OF CONTRACT DOCUMENTS

City of Phoenix Supplements to MAG Specifications and Details will govern over the MAG Standard Specifications and Details. In case of a discrepancy or conflict, Project Plans will govern over the City of Phoenix Supplements, the MAG Standard Specifications and Details. These Construction Special Provisions will govern over the City of Phoenix Supplements, the MAG Standard Specifications and Details, and the Project Plans.

PAYMENT

Payment will be made for only those items listed in the Proposal and will not be made in accordance with the measurement and payment provisions of the Standard Specifications where this differs from the items listed in the Proposal. All materials and work necessary for completion of this project are to be included in Proposal items. Any work or material not specifically referred to in these items is considered incidental to the item and included in the unit price.

NEGOTIATION CLAUSE

Recovery of damages related to expenses incurred by the Contractor for a delay for which the Flood Control District of Maricopa County is responsible, which is unreasonable under the circumstances and which was not within the contemplation of the parties to the Contract, shall be negotiated between the Contractor and the Flood Control District of Maricopa County. This provision shall not be construed to void any provision in the Contract which requires notice of delays, provides for arbitration or other procedure for settlement or provides for liquidated damages.

WORK STANDARDS

The Contractor shall comply with Sections 103 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-330) as supplemented by Department of Labor Regulations (29 CFR Part 5).

CONTRACT TIME

The Contractor shall start work within seven (7) calendar days after Notice to Proceed. Contract duration shall be 210 calendar days.

It is not anticipated that a contract for construction of the Arizona Canal Diversion Channel will be awarded before the completion of this Contract.

WATER, LIGHT, POWER, HEAT, TELEPHONE

All water for construction purposes, drinking water, lighting, temporary electric power, heat and telephone service shall be arranged for and provided for the requirements of the work by the Contractor at his expense.

PROGRESS SCHEDULE

The Contractor shall submit his proposed work progress schedule to the Engineer for approval before starting the work. Weekly updates to the schedule shall be submitted to the inspector at the weekly coordination meeting.

MATERIAL SOURCES

Select material, aggregate base and mineral aggregate shall be obtained from commercial sources. The Contractor shall pay all royalties, or any other charges or expenses, incurred in connection with the securing and hauling of the material. The Contractor will be required to furnish the Engineer with a list of his proposed commercial sources prior to use, and shall present certificates stating that the material produced from any commercial sources is in accordance with the Uniform Standard Specifications and these Special Provisions.

101.2 DEFINITIONS AND TERMS

Change the definition of the **Budget Project** to read as follows: A project financed by funds set aside in the annual budget or otherwise approved by the Board of Directors of the Flood Control District of Maricopa County.

Change the definition of Engineer to read as follows: The Chief Engineer and General Manager of the Flood Control District of Maricopa County acting directly or through his duly authorized representative.

Change the definition of Owner to read as follows: The Flood Control District of Maricopa County, acting through its legally constituted officials, officers or employees.

102 ADDENDA AND SUBMISSION OF BIDDING SCHEDULE

It shall be the responsibility of prospective bidders to determine, prior to submission of a bid, if any addenda have been issued. This may be accomplished by calling 602-262-1501. Any addendum issued, if not already bound into the Special Provisions, must be included as a part of the Special Provisions, and any quantities on the Bidding Schedule requiring change shall be adjusted by pen and ink to the new figure.

Bids that do not include appropriate addenda and show appropriate changes to the Bidding Schedule shall be invalid.

102.5 PREPARATION OF PROPOSAL

The bidder's Arizona State Contractor's License number and classification shall be shown on the Proposal. The possession of such a license is a bidding requirement; in addition, the Contractor may be required to provide certification of prior satisfactory completion for similar construction.

103.6 CONTRACTOR'S INSURANCE

Concurrently with the execution of the contract, the Contractor shall furnish a Certificate of Insurance using the included Certificate or one of equal wording that names the additional insureds as set out in the included Certificate and in 103.6.1 (D) below. The certificate shall also name the additional insureds as Certificate Holders. The types of insurance and the limits of liability shall be as indicated on the included form.

103.6.1(D): Add Parsons Brinckerhoff Con. Services, Inc., Maricopa County, City of Phoenix, and other entities as mentioned on the included Certificate of Insurance as additional insureds. The certificate shall also name the additional insureds as Certificate Holders.

103.6.2: The Contractor shall also indemnify and hold harmless the Owner, the Consultant, the Owner's Representative, any jurisdiction or agency issuing permits for any work involved in the project, and their consultants, and each of their directors, officers, employees, and agents from and against all losses, expenses, damages (including damages to the work itself), attorneys' fees, and other costs, including costs of defense which any of them may incur with respect to the failure, neglect, or refusal of Contractor to faithfully perform the work and all of the Contractor's obligations under the contract. Such costs, expenses, and damages shall include all cost, including attorneys' fees, incurred by the indemnified parties in any lawsuit to which they are a party.

104.1.2 TRAFFIC REGULATIONS

A. The following shall be considered a major street.

12th Street

B. All traffic and/or traffic control devices on this project shall be provided, maintained and/or controlled as specified in the City of Phoenix Traffic Barricade Manual, latest revision.

- C. Permission to restrict City streets, sidewalks, and alleys (street closure permits) shall be required as specified in Section III of the Traffic Barricade Manual.
- D. Unless otherwise provided for in the Plans all traffic on this project shall be regulated as specified in Section IV of the Traffic Barricade Manual.
- E. Twelfth Street at the Arizona Canal. Twelfth Street can be reduced to two lanes (one each way) at the times noted on the Traffic Control Plans when construction requires.

The Contractor shall notify the City of Phoenix Streets and Traffic Department 48 hours prior to street closures.
- F. Temporary traffic control shall be the responsibility of the Contractor.
- G. The Contractor shall provide a traffic control plan for each barricade installation used for this project.
- H. Special Traffic Requirement - The Engineer shall provide a scaled 24 in. x 36 in. base map vellum covering the construction area and traffic control zone. The map will include existing signing, striping and signalization. The Contractor shall provide the traffic control layout and barricade placement, as provided above, for each phase or subphase. The Contractor shall submit the above layout at least 14 days prior to implementation to the Engineer. The Contractor shall not implement the traffic control plan until approved by the City of Phoenix.

Pedestrian Access and Bike Path Requirements: Contractor shall provide and maintain clean, safe and adequate pedestrian walkways, sidewalks and crosswalks free of dirt, mud, dust, debris, equipment and material storage at all times.

Contractor shall provide "bike path" detour signing and maintain the bike path open and free of obstructions at all times. A bike path detour plan shall be submitted for approval prior to implementation.

Police Officer Requirements: Police officer requirements shall be as noted in Section 401 of these Special Provisions.

104.20 SUBSURFACE INVESTIGATION

Soil borings have been performed at the site of the work. A log of the borings is reproduced on the Drawings. The complete report is on file with the Engineer, and may be reviewed by the Bidders or the Contractor at a location designated by the Engineer.

The soil boring logs are included in the project of the Contractor's information only. No guarantee is made of the accuracy of the boring logs in the soils report. The Contractor shall make his own determination as to soil and subsurface conditions and shall complete his work in whatever material and under whatever condition he may encounter or create, without extra cost (except as modified in MAG). Existing moisture conditions shall be no basis for claim for additional monies or time extensions. The Contractor shall manipulate the existing soil as required to achieve stable soil conditions and the required densities.

The use of this information shall be at the Bidders' or the Contractor's discretion. The Bidders or the Contractor shall recognize the fact that the determination of the types and sizes of material was limited by the size of the auger or drill used to drill the hole. Bidders or Contractor shall make whatever other investigations as are necessary in order to determine to their or his satisfaction the conditions that exist.

105.2 PLANS AND SHOP DRAWINGS

Prior to purchase or fabrication, the Contractor shall furnish the Engineer with shop drawings, layout diagrams, manufacturer's catalog data, and detailed information, in sufficient detail to show complete compliance with all specified requirements, covering but not limited to the following items:

1. Detailed sequence of construction
2. Concrete mix designs
3. Precast girders
4. Reinforcing steel
5. Metal fencing
6. Bearing pads
7. Shoring and bracing plans for structure excavation
8. Precast box culvert segments
9. Fabricated pipe and design data, including rubber gaskets
10. Precast manhole risers
11. Castings
12. Utility protection plans
13. Epoxy lined 6-inch force main
14. Pump station components

The number of copies of shop drawings required for approval shall be as follows:

Initial Submittal: Three (3) copies. One (1) copy will be returned to the Contractor.

Final Submittal: Six (6) copies. Two (2) copies will be returned to the Contractor.

Drawings for shoring and bracing plans for structure excavation shall be prepared by and bear the seal and signature of a licensed Professional Civil or Structural Engineer in the State of Arizona.

When submitted for the Engineer's review, shop drawings shall bear the Contractor's certification that he has reviewed, checked, and approved the shop drawings, and that they are in conformance with the requirements of the Contract Documents. The Engineer will not review any submittals which do not bear the Contractor's certification.

After the review has been completed, the above drawings, lists, samples, design calculations, and other data, shall become a part of the Contract Documents and the fabrications furnished shall conform to the submittal.

Review of material and layout drawings consists of review for general conformity to Plans and Specifications and in no way relieves the Contractor or the supplier from responsibility for the correctness of the drawings.

Deviations or changes from Plans or Specifications must be called out as such and will require review by the Engineer for approval or rejection.

105.6 COOPERATION WITH UTILITIES

An attempt has been made to determine the locations of all underground utilities and drainage pipes, culverts, and structures. The Contractor shall comply with the requirements of the ARS 40-360 21 through 40-360-29 in notification to the interested utility owners prior to the start of construction and shall ascertain the approximate locations of the various underground utilities shown on the plans and as may be brought to his attention. The exact locations of these underground utilities shall be determined by excavations made by the Contractor prior to any trenching operations. It shall be the Contractor's responsibility to cooperate with the pertinent utility companies, so that any obstructing utility installation may be adjusted. Should the Contractor's operations result in damage to any utility, the location of which has been brought to his attention, he shall assume full responsibility for such damage.

Any facility or work which may be performed for the accommodation of any utility shall be paid for by the utility owner. The Contractor shall make all arrangements that may be necessary for the construction, and any financial agreement shall be solely between the Contractor and utility owner.

During construction, utilities such as APS and Southwest Gas may be relocating utilities within the project work area. The Contractor will coordinate with these utilities as required. Existing overhead electrical will be relocated by APS prior to construction.

The following phone numbers should put the Contractor in contact with the proper personnel:

Flood Control District	262-1501
US West Communication - Bruce Crisman	295-2407
Salt River Project - Tim Phillips	236-2956
Arizona Public Service - Lois Winkler.....	371-6837
Location Staking (APS, US West Communication, SRP)	263-1100
City of Phoenix Streets and Traffic - Marshal Hollen.....	262-6565
City of Phoenix Water and Wastewater - Gerald Arakaki.....	261-8229
Southwest Gas Company - Brian Herzog.....	484-5306
Dimension Cable Services - Blair Tanner	866-0072
	(Ext. 243)

105.8 CONSTRUCTION STAKES, LINES AND GRADES

The project control lines and benchmark elevation are shown on the drawings and will be established by the Engineer. The Contractor shall establish offset stakes and temporary benchmarks for referencing the designated construction lines and grades. The Contractor shall provide all rough grade, fine grade, and structural reference lines and shall be responsible for their conformance with the Plans and Specifications.

Survey work shall be performed by a qualified and experienced surveyor under the supervision of a licensed land surveyor.

The Contractor shall furnish field books to be used for recording survey data and field notes. These books shall be available for inspection by the Engineer at any time and shall become the property of the Engineer upon completion of the work.

The Flood Control District of Maricopa County reserves the right to adjust design grades or the locations of the sewer line structures prior to construction if, in the opinion of the Engineer, it should become necessary, without additional cost to the Flood Control District of Maricopa County.

The Engineer reserves the right to make inspections and random checks of any portion of the staking and layout work. If, in the Engineer's opinion, the work is not being performed in a manner that will maintain proper control and accuracy of the work, he will order any or all of the staking and layout work redone at no additional cost.

No separate payment will be made for construction surveying. The cost shall be included in the bid price for related items of related work.

105.10 INSPECTION OF WORK

Work will be subject to City of Phoenix inspection and acceptance prior to final acceptance by the Engineer.

105.12 MAINTENANCE DURING CONSTRUCTION

The Contractor shall maintain the work during construction and until the project is accepted. This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end so that the roadway or structures are kept in satisfactory conditions at all times.

106 CONTROL OF MATERIALS

SOURCE OF MATERIALS AND QUALITY

The Contractor shall guarantee the construction work for one year against faulty materials, faulty workmanship and failure to meet the requirements of the Specifications. Said guarantee by the Contractor shall not apply to damage caused by earthquakes or other acts of God, land subsidence, or faulty operations or any abuse of the structures by others.

106.3 PLANT INSPECTION

The Contractor shall be responsible for all expenses, including but not limited to, travel and per diem expenses, for required inspections by the Engineer and/or the cost of inspection and testing by an independent testing laboratory as required by and at the discretion of the Engineer for any inspection of precast concrete girders and box culvert segments manufactured outside of a fifty-mile radius from the City limits of Phoenix, Arizona.

106.5 CONTRACTOR'S MARSHALING YARDS

The Contractor shall obtain approval of the Engineer when using vacant property to park and service equipment and store material for use.

- A. The Contractor shall notify adjacent property owners/residents of this proposed use.
- B. Any use of vacant property adjacent to or near the project for parking or servicing equipment and/or storing material will require the Contractor to obtain written approval from the property owner. This approval shall contain any requirements which are a condition of this approval.
- C. A copy of the property owner's approval shall be submitted, along with the Contractor's request to the Engineer for approval for the use of the marshaling yard in connection with the project. An appropriate distance from adjacent property will be set by the Engineer on a case by case basis based on the size and type of equipment to be used on the project.

107.2 PERMITS

The Contractor shall be responsible for obtaining all permits and licenses, pay all charges, fees, taxes and give all notices necessary and incidental to the due and lawful prosecution of the work. Permits for earth moving may be obtained from the Bureau of Air Pollution Control, Maricopa County Department of Health Services, 1845 East Roosevelt, telephone number 258-6381.

A no charge permit is required from the City of Phoenix.

A permit from the Salt River Valley Water Users Association for work in their right-of-way will be supplied by the Flood Control District.

108.5 LIMITATION OF OPERATIONS

Should the Contractor or subcontractor perform any work before or after regular working hours, on weekends, or legal holidays, any charges incurred by the District for inspection of the work, surveys, or tests of materials will be deducted from monies due or to become due to the Contractor except for three weekend closures.

108.9 FAILURE TO COMPLETE ON TIME

The actual cost per calendar day incurred by the District for Consultant Administrative and Inspection Services on this project will be added to the daily charges as indicated by TABLE 108, LIQUIDATED DAMAGES, as shown in the MAG Uniformed Standard Specifications (not in the Phoenix Supplement), and will be deducted from monies due or to become due to the Contractor for each and every calendar day that work shall remain uncompleted after the time specified for the completion of the work in the proposal, or as adjusted by the Engineer. Nothing contained in this provision shall prohibit the District from deducting from monies due or to become due to the Contractor any other costs incurred by the District directly attributable to the delay in completing this Contract.

109 MEASUREMENTS AND PAYMENTS

Under MAG Section 109.5.1 Equipment, the following exception is made:

Unless a prior written agreement has been made, the Maricopa County Flood Control District will not pay move-in/move-out costs and standby equipment rates.

201 CLEARING AND GRUBBING

The work under this item consists of removal and disposal of all trees, stumps, asphaltic pavement, and structures within the limits of the roadways, canal and other areas designated on the Plans. Materials shall be disposed of off-site. Also see Sections 205.6 and 350 in these Special Provisions.

205.6 DISPOSAL OF SURPLUS MATERIAL

All surplus and/or waste material may be disposed of at the Contractor's discretion subject to the following conditions:

(A) If the City landfills are used, the Contractor shall pay the normal dumping fee.

(B) If private property within the City limits is used, the Contractor shall obtain written permission from the property owner and deliver a copy of this agreement to the Engineer prior to any hauling or dumping. All disposal and grading shall be in strict conformance with the City of Phoenix Grading and Drainage Ordinance. The Contractor shall obtain and pay for the necessary permit(s).

(C) If the surplus material is disposed of outside the City limits, the Contractor shall comply with all applicable laws/ordinances of the agencies concerned and be responsible for all cost incurred.

No measurement or direct payment will be made for hauling and disposal of surplus and/or waste material, the cost shall be incidental to the cost of the project.

SECTION 206 STRUCTURE EXCAVATION AND BACKFILL:

Structure excavation and backfill shall conform to Section 206 of the Uniform Standard Specifications.

Prior to excavating for the construction of the pedestrian underpass, the Contractor shall submit a complete detailed shoring and bracing plan prepared by and bearing the seal and signature of a licensed Professional Civil or Structural Engineer of the State of Arizona.

Structure backfill shall be compacted in accordance with Table 601-2, Type III of the Uniform Standard Specifications, unless noted otherwise on the Plans.

AB slurry backfill shall consist of a stabilized non-settling backfill to be used in place of soil backfill adjacent to and over the pedestrian underpass. The AB slurry backfill shall consist of a sand or aggregate/cement mixture or a sand, cement and fly ash mixture capable of free flow without segregation prior to set. It shall be vibrated during placement. A minimum compressive strength of 250 psi should be achieved within 12 hours after placement to allow construction loads for placement of the approach slab according to the traffic control plan. The mix design shall be submitted to and approved by the Engineer at least two weeks prior to construction of the pedestrian underpass.

Payment for all work under this section shall be at the contract unit price per cubic yard for Item 206-1, Structure Excavation, Item 206-2, Structure Backfill, and Item 206-3, AB Slurry Backfill.

301 SUBGRADE PREPARATION

Subgrade preparation shall consist of shaping the roadway subgrades and pump station compound (including paved entrance) to the grades and cross sections for the new roadways, bridge approach slabs and pump station as shown on the Plans and in accordance with Section 301 of the Uniform Standard Specifications.

This item shall also include all work necessary for the construction of ditches, and excavation, filling, grading, shaping and miscellaneous grading work between the back of curb or edge of pavement and the right-of-way or construction easement.

Payment for all work under this section shall be at the Contract unit price per square yard bid for Item 301-1, Subgrade Preparation.

310 UNTREATED BASE

Item 310, Aggregate Base, shall conform in its entirety to the requirements of Section 310 of the Uniform Standard Specifications. Aggregate base shall be crushed in accordance with Section 702.2.

The Contractor will be required to furnish the Engineer certified weight tickets covering all of the aggregate base placed on the project. Final pay quantities will be based upon the scale tickets accepted by the Engineer.

321 ASPHALT CONCRETE PAVEMENT

Asphalt concrete pavement shall consist of furnishing and placing a plant-mixed asphalt concrete road surfacing material to the compacted thickness shown on the Plans and in accordance with Section 321 of the Uniform Standard Specifications.

The mineral aggregate shall meet the grading requirements within the range of the specified tolerances for Mix-Designation of C-3/4 in accordance with Section 710 of the Uniform Standard Specifications and the City of Phoenix Supplement to the Uniform Standard Specifications.

The Contractor shall furnish certified weight tickets covering all plant-mixed asphalt concrete placed on the project.

Payment for Item 321-1 will be made at the Contract unit price bid per ton.

336 PAVEMENT REPLACEMENT

Item 336-1, Pavement Replacement, shall be in accordance with MAG Section 336.

340 CONCRETE CURB AND GUTTER, SIDEWALKS, DRIVEWAYS AND ALLEY ENTRANCES

Items 340-1 through 340-6 of this project shall conform in its entirety to Section 340 of the MAG Standard Specifications.

350 REMOVAL OF EXISTING IMPROVEMENTS

Items 350-1 through 350-5 shall conform to Section 350 of the MAG Specifications and Section 350 of the City of Phoenix Supplements.

401 TRAFFIC CONTROL

Attention is directed to Section 401.2, Traffic Control Devices, of the MAG Standard Specifications, and to the City of Phoenix Traffic Barricade Manual.

Part A of Section 401.2 shall include traffic striping, including but not limited to, pedestrian crosswalks, cross-hatch and lane line, raised pavement markers and pavement striping removal, as indicated on the Plans.

The lump sum unit price for item 401-1, Traffic Control, shall include all items, relating to traffic control for maintaining necessary and adequate devices for the protection of the work, the workmen and the traveling public.

Payment for permanent barricade will be at the unit price bid for Item 401-3, Permanent Barricade.

POLICE OFFICER REQUIREMENTS

The Contractor shall provide one off-duty police officer to direct traffic in the vicinity of the construction site as required and two additional officers when necessary to flag traffic to allow men and equipment into or out of the work area.

Payment for off-duty police officers will be made at the current contractor's hourly rate which is approximately \$20.00 per hour. Bid Item 401-3, Uniformed, Off-Duty Law Enforcement Officer, shall be based on 770 manhours will be paid on an as-used basis.

CONSTRUCTION SPECIAL PROVISIONS

405.5.1 SURVEY MONUMENTS

Survey monuments which are disturbed by the Contractor shall be restored or replaced by the Contractor at no additional cost to the Owner.

420 CHAIN LINK GATES

Chain link gates shall be installed as indicated on the Plan and herein specified.

The gate shall be protected against damage and, if damaged, it shall be repaired prior to final acceptance.

Except where indicated differently on the Plans, gate posts and concrete foundations for gate posts shall be as determined by the following schedule:

<u>Gate Leaf Width,</u> <u>feet</u>	<u>Size OD,</u> <u>inches</u>	<u>Weight,</u> <u>lb/lf</u>	<u>Concrete Foundation</u>	
			<u>Diameter,</u> <u>inches</u>	<u>Depth,</u> <u>feet</u>
0 to 6	2-7/8	5.79	12	4
Over 7 to 13	4	9.11	18	3
Over 13 to 18	6-5/8	18.97	18	4
Over 18	8-5/8	24.70	18	4.5

All posts, rails, and appurtenances shall be hot dipped zinc coated steel per ASTM A 120, A 121, A 123, and A 153, whichever is applicable. Pipe posts shall have tops which exclude moisture.

420.1 SWING GATES

Except as otherwise indicated or specified, all chain link fence gates shall be swing gates.

Swing chain link gates shall be provided where indicated on the Plans. Gate frames shall be made of 1.90-inch OD galvanized pipe weighing 2.72 pounds per linear foot. Corner fittings shall be heavy pressed steel or malleable castings.

Gates shall be provided with 3/8 inch galvanized cross tensioning rods and turnbuckles rigidly attached to the gate frame.

The corners of gate frames shall be fastened together and reinforced with a fitting designed for the purpose or by welding. All welds shall be ground smooth.

Vertical stiffeners shall be provided on gates at 6 feet on center on gates 12 feet and wider and horizontal stiffeners shall be provided gates over 7 feet height.

Chain link fence fabric shall be attached to the gate frame by the use of tension bars and tie wires as specified for fence construction, and suitable tension connectors spaced at approximately 16-inch intervals.

Gates shall be provided with a combination steel or malleable iron catch and locking attachment of acceptable design. Stops to hold gates open and a center rest with catch shall be provided where required.

Payment for chain link gate will be made at the unit price bid for Item 420-1, chain Link Gate.

501 SHEET PILING

Contractor shall retain the services of a professional geotechnical engineer licensed to practice civil or structural engineering in the State of Arizona. The Contractor's engineer shall design, prepare plans, and monitor installation of temporary sheet piling or equivalent material to retain excavations as indicated on the Plans. No installation of sheet piling or equivalent material may proceed until plans have been accepted by the Engineer.

Payment for sheet piling and related geotechnical engineering will be made at the contract lump sum price for Item 501-1, Sheet Piling.

502 DRILLED SHAFT FOUNDATIONS

502.1 DESCRIPTION

Drilled Shaft Foundations shall be constructed in accordance with ADOT Section 609 except as otherwise specified herein or on the Plans.

502.2 MATERIALS

502.2.1 Concrete:

Concrete shall be Class AA conforming to the requirements of MAG Section 725 for the strength of portland cement concrete indicated on the Project Plans. Water reducing and air entraining agents may be used.

502.2.2 Reinforcing Steel:

Reinforcing steel shall conform to the requirements of MAG Section 727.

502.2.3 Shaft Forms:

It is not anticipated that shaft forms will be necessary, however if the size of the shafts adjacent to the channel cannot be maintained within 2 inches of the shaft diameter, as indicated on the Plans, for the depth of the proposed channel, or if over drilling will narrow the channel width, sonotube or an approved method shall be used to control the shaft diameter and location indicated on the Plans.

502.3 CONSTRUCTION REQUIREMENTS:

502.3.1 Excavation:

Excavation of adjacent shafts at any pier or abutment will not be permitted until 48 hours after the adjacent shaft has been concreted.

The Contract shall protect the shaft from caving in at the surface either by constructing a concrete slab or by placing a temporary casing or by other methods as accepted by the Engineer. The Contractor shall either drill or form a circular opening at the center of the slab. The slab shall be broken up and removed at the completion of the drilled shaft construction. If a casing is used, it shall be removed after the concreting of the shaft is completed and while the concrete is still fluid. Casing shall not be left in place except as indicated on the Project Plans or as accepted by the Engineer.

502.3.2 CONCRETE:

General: The Contractor shall exercise care so that no damage to a completed drilled shaft will occur. The Contractor shall not begin construction of a drilled shaft until at least 48 hours after the concreting of an adjacent drilled shaft is completed. Concrete shall be placed as soon as possible after excavation and immediately after placement of the reinforcing steel cage. Vibration shall be used to consolidate concrete during placement, but extreme care shall be taken to avoid sloughing of loose material during vibration.

502.4 METHOD OF MEASUREMENT:

Drilled shafts will be measured by the linear foot. measurement will be made from the top of the accepted drilled shaft to the bottom, as indicated on the Project Plans or as directed by the Engineer.

502.5 BASIS OF PAYMENT:

The accepted quantities of drilled shafts, measured as provided above, will be paid for at the contract unit price per linear foot for item 502-1, Drilled Shaft Foundation (36"). The price paid shall be for drilled shafts, complete in place, including excavation, metal casing, steel reinforcing, portland cement concrete, concrete slabs, concrete anchors, and any needed forming, curing and finishing. No additional payment will be made for metal casing that is to remain in place.

505 CONCRETE STRUCTURES

The work under this section shall consist of furnishing all labor, materials and equipment for the construction of the concrete portions of the bridge structure, including the approach slabs, pedestrian underpass, bridge sidewalks, and the sewage pump station, in accordance with the Plans and Section 505 of the Uniform Standard Specification, except as specified in the Construction Special Provisions.

GENERAL: It shall be the Contractor's responsibility to protect the structure and construction site from damage that may occur during the construction period and until final acceptance of the completed bridge by the Flood Control District.

Upon completion of the construction, the Contractor shall clear the work area of all debris.

Concrete for the approach slabs shall attain its required strength within 12 hours after placement to allow vehicular loads in accordance with the traffic control plans.

The following strengths of concrete shall be furnished for Cast-in-Place Elements:

Item 505-1 - Class "A" Concrete $f'_c = 3,000$ psi
Cap Beams, Abutment, Barriers, Retaining Walls, Pump Station

Item 505-2 - Class "AA" Concrete $f'_c = 4,000$ psi
Approach Slabs, Sidewalks on Bridges

The Contractor shall determine the mix proportions and shall furnish concrete which conforms to the requirement of these Specifications. It shall be the responsibility of the Contractor to proportion, mix, place, finish, and cure the concrete properly in accordance with the requirements of these Specifications.

ADMIXTURES: The Contractor shall furnish Certificates of Compliance conforming to the requirements of MAG Subsection 106.2 for each type of admixture furnished. Admixtures containing chlorides will not be acceptable for concrete containing uncoated reinforcing steel or embedded metal items.

All concrete admixtures shall be stored in suitable containers in accordance with the manufacturer's recommendations. All liquid admixtures shall be protected from freezing.

Air-entraining admixtures shall conform to the requirements of AASHTO M 154.

Water reducing and accelerating admixtures shall conform to the requirements of AASHTO M 194.

Fly ash shall conform to the requirements of ASTM C 618 for Class F, except that the pozzolanic activity index with lime shall be reduced to a minimum of 650 pounds per square inch at seven days. The Blaine fineness shall have an average value of at least 2,800, with a minimum value of 2,600 for any one sample. The average value will be determined on the last five consecutive samples. The loss on ignition shall not exceed 3.0 percent.

DESIGN OF CONCRETE MIX: Portland cement concrete shall comply with Section 725 of the MAG Uniform Standard Specification for Public Works Construction.

A fly ash admixture may be used at the option of the Contractor only when portland cement is used. A maximum of 15 percent of the required weight of portland cement may be replaced with a fly ash admixture. A minimum of 1.2 pounds of fly ash shall replace each 1.0 pound of portland cement removed.

Concrete shall have a compressive strength not less than that indicated on the Project Plans. Unless otherwise indicated on the Project Plans, the (f'_c) of concrete shall be the required 28-day compressive strength.

The coarse aggregate size designation for concrete shall be chosen by the Contractor and approved by the Engineer and shall conform to the size designation and grading requirements of AASHTO M 43. In choosing the size designation, the maximum size of coarse aggregate shall not be larger than 1/5 of the narrowest dimension between sides of adjacent forms, or 2/3 of the minimum clear spacing between reinforcing bars, or 1/3 the depth of the slab, whichever is least.

The proposed slump shall be chosen by the Contractor. Concrete at the proposed slumps shall be sufficiently workable to allow proper placement without harmful segregation, bleeding, or incomplete consolidation.

Air-entraining admixtures will be required for all classes of concrete. The amount of entrained air in the concrete mixture shall not be less than four percent nor more than seven percent by volume.

Unless specifically prohibited, water reducing admixtures may be used at the option of the Contractor.

At least two weeks prior to the appropriate concreting operation, the Contractor shall furnish a mix design for each strength of concrete for review and approval. More than one mix design for each strength of concrete may be submitted for approval, providing specific items and locations of intended uses accompany the mix design. The Contractor shall substantiate each mix design by furnishing test data and providing all details of the mixtures proposed for use.

The complete solid volume mix designs submitted for approval shall include all weights and volumes of all ingredients. The brand, type, and source of hydraulic cement and admixtures, the coarse aggregate size number designation, source of aggregates, the specific gravities of all ingredients, the proposed slump, a code number to identify the mix design, and the intended use of each mix design shall be an integral part of each mix design.

No changes in the approved mix designs or code numbers shall be made by the Contractor except by the approval of the Engineer. A new mix design shall be submitted for approval any time the Contractor requests a change in materials or proportioning of the materials from that given in each approved mix design. In no case shall the approval of a mix design relieve the Contractor of the responsibility for the results obtained by the use of such approved mix design.

Mix designs from previous or concurrent projects may be submitted for approval. The Engineer may waive trial batches at any time.

The Contractor may obtain concrete for each strength of concrete from an approved commercial source.

For each strength of concrete, the Contractor shall furnish an invoice for each batch of concrete. The minimum items required of each invoice shall be the mix design code number, date, time batched, truck identification or number, and name of identification of batch plant.

Testing for consistency shall be in accordance with the requirement of AASHTO T 119 to determine the consistency in slump. The Contractor shall be responsible for furnishing concrete at the slump shown on the approved mix designs with a permissible variation of ± 1 inch. Concrete that fails to conform to the consistency requirements will be rejected.

DIMENSIONAL TOLERANCES: Construction dimensional tolerances shall be in accordance with Section 601-4, Tests on Finished Structures, of the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction, Edition of 1987 (revised to date).

REINFORCING STEEL: Reinforcing steel shall be furnished in the sizes, shapes, and lengths indicated on the Plans and in conformance with the requirements of these Special Provisions. Certificates of Compliance conforming to the requirements of MAG Subsection 106.2 shall be submitted.

When reinforcing steel is delivered to the site of the work, the Contractor shall furnish the Engineer with three copies of all shipping documents. Each shipping document shall show the sizes, lengths and weights of the reinforcing steel separately for each structure.

Shop drawings and lists showing the bending of reinforcing bars shall be submitted by the Contractor to the Engineer for approval, but such approval shall not relieve the Contractor of responsibility for the correctness of such drawings and lists.

Any discrepancy or error found by the Contractor in checking a bending diagram indicated on the Project Plans, or in preparing shop drawings or lists, shall be reported immediately to the Engineer, and the discrepancy or error shall be corrected in advance of fabrication and delivery of materials.

When bending is required, it shall be done without the use of heat, and bars having cracks or splits at the bends will be rejected.

Reinforcement shall be accurately fabricated and placed as indicted on the Plans and shall be firmly held in place by wire ties at all intersections and splices with 16 gauge or heavier tie wire and using pre-cast mortar blocks or ferrous metal chairs, spacers, metal hangars, supporting wires or other approved supports. Where reinforcement spacing is less than 12 inches in each direction, alternate intersections may be tied. Tack welding of reinforcement will not be permitted unless approved in writing by the Engineer.

Distances from the forms shall be maintained so that the reinforcement does not vary from the position indicated on the Plans by more than 1/4 inch. Reinforcement in any member shall be placed, inspected and approved before any concrete is placed.

All reinforcement shall be furnished in the full lengths indicated on the Project Plans. Splicing of bars, except as indicated on the Plans, will not be permitted without the Engineer's approval. Splices shall be staggered as far as possible. The type and method of splices or connections shall be approved by the Engineer.

In lapped splices, the bars shall be placed in contact with one another and wired together in such a manner as to maintain a clearance of not less than the minimum clear distance to other bars and the minimum distance to the surface of the concrete, as specified in the AASHTO Standard Specifications for Highway Bridges. Lap lengths shall be as indicated on the Plans.

PVC Liner Plate for the Sewage Pump Station and Manholes:

Liner plate material for interior faces of concrete structures and manholes shall conform to Section 741 of MAG and shall be installed on surfaces indicated on the drawings. All PVC liner plate shall be white in color. Installation shall conform to Section 741 of MAG, where

applicable, the manufacturer's recommendations, and these special provisions. The Contractor shall have a technical representative of the PVC liner manufacturer present during initial placement of the liner to ensure that proper application procedures and materials are used.

PEDESTRIAN UNDERPASS: The pedestrian underpass consists of precast concrete box culvert segments of the size and length shown on the Plans. The segments shall be installed on a sand bedding at the location and grade shown on the Plans. Each joint shall be sealed, all electrical items installed and temporary end closures constructed prior to backfilling.

The sand bedding shall consist of a 6 in. compacted layer meeting the requirements for fine aggregates for bituminous paving mixtures, AASHTO M29. Bedding shall meet Type III backfill requirements per MAG Table 601-2.

Electrical components shall be installed as shown on the Plans. Electrical conduit shall be placed and capped prior to backfilling. Tracer wires and markers shall be installed for future locating.

The temporary closure shall consist of 8 in. x 8 in. timbers placed at the ends of the underpass and spiked together to prevent intrusion of backfill. Timbers shall be Douglas Fir-Larch Dense No. 1 or better and shall be marked as specified in MAG 778.3.

Concrete strength shall meet the requirements for Class A Concrete, $f'c = 3,000$ psi.

The precast segments may be steam cured in accordance with MAG 506.2.

The precast segments may not be transported before the concrete attains its required strength. Extreme care shall be taken in handling, storing, moving and placing precast segments to avoid twisting, racking or other distortion that would result in cracking or damage to the segments. The precast segments shall be handled, transported and placed in an upright position and the points of support on the bottom shall be at the same plan location as the lifting points on top. Any damaged or cracked segments shall be replaced or repaired as required by the Engineer.

PVC DUCTS: All conduit and fittings within bridge sidewalks and sleeves under approach slabs shall be listed by UL, and conform to NEC standards. All conduit shall be rigid polyvinyl chloride (PVC) nonmetallic type conforming to the requirements of UL651 for rigid nonmetallic conduit. PVC conduit and fittings shall be Schedule 40, heavy wall, manufactured from high impact material and shall be rated for use at 90 degrees Centigrade.

Conduit in bridge sidewalks and sleeves under approach slabs shall be as indicated on the Plans. Each conduit shall be equipped with a pull-wire. PVC expansion sleeves shall be installed at the abutment walls. All conduit shall be fitted with a PVC cap. Tracer wires and markers shall be installed for future locating.

PIPE HANGERS: The furnishing and installation of pipe hangers and concrete inserts for the support of utilities shall be as shown on the Plans.

PAYMENT: Payment for concrete bridge structures will be made in accordance with the Uniform Standard Specifications (MAG) and the following.

Payment for cast-in-place concrete bridge work except for steel reinforcement, PVC pipe, and pipe hangers will be made at the contract unit price per cubic yard for Item 505-1, Structural Concrete, Class A and Item 505-2, Structural Concrete, Class AA.

Payment for steel reinforcement for concrete will be made at the contract unit price per pound for Item 505-3, Steel Reinforcement.

Payment for PVC pipe for concrete embedment and sleeves will be made at the contract unit price per lineal foot for Item 505-4, PVC Pipe Sleeves.

Payment for pipe hangers and concrete inserts for utility support will be made at the contract lump sum price for Item 505-5, Pipe Hangers.

Payment for precast concrete box culvert segments for the pedestrian underpass will be made at the contract unit price per lineal foot for item 505-6, 10 x 10 Precast Concrete Box. This payment includes furnishing complete in place including concrete, reinforcing steel, sand bedding, electrical components, joint sealant, temporary closures and incidental materials necessary for installation of the segments as shown on the Plans.

Structural steel items embedded in the concrete are incidental to concrete unit prices.

506 PRECAST PRESTRESSED CONCRETE BRIDGE MEMBER

The work under this section shall consist of furnishing and erecting the bridge members as indicated on the Plans and in accordance with AASHTO Standard Specifications for Highway Bridges dated 1983, with Interim Specifications of 1984 thru 1988.

All materials and construction of prestressed bridge members shall conform to Section 506 of the Uniform Standard Specifications, except as modified by these Construction Special Provisions.

Portland Cement Concrete for prestressed bridge members shall be Class S Concrete and shall conform to Section 725 of the Uniform Standard Specifications and these Construction Special Provisions.

Class "S" Concrete $f'_c = 5,000$ psi

The elastomeric bearing pads shall meet the requirements of Section 25 - Elastomeric Bearings of the AASHTO Standard Specifications for Highway Bridges and shall be 60 durometer hardness.

High strength, nonmetallic, nonshrink grout shall be used for grouting handholes, pockets, keyways, dowel holes and the joint between the abutment backwall and the precast girders as noted on the Plans. The grout shall attain 5,000 psi compressive strength within 24 hours after placement. It shall be flowable for keyway, dowel hole and joint applications and plastic for handhole and pocket applications. Follow manufacturer's recommendations for surface preparation, mixing, placement, finishing and curing.

Threaded reinforcing bar couplers shall be used for splicing the sidewalk reinforcing to the precast girders as noted on the Plans. The couplers shall develop 125 percent of the yield strength of the bar.

No separate payment will be made for the elastomeric bearing pads, grout, tie rods, dowels, prestressing or post-tensioning steel, reinforcing steel, couplers or any embedded items necessary to the furnishing of the bridge members complete-in-place.

Payment will be made at the contract unit price per each for Item 506-1, Precast, Prestressed Concrete Bridge Member (Box Girders).

510 MASONRY

This Specification shall be used for all masonry work in lieu of MAG Section 510, Concrete Block Masonry.

510.1 GENERAL

All work shall be executed in a workmanlike manner and in full compliance with all applicable codes and ordinances.

All concrete masonry walls shall be laid in uniform and true courses, level, plumb and without projection or offset of adjacent block. The foundation shall be thoroughly cleaned of all laitance, grease, oil, mud, dirt, mortar droppings, or other objectionable matter by means of a bush hammer or heavy sandblasting before placing the first course of masonry units. Full mortar bedding shall be used for the first course on the foundation. Full mortar coverage shall be provided on all face shells and webs. Vertical head joints shall be buttered well for a thickness equal to the face shell of the masonry unit, and these joints shall be shoved tightly so that the mortar bonds well to both masonry units. Joints shall be solidly filled from the face of the masonry units to the depth of the face shell.

Masonry units shall be laid in the wall to the desired height with joints of uniform thickness. Units shall be leveled, plumbed, and straightened before the mortar has stiffened. Bond shall be plumb throughout.

All masonry units shall be laid to preserve the unobstructed vertical continuity of the cells to be filled. Walls and cross webs forming such cells to be filled shall be full-bedded in mortar to prevent leakage of grout.

Masonry units shall be laid in such a way that cracks are not formed at the time the masonry unit is placed in the wall.

Each masonry unit shall be adjusted to its final position in the wall while the mortar is still soft and plastic enough to insure a good bond. If the position of the masonry unit is shifted after the mortar has stiffened, or bond is broken or cracks are formed, the masonry unit shall be relaid in new mortar.

Masonry units shall be cured and dried before being used and surface shall be clean and free from dirt when laid in the walls. Masonry units shall not be wetted before being used but shall be laid dry.

510.2 MORTAR JOINTS

Mortar joints shall be straight, clean, smooth, and uniform in thickness and, unless otherwise noted or indicated on the Plans, shall be tooled slightly concave. Joint thickness to be 3/8-inch both vertical and horizontal unless otherwise shown. Where fresh masonry joins totally or partially set masonry, the set masonry shall be cleaned and roughened before laying new work.

510.3 JOINT REINFORCEMENT

Longitudinal wire joint reinforcement shall be lap spliced 75 wire diameters.

Longitudinal wires shall rest in the approximate centers of the mortar beds and shall have not less than 5/8-inch mortar cover on the exposed face.

Intersecting masonry walls shall be provided with prefabricated joint wire reinforcement tees. Intersecting wall joints shall be raked 1/2-inch and caulked.

510.4 BOND PATTERN

Bond pattern shall be as indicated on the Plans. Where no bond pattern is shown, the wall shall be laid up in a straight, uniform course with regular running bond.

510.5 GROUTING AND VERTICAL REINFORCEMENT

All spaces and cells containing vertical bar reinforcement shall be filled solidly with grout. Vertical cells containing bar reinforcement shall be filled solidly with grout in lifts not exceeding 8 feet in height. When the grouting is stopped for one hour or longer, horizontal construction joints shall be formed by stopping the pour of grout 1-1/2 inches below the top of the uppermost unit.

Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell measuring not less than 2 inches by 3 inches. Cleanout openings shall be provided at the bottoms of all cells to be filled at each lift or pour of grout where such lift or pour of grout is in excess of 4 feet in height. Any overhanging mortar or other obstruction or debris shall be removed from the insides of such cell walls. The cleanouts shall be sealed after inspection and before grouting. Bars shall be held in position by steel wire bar positioners or tied to dowels with wire ties.

Vertical reinforcing bars shall be centered in the cells. Where bars are spliced, the splice shall not be less than 50 bar diameters and footing dowels shall lap the vertical reinforcing bars 50 bar diameters. After grout has been placed, it shall be consolidated by rodding or by use of an immersion vibrator designed for the purpose.

Reinforcing steel shall be in place and reviewed by the Engineer before grouting shall begin.

510.6 BOND BEAMS

Bond beam units shall be installed where indicated on the Plans. Bond beams shall be made up of special bond beam block with horizontal bar reinforcement. Horizontal bar reinforcement shall be solidly grouted in place. Bar reinforcement shall be continuous through control joints. Openings in the bottom of bond beams shall be provided with wire mesh to support the group.

510.7 CUTTING OF MASONRY UNITS

All necessary cutting of concrete masonry units to form chases, etc. for anchorage or other appurtenances shall be required. All cutting and fitting of exposed block units shall be done with a power driven Carborundum or diamond disc blade saw.

510.8 CONTROL JOINTS

Control joints shall be as indicated in the Plans or as specified. They shall be full height and continuous in appearance, although bond beams and bond beam reinforcing bars shall be continuous through the joint. The control joint shall be caulked and shall be mortar joint in appearance. Fill material for control joints shall be premolded, wide flange control joint filler. All joints shall be caulked to produce a weathertight structure.

510.9 ANCHOR BOLTS

A 6-inch minimum width of grouted hollow masonry shall be provided all around anchor bolts and other attachment locations. Anchor bolts shall be held in place by a template to assure precise alignment of anchor bolts. Cutting, reaming or other means of accommodating misaligned anchor bolts in support angles will not be accepted.

510.10 HANDLING OF MASONRY UNITS

All masonry units shall be transported and handled in such manner as to prevent chipping and breakage. Storage piles, stacks, or bins shall be located to protect materials from heavy traffic. Chipped, cracked, or otherwise defective units shall be removed from the work. Any unit that is chipped, cracked, broken, or otherwise defective, whether before or after setting, will be rejected and shall be removed and replaced.

510.11 FOOTING FOR MASONRY

The footing supporting the masonry shall be excavated to neat lines as shown on the plans. Concrete and reinforcing for the footing shall meet the requirements of MAG Section 505 as modified by these special provisions. Concrete strength, $f'c$, shall be 3000 psi.

510.12 ENCLOSURES

Where concrete masonry is to enclose conduits, pipes, stacks, ducts, and similar items; chases, cavities, and similar spaces shall be constructed as required, whether indicated on the Plans or not. Openings around flush mounted electrical outlet boxes including the flush joint above the box, shall be pointed with mortar. No such work shall be covered until advised that work has been inspected and tested.

510.13 PATCHING

Patching of exposed concrete masonry units shall be done at the conclusion of the general work and shall be done in such a manner that the patching will be indistinguishable from similar surroundings or adjoining work.

510.14 PROTECTION OF MASONRY

Temporary protection shall be provided for all exposed masonry corners subject to injury. Concrete scum and grout stains on masonry shall be removed immediately. The wall shall be adequately braced against wind and other forces during construction. When rain or snow is imminent, the tops of unfinished walls shall be fully covered and protected with waterproof paper, polyethylene, or other means accepted by the Engineer.

510.15 WATER CURING

Masonry shall be kept damp for at least five days by frequently fogging with a nozzle regulated spray to moisten the faces of the masonry without causing water to flow down the walls.

510.16 MISCELLANEOUS

All items as required, including anchors, sleeves, frames, structural steel, anchor bolts, and miscellaneous iron shall be built in for a complete job.

510.17 MATERIALS

Concrete masonry block shall meet requirements of MAG 775.6. Mortar and grout shall meet requirements of MAG Section 776. Mortar shall be Type 5. Grout shall be Type Fine or Coarse. Reinforcing steel shall meet the requirements of MAG Section 505 as modified by these special provisions. Reinforcing steel shall be ASTM A615, Grade 40. Grade 60 reinforcing steel may be used with no reduction in the amount required by the plans.

510.18 CONTROL JOINT FILLER

Premolded joint filler shall be wide flange Rapid Poly-Joint manufactured by Dur-O-Wall; wide flange Vert-A-Joint manufactured by Vert-A-Joint Company; or equal.

510.19 CAULKING

All caulking for masonry control joints, and at other locations in masonry construction shall be done with a 1 part, nonsag, high performance, polysulfide base sealant. Caulking shall conform to requirements of Interim Federal Specification TT-S-00230C, Type 2, Class A, and shall be Chem Calk 100 by Woodmont Products, Inc.; PRC 7000 by Products Research and Chemical Corp.; or equal.

Application, including necessary primer and backer rod, shall be per manufacturer's recommendations. Sealant shall not be applied on wet or frosty surfaces or when surface temperature is above 130 degrees F. The depth of sealant in a joint shall not be greater than its width nor less than 1/4-inch. Sealant depths shall be as follows:

<u>Joint Width</u>	<u>Sealant Depth</u>
1/4 inch to 3/8 inch	1/4 inch
1/2 inch to 1 inch	3/8 inch

510.20 PAYMENT

Payment for concrete block masonry will be made at the contract unit price per square foot of masonry wall for Item 510-1, Concrete Block Masonry.

The Contract price paid for concrete block masonry shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing and furnishing concrete block masonry complete in place as indicated on the Plans, and as specified.

Payment for reinforcing steel and excavation and concrete for the footing will not be paid for separately but will be considered as incidental to materials and work required to complete construction of the concrete block masonry.

515 STRUCTURAL AND MISCELLANEOUS METALS

This Specification shall be used for all nonbridge metal work in lieu of MAG Section 515, Steel Structures.

515.1 GENERAL

This part of the Specifications includes, but is not limited to, the following items:

- Aluminum and miscellaneous nonferrous metals
- Anchors and anchor bolts
- Bolts
- Cast iron frames and covers
- Grating and frames
- Hatches
- Ladders
- Manhole frames and covers
- Miscellaneous aluminum
- Miscellaneous cast iron
- Miscellaneous metal items shown on the Plans or specified
- Miscellaneous structural steel
- Structural Steel
- Sheet metalwork
- Supports for mechanical equipment

515.2 MATERIALS

Unless otherwise specified or indicated on the Plans or Typical Details, structural and miscellaneous metals shall conform to the standards of the American Society for Testing and Materials (ASTM), latest revision, including but not limited to the following:

<u>Item</u>	<u>ASTM Standard No.</u>	<u>Class, Grade, Type or Alloy No.</u>
<u>Cast Iron</u>		
Cast Iron	A 48	Class 40B
<u>Steel</u>		
Galvanized sheet iron or steel	A 446 A 525 A 526	Coating G90 (min.)
Structural steel	A 36	
Standard bolts, nuts, and washers	A 307	
High strength bolts, nuts, and washers	A 325	
Tubing, cold-formed	A 500	
Tubing, hot-formed	A 501	
Black steel, sheet or strip	A 569 A 570	
Coil (plate)	A 635	
Steel pipe	A 53	Grade B

515.3 STRUCTURAL ALUMINUM

The Contractor shall furnish and install all structural aluminum items in accordance with the Plans and Typical Details, and as specified. He shall provide all supplementary parts necessary to complete each item even though such work is not definitely covered by the Plans and Specifications. Their size, form, attachment, and location shall be such as to conform to the best of current practice.

515.3.1 ALUMINUM LAYOUT

Hole centers may be center punched and cutoff lines may be punched or scribed. Center punching and scribing shall not be used where such marks would remain on fabricated material.

A temperature correction shall be applied where necessary in the layout of critical dimensions. The coefficient of expansion shall be taken as 0.000013 per degree F.

515.3.2 CUTTING ALUMINUM

Material 1/2-inch thick or less may be sheared, sawed, or cut with a router. Material more than 1/2-inch thick shall be sawed or routed. Cut edges shall be true and smooth, and free from excessive burrs or ragged breaks. Edges of plates carrying calculated stresses shall be

planed to a depth of 1/4-inch, except in the case of sawed or routed edges of a quality equivalent to a planed edge. Reentrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting. Flame cutting of aluminum alloys is not permitted.

Rivet or bolt holes may be punched or drilled to finished size before assembly. The finished diameter of holes for unfinished bolts shall be not more than 1/16-inch larger than the nominal bolt diameter. All holes shall be cylindrical and perpendicular to the principal surface. Holes shall not be drifted in such a manner as to distort the metal.

515.3.3 ALUMINUM FORMING AND ASSEMBLY

Structural material shall not be heated, with the following exceptions:

Aluminum material may be heated to a temperature not exceeding 400 degrees F for a period not exceeding 30 minutes to facilitate bending or welding. Such heating shall be done only when proper temperature controls and supervision are provided to insure that the limitations on temperature and time are observed.

All chips lodged between contacting surfaces shall be removed before assembly.

515.3.4 BOLTS FOR ALUMINUM

All bolts, nuts, and washers for bolting aluminum shall be Type 304 or Type 316 stainless steel of sizes indicated on the Plans.

515.3.5 WELDING ALUMINUM

This Specification shall apply to both field and shop welding operations. The general recommendations and regulations specified in the American Welding Society specifications D1.1, "Structural Welding Code," apply as well to 6061-T6 structures. Detail requirements in the above Specifications apply only to steel structures. Detail requirements for welding aluminum alloy 6061-T6 shall be as specified in the following paragraphs.

Filler rod metal for welding shall be aluminum alloy welding rods conforming to the requirements of AWS A 5.10 and shall be AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.

Welding of any structure which is to be anodized shall be done using filler alloy rods which will not discolor when anodized. ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556 filler alloy rods shall be used.

The welding process and welding operators shall both meet a qualification test. The method of qualification shall conform to the method described in the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications," Part B. Aluminum alloy 6061-T6 shall be used for the qualification test plates. Operators shall be qualified on the basis of bend tests and a fillet weld soundness test.

Dirt, grease, forming or machining lubricants, or any organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing. Additional operations to remove the oxide coating just prior to welding shall be required

when the inert gas tungsten arc welding method is used. This may be done by etching or by scratch brushing. The oxide coating may not need to be removed if the welding is done with the automatic or semiautomatic inert gas shielded metal arc.

Suitable edge preparation to assure 100 percent penetration in butt welds shall be used. Oxygen cutting shall not be used. Sawing, chipping, machining, or shearing may be used.

Any welding of aluminum shall be done using a nonconsumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG). No welding process that requires the use of a welding flux shall be used.

515.3.6 ALUMINUM COATING

Coat all aluminum in contact with concrete with two coats of zinc chromate primer before installation. Paint shall be Sherman Williams Zinc Chromate primer B50 YI, Glidden No. 5533 Zinc Chromate Primer or approved equal.

515.4 GRATINGS

Except as otherwise specified or indicated on the Plans, grating shall be aluminum grating supported on aluminum shelf angles as indicated on the Plans. All surfaces of shelf angles, rebates, and anchors in contact with concrete shall be coated in accordance with these Specifications.

Grating shall cover the areas indicated and detailed on the Plans. Where grating is indicated over an opening, it shall cover the entire opening, unless specifically noted or detailed otherwise. The top surfaces of grating sections adjacent to each other shall be in the same plane.

Aluminum plate or angles shall be installed where required to fill openings at changes in elevation and at openings between equipment and grating. Angle stops shall be installed at ends of grating to prevent grating from sliding out of rebate.

There shall be not more than 1/8-inch clearance between the ends of the grating and the inside face of the vertical leg of the shelf angles. The horizontal bearing leg of the shelf angle shall not be less than 2 inches. Ends of grating and cutouts shall be banded. The width of the end band of the grating shall be 1/4-inch less than the depth of the grating with the top of the grating and the top edge of the banding flush. The width of cutout banding shall be full-depth of grating.

Cutouts in the grating shall be provided where required for equipment access or protrusion, including valve operators or stems, and gate frames. Edges of cutouts shall be banded with aluminum material similar to end banding.

Where an area requires more than one grating section to cover the area, adjacent grating sections shall be clamped together at the 1/4 points with acceptable fasteners.

The Contractor shall furnish to the Engineer calculations from the grating manufacturer showing that the grating will meet the load-bearing and deflection provisions of the specifications for each size of grating and for each span. The Contractor shall, if requested

by the Engineer, test under full load one section of each size of grating for each span length involved on the job, to show compliance with these Specifications. A suitable dial gauge shall be provided by the Contractor for measuring deflections. Grating shall be fabricated in units which do not exceed 50 pounds each.

515.4.1 ALUMINUM GRATING

Aluminum grating shall be supported on aluminum shelf angles as indicated on the Plans.

Gratings, shelf angles, and anchors shall be of 6061-T6 or 6063-T6 aluminum alloy, except that cross bars may be of 6063-T5 aluminum alloy.

Aluminum grating shall be of such bar size and spacing that, as determined by the manufacturer, the grating will support a uniform loading of 100 pounds per square foot on the entire area of the grating, using an extreme fiber stress of not more than 12,000 pounds per square inch, and that the maximum deflection under this loading will not be more than 1/240 of the clear span of the grating. The spacing of the main grating bars shall not be more than 1-1/8 inches clear between bars.

Grating shall be Aluminum Type GAL manufactured by McNichols Co., Tampa Florida or equal.

515.5 ANCHOR BOLTS AND INSERTS

Anchor bolts shall be cast in place when concrete is placed, wherever feasible. Anchor bolts, concrete anchors, and flush shells embedded in concrete shall be accurately spaced with bolts truly normal to the surfaces from which they project.

All anchor bolts and nuts which will at any time be submerged in water or, in the case of structures customarily containing water, where they are located below the tops of the walls, even if above water level, or in ceilings or overheads, anchor bolts in the dry side of water bearing walls, and anchor bolts securing aluminum to steel or concrete equipment anchor bolts shall be Type 316 stainless steel. Other anchor bolts not required to be of stainless steel shall be stainless steel or galvanized carbon steel conforming to ASTM A 307 or ASTM A 36, at the Contractor's option.

Concrete anchors and flush shells shall be as specified in the following paragraphs.

Anchor bolts shall not touch reinforcing steel. Where anchor bolts are within 1/4-inch of reinforcing steel, anchor bolts shall be insulated with not less than three wraps of 10-mil PVC tape in the area adjacent to the reinforcing steel.

In anchoring machinery bases subject to heavy vibration, two nuts shall be used, one serving as a locknut. All bolts, when indicated for future use, shall be first coated thoroughly with nonoxidizing wax, followed by turning nuts down to the full depth of thread. Exposed thread shall then be neatly wrapped with a waterproof polyvinyl tape.

515.5.1 INSTALLATION

Unless indicated otherwise on the Plans, anchor bolts shall be embedded not less than 12 diameters and shall have a head or a hook not less than 4 diameters in length. Where indicated on the Plans, anchor bolts shall be set in metal sleeves. Sleeves shall be filled with grout when the machine or other equipment is grouted in place.

515.5.2 CONCRETE ANCHORS

Concrete anchors, where indicated on the Plans or specified, shall mean drilled in place anchors with integral anchor bolts. Concrete anchors shall be ITT-Phillips Red Head "Wedge Anchors" with integral anchor bolts; Expansion Products Company "Wej-It" concrete anchors with integral anchor bolts; or equal.

The material of each concrete anchor, including its integral anchor bolt, washer, and nut, shall be stainless steel Type 304 or Type 316.

Concrete anchors shall have the following minimum embedment lengths:

<u>Size, inches</u>	<u>Embedment Length, inches</u>
1/4	1-3/4
3/8	1-7/8
1/2	2-1/4
5/8	2-3/4
3/4	3-1/4

Prior to installation or use of anchor bolts, the Contractor shall perform the following test with the test results subject to review and acceptance by the Engineer. The Contractor shall furnish not less than four Type 304 or Type 316 stainless steel anchor bolts, 5/8-inch size of the type proposed to be used, and install the anchor bolts in a test block of concrete to the specified embedment length. After the concrete has set, the Contractor shall furnish and install one 5/8-inch nut on each anchor bolt. Each nut shall be tightened with an applied torque of 10 foot-pounds. Each nut shall then be loosened, and then retightened with an applied torque load of 10 foot-pounds. Any visible evidence of turning of any of the anchor bolts shall be cause for rejection of the concrete anchors by the Engineer.

Anchor bolts may be cast in the concrete in lieu of using concrete anchors.

Cast iron, lead cinch, or slug-in anchors will not be accepted as substitutes for concrete anchors.

515.6 FLOOR ACCESS DOORS

Exterior type floor access doors shall be Type JD-AL Special, as manufactured by the Bilco Company; GT or AM, as manufactured by Babcock-Davis Associates, Inc.; or equal.

Door leaf shall be aluminum diamond plate capable of withstanding a live load of 300 pounds per square foot. Channel frame shall be 1/4 inch aluminum with an anchor flange around the perimeter. An extruded neoprene membrane shall be provided to provide a weathertight seal. Doors shall be equipped with a minimum of two heavy forged brass hinges with stainless steel pins, spring operators to afford easy operation, and an automatic

hold-open arm with release handle. A snap lock with removable handle shall be provided. A 1-1/2 inch drainage coupling shall be located in the channel frame. Factory finish shall be mill finish with shop coating applied to exterior of the frame in accordance with these Contract Documents. Size and location shall be per Plans. Installation shall be in accordance with manufacturer's instruction.

515.8 PAYMENT

Unless otherwise provided in the proposal, the basis for payment for steel and miscellaneous metal shall be as follows:

Payment for all miscellaneous metal except special aluminum hatches and jib crane will be made at the contract lump sum price for item 515-1, Miscellaneous Metal.

Payment for special aluminum hatches will be made at the contract lump sum price for Item 515-2.

Full compensation for furnishing and placing sheet piling, performed fabric pads, elastomeric or elastic bearing pads, and red lead paste, and for grouting masonry or bearing plates as indicated on the Plans shall be considered as included in the price paid for structural and miscellaneous metal and no separate payment will be made therefore. Where the Specifications or Plans require metal to be galvanized, the price paid shall be considered as full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing the galvanized metal complete in place, as indicated on the Plans, and as specified in the Specifications and the Special Provisions, and as directed by the Engineer.

520 ORNAMENTAL IRON FENCE

The work under this section consists of furnishing and installing ornamental iron fence on the bridge and approach barrier walls. Fence shall be comprised of individual vertical pickets mounted on horizontal rails in panel lengths as shown on the plans. Pickets shall be made of 3/4 inch square tube or bar stock. Pickets shall be 4 inches center to center. Individual pickets shall be supported by no less than two 1-1/2 inch square tube horizontal rails. Panel shall be supported by vertical posts made of 3-inch square tube.

Prior to beginning any work on the fabrication of the fence, the Contractor shall submit shop drawings for approval, showing complete fence details.

The Engineer shall be furnished complete copies, in triplicate, of all mill reports on steel materials furnished.

The fence shall be fabricated by welding using the electric arc process in conformance with the Bridge Welding Code, AWS D1.5-88.

Fence panel shall be straight and true to dimensions.

The fence shall be carefully erected, true to line and grade. Posts and pickets shall be vertical and parallel, with the deviation from the vertical for the full height of the panel not exceeding 1/8 inch. After erecting the railing, any abrasions or exposed steel shall be repaired in accordance with MAG Section 530.

Payment for this item will be made at the contract unit price per linear foot for Item 520-1, Ornamental Iron Fence.

SECTION 601 TRENCH EXCAVATION, BACKFILLING, AND COMPACTION

A. CITY OF PHOENIX SUPPLEMENT SUB-SECTION 601.2.1 GENERAL: Is amended to add the following paragraph:

"No extra compensation or additional time will be authorized for claims that soil conditions differ from those anticipated or those indicated by soil logs and/or reports. It is the Contractor's responsibility to make his own determination as to actual existing conditions."

B. SUB-SECTION 601.2.2 TRENCH WIDTH: is amended to add the following paragraph:

"If the Contractor elects to slope the trench walls in lieu of shoring, sheeting or other wall support measures, he shall be responsible for any and all problems encountered and costs incurred as a result of the increased trench width. Furthermore, no increase in contract time will be allowed as a result of sloping trench walls."

C. SUB-SECTION 601.2.5 OVER EXCAVATION: is amended to add the following paragraph:

"When the Engineer determines that over excavation and backfilling, below the normal foundation and bedding depth, are required as a result of unsuitable material, it will be considered extra work. Payment and construction time extension will be negotiated with the Contractor or as otherwise provided for these contract documents. As a condition of the Contractor receiving payment, agreement on method of payment and construction time extension shall be reached prior to start of work unless otherwise authorized in writing by the Engineer."

D. SUB-SECTION 601.2.8 GRADING AND STOCKPILING: Add the following paragraphs:

"Excavated material shall not be considered as unsuitable due to an excessive moisture content or an inadequate moisture content for proper compaction. The Contractor shall take whatever measures are required at his own expense to add or remove moisture from material to be used as backfill in order that proper compaction can be obtained within the limits set in Section 601.4.

The Contractor may elect, at no cost to the Contracting Agency, to haul off and dispose of excessively wet or dry material and replace it with material conforming to the specifications for backfill.

In either event, the proper compaction shall be obtained. There will be no additional payment or time extension for this work."

E. SUB-SECTION 601.4.3 BACKFILL: Delete fourth paragraph in its entirety, and substitute the following:

"When mechanical compaction is to be used, the Contractor will provide a test section demonstrating his proposed method and equipment to be used. Upon agreement with the Engineer as to the acceptability of the Contractor's proposed method and equipment, they shall not be changed without prior approval of the Engineer. Mechanical compacted lifts in excess of one foot will not be allowed without the express written consent of the Engineer."

F. SUB-SECTION 601.4.3 BACKFILL: is amended to add the following paragraphs:

"Backfill material shall be within the range of +2% to -4% of the optimum moisture content, prior to placing the material in the trench. the moisture content shall be uniform throughout the backfill material. Material not meeting these requirements may be required to be removed from the trench and moisture added or removed to correct the deficiencies prior to replacement, all at no increase in cost to the contract.

It shall be the Contractor's responsibility to blend excavated material, removing or adding moisture as may be necessary to meet the requirements of the specifications, all at no increase in cost to the contract.

Excavated material when used for backfill shall meet the requirement of the preceding paragraph.

The moisture content requirements contained herein are waived when granular material is used and water settled.

The Engineer may require all or any part of the trench to be lead tested for stability with Contractor's equipment prior to placement of asphalt or Portland cement concrete pavement. Unstable areas as determined by the Engineer shall be corrected by the Contractor at no increased cost to the contract."

LIMITS OF BACKFILL TYPE

- Type I : Canal right-of-way, street right-of-ways and to 10 ft. above pipes in the ACDC right-of-way.
- Type II : Will not be used.
- Type III: For all structures.

G. SUBMITTAL: The Contractor shall submit his plan, methods, and procedures for protecting existing utilities prior to beginning construction. Approval of the plan does not limit the Contractor's responsibility for utility protection, and the Contractor shall implement all additional utility protection measures as determined to be necessary in the field.

601.2.8 DEWATERING TRENCHES

This item covers the entire project except as specified elsewhere in these Special Provisions.

Any water encountered during installation of the new pipes shall be disposed of by the Contractor in such a manner as will not cause damage to public or private property or constitute a nuisance or menace to the public. The Contractor shall furnish, install, and operate pumps, pipes, appliances, and equipment of sufficient capacity and so located as to keep all excavations and accesses free from water while work is in progress, and during weekends and holidays when required by the Engineer. The Contractor shall provide all means or facilities necessary to conduct water to the pumps. This is not a pay item.

610 WATERLINE CONSTRUCTION

Waterline construction shall be in accordance with MAG Section 610 and 750.

Payment shall be made at the unit prices bid for Items 610-1 through 610-3.

611 DISINFECTING WATER MAINS

Disinfecting water mains shall be in accordance with MAG Section 611.

615 SEWER LINE CONSTRUCTION

Sewer line construction shall be in accordance with MAG Section 615.

Item 615-2, DIP Discharge Section, shall consist of 18-inch DIP, 18 in. x 8 in. DI eccentric reducer, 8-inch DIP and flexible coupling as shown on the Plans. Fittings shall have flanged joints. Bolts for the flexible coupling shall be 316 stainless steel as specified in Section 152110.

Item 615-2, DIP Discharge Section, and Item 615-3, 6-inch DIP Force Main, shall be lined with coal tar epoxy conforming to the specification in Section 150130 of these special provisions.

The trenching, bedding and backfilling of all items in this section shall be in accordance with MAG Section 601 and the amendments in these special provisions.

Payment shall be made at the unit prices bid for Items 615-1 through 615-5.

625 MANHOLES

Manholes shall be constructed in accordance with MAG Section 625.

Payment shall be made at the unit prices bid for Items 625-1 and 625-2.

Item 625-2, 60-inch Sanitary Sewer Manhole, shall be PVC lined as shown on the Plans and in accordance with MAG Section 741 and these special provisions.

702 DECOMPOSED GRANITE

Provide and place decomposed granite for dustproofing the area within the pump station compound to the depth and grades shown on the Plans. Decomposed granite shall comply to Section 702.4 of the MAG Uniform Standard Specifications and shall be sterilized to inhibit the growth of weeds and other vegetation.

The Contractor shall furnish certified weight tickets covering all decomposed granite placed on the project.

Payment for Item 702-1, Decomposed Granite, will be made at the contract price bid per ton.

741 LININGS FOR REINFORCED CONCRETE SANITARY SEWER PIPE

Section 741 shall be amended to include the following paragraphs:

741.3.1 Liner plate sheets shall be closely fitted and properly secured to the inner forms. Sheets shall be cut to fit curved and warped surfaces, using a minimum number of separate pieces. If liner plate joints are to be Type C-3 joints, as described below, the adjacent sheets shall be butted with not more than 1/8 in. opening between the sheets. A welding strip shall be fusion-welded on the backs of butt joints to prevent wet concrete from flowing around the edges.

Unless otherwise indicated on the plans, liner plate shall be returned 4 in. at the surfaces of contact between the concrete structure and items not of concrete. The same procedure shall be followed at joints where the type of protective lining is changed or the new work is built to join existing unlined concrete. At each return, the returned liner plate shall be sealed to the adjacent surface in contact with the plastic-lined concrete using Amercoat Bi, 19Y adhesive, the joint space shall be filled with 2 in. of densely-caulked lead wool or other approved caulking material.

741.3.2 Joints in Liner Plate for Cast-in-Place Concrete Structures

Liner plate at joints shall be free of all mortar and other foreign material and shall be clean and dry before joints are made.

Field joints in the liner plate shall be of the following described types, used as prescribed:

Type C-1: The joint shall be made with a separate 4-inch joint strip and two welding strips. The width of the space between adjacent liner plate sheets shall not exceed 2 inches. The 4-inch joint strip shall lap over each liner plate a minimum of 1 inch. It may be used at any transverse or longitudinal joint.

Type C-2: The joint shall be made by lapping sheets not less than 1 inch. One welding strip is required. the upstream sheet shall overlap the one downstream.

Type C-3: The joint consists of one welding strip applied to the face of the liner plate sheets butted together, with one welding strip applied on the back of the joint. It will not be permitted if the gap between the sheets exceeds 1/8 inch.

All welding is to be in strict conformance with liner plate manufacturer's specifications.

750.3 DUCTILE IRON WATER PIPE JOINT REQUIREMENTS

Restrained joints for ductile iron pipe shall be per MAG Standard Detail 302, or alternate method, as approved by the Engineer.

787.3 WATER, SEWER AND SURVEY FRAME AND COVER, MAG DETAIL 270

The bearing surfaces of the frame and cover shall be machined, tolerance $\pm 1/32$ inch, so that the cover seats firmly on the frame without rocking.

787.3.1 ALUMINUM MANHOLE COVERS

The City of Phoenix Water and Wastewater Department has the following state policy "MAG Standard Detail 425 - 24 in. Aluminum Manhole Frame and Cover is not approved by the City of Phoenix."

DIVISION 12 - PUMPS

120000 GENERAL

The Contractor shall furnish, install, and test all pumps as indicated on the Plans, or as specified herein. It is the intent of these Specifications to obtain pumps of heavy-duty construction for heavy-duty continuous service or for intermittent service, whichever imposes the most severe service on pump. Pumps will be installed at an elevation of approximately 1,200 feet above sea level.

Each pump shall be furnished as a complete, ready-to-install unit by a single supplier, including but not limited to pump, motor, mountings, and (if so specified and equipped) variable speed drive, engine, and/or drive shaft assembly.

Pumps that have mechanical defects or do not meet the range of head-capacity characteristics, horsepower, efficiency, and vibration requirements will be rejected after testing and shall be replaced without additional cost to the Owner for furnishing, removal, reinstallation, and retesting. mechanical defects shall include excessive vibration, improper balancing of any rotating parts, improper tolerances, binding, excessive bearing heating, defective materials, including materials that do not conform to the Specifications, improper fitting of parts, and any other defect which will in time damage the pump or unreasonably impair the efficiency of the pump.

120001 CONSTRUCTION

No pump will be accepted by the Engineer for construction until the Contractor has submitted to the Engineer for acceptance sufficient literature, detailed specifications, and drawings indicating dimensions, make, style, speed, size, type, horsepower, full-load amps, head-capacity, efficiency, NPSH curves, specific materials used, design features, weights, and any other information required.

Any bronze used in the manufacture of any pump shall not contain more than 2 percent aluminum nor more than 6 percent zinc.

Impellers, cases, seals, shafts, bearings, and any other item which does not comply with the Specifications as to their metallurgy, material, or hardness shall be replaced without additional cost to the Owner for new parts, removal, and replacement.

CONSTRUCTION SPECIAL PROVISIONS

120002 INSTALLATION

Before installation, the Contractor shall furnish three sets of installation instructions and three sets of lubrication instruction for each type of pump. These instructions shall include detailed instructions for adjustment and recommendations for the proper type of lubricant.

Pumps shall be installed and adjusted as specified and in accordance with the manufacturer's recommendations and in such manner that connecting piping will not impose any strain whatever on any pump. Pumps flanges, screwed connections, or flexible connections, or flexible connections will meet without strain or distortion. Pump foundation pads shall be doweled and keyed to the floor slab upon which it rests.

120003 MOTORS

Motors shall be in accordance with the provisions of DIVISION 14 in addition to the following provisions and characteristics specified hereinafter.

Motors, as furnished and installed, shall be of sufficient horsepower rating so that the rate horsepower and full-load amps will not be exceeded at any point on the pump curve within the specified operating range of the pump. The operating range shall be that part of the pump curve within the limits specified.

120004 TESTS

Each pump and driver, unless otherwise specified, shall be field tested for compliance with these specifications as to head-capacity, and horsepower. In addition, when so specified, each pump shall be test run at the place of manufacture and certified performance curves and other required data shall be submitted to the Engineer for acceptance before the pump is delivered to the jobsite. Unless otherwise specified, the Contractor shall furnish all manpower, facilities, power, and equipment required for making tests. Field tests and manufacturers' tests shall be conducted in accordance with the latest requirements of the Hydraulic Institute Standards.

120005 VIBRATION

Vibration shall be tested with a Starret vibrometer or a vibrometer acceptable to the Engineer.

The vibration limits of pumps shall be as described in the Hydraulic Institute Standards except that peak-to-peak vibration amplitude shall not exceed 2 mils, unless otherwise specified, for any frequency at any distance from base to point of measurement. It shall be the responsibility of the manufacturer to dynamically balance the pump and motor, to reinforce, stiffen, or support the pump casing, frame, pedestal, or shafting to keep vibration within the limits as described herein.

120560 NONCLOG CENTRIFUGAL PUMPS - SUBMERSIBLE

The Contractor shall furnish and install, complete in place in operable condition, submersible type nonclog centrifugal wastewater pumps. The pumps shall be installed as indicated on the Plans, and as specified herein.

The pumps shall be as manufactured by Davis EMU, Flygt Corporation, Gorman-Rupp Corporation, or equal.

Each pump shall be rated to deliver not less than 400 gpm at 27 feet total head, with efficiency not less than 60 percent and speed not more than 1,800 rpm. Each pump shall be capable of operation at all points on its curve between 300 gpm and the flow corresponding 20 feet total head, with available net positive suction head (NPSHA) of 30 feet. The pump shall operate over this range without excessive noise or vibration, without exceeding motor horsepower rating, and free of cavitation or any other mechanical defects.

Each pump shall be designed for operation for not less than 30 minutes with the motor completely unsubmerged, without damage or overheating of any kind. Each pump unit shall be designed for intermittent operation of 10 starts per hour without harmful effect.

The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 60 feet.

The pump casing, motor housing, bearing housing and impeller shall be constructed of cast iron. All exterior fasteners shall be stainless steel. Pump shaft shall be stainless steel.

The impeller shall be nonclogging design capable of handling solids, fibrous material, heavy sludge, scum, and other material found in normal wastewater applications. The maximum temperature will be 85 degrees F. The impeller shall be statically and dynamically balanced for quiet, vibration-free operation. The impeller shall be slip fit to the shaft and key driven. A wear ring system shall be provided for efficient sealing between impeller and volute and shall be replaceable. The impeller shall pass up to 3-inch spherical solids.

The pump shall be provided with a tandem mechanical rotating shaft seal system. Upper seals shall run in an oil reservoir. The lower seal unit, between the pump and oil chamber, shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper seal unit shall contain one stationary tungsten carbide ring and one positively driven rotating carbon ring. Each interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable. Shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower units, are not acceptable.

The mechanical seal oil reservoir shall be fitted with a moisture detector which shall be wired into the control panel to alarm the presence of water.

The pump motor shall be housed in an air filled or oil filled, watertight motor housing with a removable motor cap for easy access to stator wires, and with a watertight seal between stator lead and motor compartments. The motor shall be NEMA Design B for continuous duty with Class "F" -155 degrees C insulation stainless steel shaft with heavy-duty long life ball bearings. The stator windings shall be furnished with thermal sensors, one per phase, for thermal protection of the motor. These shall be used in conjunction with and supplemental to external motor overload protection, and shall be wired into the control panel.

The motor shall have the following characteristics:

Horsepower - not less than	5
Speed - rpm, maximum	1,800
Volts	208
Phase	3
Hertz	60
Service Factor	1.10

The pump motor shall be sparkproof and explosion-proof for Class 1, Group D, Division 1 hazardous location.

Pump motor cable shall be suitable for submersible wastewater pump applications. Cable sizing shall conform to National Electric Code Specifications for pump motors, and shall be of adequate size to allow motor voltage conversion without replacing cable.

A sliding guide bracket shall be provided to allow the pump unit to be raised or lowered on guide rails to automatically be connected and disconnected from its mating discharge connection permanently installed in the wet well. The pump shall be easily removed and installed for inspection and service. Each pump shall be furnished with stainless steel lifting cable of adequate strength and length. Each pump shall be furnished with upper guide holder and liquid sensor cable holder. Lower guide holders shall be firmly and rigidly connected to discharge connection. Guide bars shall be stainless steel, 2-inch diameter Schedule 40 pipe or 2-inch "T" bar, and shall not support any weight of the pump. Guide bars shall be stabilized with intermediate supports of heavy-gauge stainless steel attached to the discharge risers or wet well structure at not greater than 8 ft. 0 in. centers.

Pump controls shall be as specified in DIVISION 16.

Payment for pumps will be made at the unit price bid for Item 1200-1, Pumps.

DIVISION 14 - MECHANICAL EQUIPMENT

140000 GENERAL REQUIREMENTS

Specifications contained in this section shall apply to all items of mechanical equipment the same as if these Specifications were contained in the individual section for the equipment in this Division, or any other Division herein.

All items of equipment shall be the product, modified as specified herein, of a manufacturer experienced in the design, construction, and operation of equipment for the purpose required, and who shall have established a record of successful operation of such equipment manufactured or produced by them. When two or more units of equipment for the same purpose are required, they shall be products of the same manufacturer. Equipment shall be made up of parts which are designed to act as a unit, and the manufacturer shall guarantee that when the component parts are assembled into the final unit, these parts will fit and operate satisfactorily.

Except as otherwise provided, the responsibility of the equipment manufacturer shall extend to the selection and mounting of gear drive units, motors or other prime movers, accessories and auxiliaries required for proper operation.

140010 SUBSTITUTION OF EQUIPMENT

Equipment shall be readily adaptable for installation and operation in the structures as indicated on the Plans.

Equipment or equal quality and performance may be substituted for those indicated or specified, except as otherwise provided for in the Proposal and Contract. Any revisions to structures, piping, electrical, or other work as a result of the substitution shall be acceptable to the Engineer, and the cost of all such revisions shall be borne by the Contractor.

All specific requirements of these Specifications must be adhered to, and modifications shall be made in the specified model of manufacturer's equipment to make it conform to the specific requirements of these Specifications if the standard product does not fulfill all requirements.

140011 SHOP DRAWINGS

Complete assembly, support, and installation drawings together with detailed specifications and/or catalog data covering equipment, parts, material used, weights and outline dimensions, controls, and other accessories forming a part of the equipment furnished shall be submitted to the Engineer for review. Methods of anchoring with consideration of seismic design for restraint per Uniform Building Code and/or mechanical stops shall be included in the submittals. Size, location, and spacing of foundation bolts, including vertical and/or horizontal adjustments available for installation and future adjustment shall be clearly indicated.

140012 OPERATION AND MAINTENANCE MANUALS

The Contractor shall deliver to the Engineer four (4) sets of manufacturer's operation and maintenance manuals covering each piece of equipment or equipment assembly furnished under this Contract. Installation of equipment shall not begin until the above required manuals covering that part of the equipment have been supplied to the Engineer.

Each manual shall be bound into multiple volumes, each volume to be complete with an index bound into a heavy post binder with the index of each protected by a laminated clear plastic cover. The Contractor shall not deliver any O&M manuals until all required materials have been assembled and bound as specified.

The operation and maintenance manuals shall include, as a minimum, the following data for each item of mechanical, electrical, and instrumentation equipment. Information not applicable to equipment installed in the work shall be excluded.

- (1) Recommended start-up and trouble shooting procedures
- (2) Disassembly and reassembly instructions
- (3) Lubrication schedule
- (4) Recommended preventative maintenance procedures and schedules
- (5) Recommended spare parts

(6) Parts lists, by generic title and identification number, complete with section views of each assembly

(7) Name, address, and telephone number of nearest supplier and spare parts warehouse

In addition, the O&M manuals shall contain reproducible prints of the Contract record wiring diagrams, schematics, and installation drawings required under the Electrical and Instrumentation Specifications.

140013 MATERIALS AND WORKMANSHIP

All equipment shall be designed, fabricated, and assembled in accordance with the best modern practice in the manufacture of high grade machinery.

All parts and components of mechanical equipment shall be designed for satisfactory service under continuous duty without undue wear under the specified and indicated operating conditions for a period of not less than one year. Any part of mechanical equipment that shows undue or excessive wear or that fails due to wear under normal operating conditions within the first year of operation after final acceptance shall be considered as evidence of defective material or defective workmanship, and it shall be replaced by the Contractor with equipment or parts to meet the specified requirements at no cost to the Owner.

Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

Materials shall be suitable for the service conditions to be encountered. Structural steel shall conform to ASTM A36. Iron castings shall be of tough, close-grained gray iron, free from blow-holes, flaws, or other imperfections and shall conform to ASTM A48. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection.

Unless otherwise specified, all materials shall conform to the structural and miscellaneous standards of the American Institute of Steel Construction.

Bronze which will be in contact with water or any liquid, used in the manufacture of any equipment shall not contain aluminum nor more than 6 percent zinc, and shall conform to ASTM B-62, or equivalent.

Surfaces requiring painting or coating for corrosion protection shall be smooth, free from sharp edges, burrs, and projections, and shall have all welds ground smooth and all edges and corners of structural members rounded.

All steel bars, shapes, and plates shall be clean and straight before being worked. Straightening or flattening, if necessary, shall be done by a process and in a manner that will not injure the metal. Sharp kinks or bends shall be cause for rejection. Steel that has been heated partially shall be annealed, unless it is to be used in minor parts. Finished members shall be true to line and free from twists, bends, and other joints.

Tolerances and clearances shall be as indicated on the Shop Drawings and these tolerances and clearances shall be closely followed to secure proper operation of the equipment.

Unless otherwise specified, piping, fittings, and valves shall be as specified elsewhere herein. All flanges on equipment appurtenances furnished shall conform in dimensions and drilling to ANSI B16.1, Class 125 or 150, or as required.

Field welding, where required, shall be as specified elsewhere herein.

140013.10 BEARINGS

Unless otherwise specified, all equipment bearings shall be oil or grease lubricated, ball or roller anti-friction type of standard manufacture. Bearings shall be conservatively designed to withstand all stresses of the service specified. Each bearing, except as otherwise noted, shall be rated in accordance with the latest revisions of Anti-Friction Bearing Manufacturer's Association's (AFBMA) methods of Evaluating Load Ratings of Ball and Roller Bearings for B-10 rating life of 40,000 hours.

All grease lubricated bearings, except those specified to be factory sealed lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings of the standard hydraulic type. Extension tubes shall be provided for easy access.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 40 degrees C and shall be equipped with a filler pipe and an external level gauge. Fittings for pressure lubrication shall be 1/4-inch straight-type.

To avoid work hardening or "Brinelling" damage from vibration, bearings shall be separately packed or otherwise suitably protected during transport.

140014 PROTECTION OF EQUIPMENT

All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. All equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to final acceptance of the work shall be repainted to meet Specification requirements.

140015 INSTALLATION

The Contractor shall take measurements from his work at the installation sites, verify all subcontractor's drawings and be responsible for the proper installation of the equipment within the available space as specified and indicated on the Plans, and he shall secure the acceptance by the Engineer for any variations before making any changes.

The Contractor shall obtain and follow installation instructions and other recommendations from the equipment manufacturers. Manufacturer's recommendations as to grout spaces required, type of grout to be used, and tolerances for level and alignments, both vertical and horizontal, shall be obtained and followed.

Skilled workmen experienced in installation of the equipment or similar equipment shall be used. Applicable special tools and equipment, such as precision machinist levels, dial indicators, and gauges shall be utilized as required in the installations. The work shall be accomplished with good workmanship to produce satisfactory equipment installation free of vibration or other defects. Whenever applicable, the Contractor shall obtain the service of a manufacturer's representative specifically trained in erection of his equipment to supervise the installation.

Metalwork to be embedded in concrete shall be accurately placed and held in correct position while the concrete is being placed. The surface of all metalwork to be in contact with concrete shall be thoroughly cleaned immediately before concrete is placed. All anchor bolts shall be cast in place when the concrete is placed. Anchors shall be installed as recommended by the manufacturer's representative specifically trained in erection of his equipment to supervise the installation.

Anchor bolts for pumps and such other equipment where so specified, shall be encased in metal tubing having an inside diameter not less than two times that of the bolt. Pump and other similar foundations shall be left 1-inch below the grade of machine base unless otherwise noted on the Shop Drawings. After the proper setting of machine for alignment and grade, the recess below the base together with recess between the anchor bolt and the metal tube shall be grouted and carefully finished with an acceptable quick setting, nonshrink, rust-prohibitive mortar.

Prior to installation of equipment, all sacking and concrete preparation shall be completed, and the work area shall be maintained in a clean condition during the equipment installation.

Equipment not intended to vibrate during normal operation shall be rigidly attached to the foundation or other adequate support to prevent lateral and vertical displacement. Equipment intended to vibrate during normal operation shall be provided with isolators with mechanical stops which are securely anchored to foundation or other adequate support.

140016 BASES AND BEDPLATES

A heavy cast iron or welded steel base shall be provided for each item of equipment which is to be installed on a concrete pad or slab. Equipment assemblies, unless otherwise specified or indicated on the Plans or accepted Shop Drawings, shall be mounted on a single, heavy, cast iron or welded steel bedplate. Bases and bedplates shall be provided with machined support pads, dowels for alignment of mating or adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. All seams and contact edges between steel plates and shapes shall be continuously welded and ground smooth. The bottom of all bases and bedplates shall have at least two coats of zinc chromate primer before installation or grouting.

140016.10 JACKING SCREWS AND ANCHOR BOLTS

All equipment shall be anchored to supporting members by bolts or other connections to accommodate all operating forces and satisfy the seismic restraint requirements of the Uniform Building Code. Anchors shall provide resistance to a lateral force of at least 0.10 times the weight of the equipment, including its contents. Equipment installed on flexible mounts shall be given special consideration with design calculations including resonance determinations, submitted for review with Shop Drawings.

Jacking screws shall be provided in the heavy equipment bases and bedplates and where required elsewhere to aid in leveling prior to grouting.

Equipment suppliers shall furnish anchor bolts, nuts, washers, and sleeves of adequate design as required for proper anchorage of the bases and bedplates to the concrete bases. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1 inch of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

Anchor bolts, together with templates of setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.

All bolts and anchor bolts shall be of Type 316 stainless steel.

140016.20 GROUTING

After assembly and installation on the concrete base, each unit shall be leveled and aligned in place but not grouted until connecting piping has been fitted and aligned. Equipment bases shall not be grouted not foundation bolts finally tightened until all piping connections are complete and in satisfactory alignment with no stain transmitted to the equipment. Adjacent couplings shall be loosened to determine if pipe strain exists immediately before foundation is grouted. Concrete surfaces shall be cleaned and thoroughly wetted before grout or mortar is placed. To bond mortar or grout to concrete which has reached its initial set, the surface of the set concrete shall first be coated with epoxy liquid polysulfide bonding agent. Nonshrink grout and bonding agent shall be as specified elsewhere herein of these Specifications. The grout shall extend to the edge of each base or baseplate and shall be beveled at 45 degrees all around the unit and the finished surface shall not pond water within the grouted area. After grout has set, jacking screws shall be removed and nuts or anchor bolts shall be tightened, followed by an overall check on leveling and alignment.

140017 LUBRICATION

140017.10 LUBRICANT

The Contractor shall furnish all mechanical equipment with its proper supply of correct lubricant for starting, testing, and adjustment. All lubricants shall be as recommended by the equipment manufacturer. The Contractor shall limit the various types and brands of lubricants by consolidating, with all the equipment manufacturers' approval, into the least number of different types and brands. Before starting, testing and adjusting equipment, the

Contractor shall provide the Owner with four copies of a list showing the proper lubricants, after consolidation, for each item of mechanical equipment and the estimated quantity of lubricant needed for a full year's operation, assuming all equipment to be operating continuously.

140017.20 FITTINGS

All lubrication fittings shall be brought to the outside of all equipment so they are readily accessible from the outside without the necessity of removing covers, plates, housing, or guards. Fittings for underwater bearings shall be brought up above the surface of the water with 1/4 inch stainless steel tubing and mounted on the edge of the structure above. Fittings shall be buttonhead type. Lubrication fittings shall be mounted together wherever possible. They shall not be individual fittings field-mounted together, but use shall be made of factory-mounted multiple fitting assemblies.

140018 SAFETY REQUIREMENTS

All equipment furnished under these Specification shall comply with all applicable Federal safety regulations, including OSHA regulations and also all applicable State and local safety regulations and codes.

All sprockets, belts, drive chains, gearing, couplings, and all other moving parts on drive assemblies shall be enclosed in removable safety enclosures in compliance with said safety regulations.

Safety guards shall be fabricated from 16 USS gauge or heavier galvanized or aluminum clad sheet steel of 1/2-inch galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories including bolts, shall be hot-dip galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

140019 PAINTING AND COATING

Prime and finish coating materials and procedures shall be as specified elsewhere herein, except where otherwise specified.

Machined, polished, and other ferrous surfaces and nonferrous surfaces which are not to be painted shall be coated with acceptable rust preventative compound.

140020 NAMEPLATES

Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. The nameplate shall include manufacturer's name, equipment model number, identification tag number, drive speed, motor horsepower, and rated capacity. Nameplates for pumps shall also include rated total dynamic head and impeller size.

140021 WARNING SIGNS

Permanent warning signs shall be mounted at all mechanical equipment which may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. Mounting details shall be in accordance with manufacturer's recommendations; location as acceptable to the Engineer.

Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Copy shall read:

**CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL**

140022 SPECIAL TOOLS AND ACCESSORIES

The Contractor shall supply one complete set of any special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the 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 the maintenance and operation manuals describing the use of each marked tool. All wrenches and spanners shall be of best quality, hardened steel forgings with bright, finished heads and with work faces dressed to fit nuts. Each set of tools shall be neatly mounted in a tool box of suitable design provided with a hinged cover.

140023 INSTALLATION CHECKING, TESTING, AND OPERATOR INSTRUCTION

The Contractor shall operate all equipment and systems to show conformance with Specification requirements.

Where called for in the Detailed Specification of the item, or where required to secure satisfactory installation or operation, the Contractor shall furnish the services of experienced, competent and authorized factory trained representatives of the manufacturer or supplier of the items furnished. These representatives shall visit the site of work to perform the following tasks:

- (1) Inspect, check, and adjust if necessary, the items furnished and their installation.
- (2) Operate and field test the items furnished for proper operation.
- (3) Perform necessary field adjustments until the installation and operation comply with the Contract requirements.
- (4) Submit to the Engineer, through the Contractor, a written report indicating the items checked, adjustments made, results of measurements taken and tests made, and certification of the facility's readiness for operation.
- (5) Where called for in the Specifications, instruct the Owner's personnel in the operation and maintenance of the items furnished. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.

(6) Furnish such other services as are called for in the Specifications.

All moving parts of equipment and machinery shall be carefully tested for operation, and adjusted so that all parts move freely and function to secure satisfactory operation. Field performance tests of all process and pumping equipment, drive motors, including auxiliaries shall be made in accordance with the appropriate and approved test codes of the American Society of Mechanical Engineers, Hydraulic Institute Standards, NEMA and IEEE, latest editions.

Field testing shall be conducted after the project or system is substantially complete such that each item of equipment is ready for integrated operation with other equipment at the plant. Testing, measuring, and calibrating procedures shall be submitted to the Engineer for review and acceptance prior to start-up and field testing of equipment.

All equipment shall be tested continuously under actual or simulated operating conditions. The manufacturer's representative shall make all necessary field adjustments and correct defects in materials or workmanship during this test period.

The equipment shall be properly filled, by the Contractor, with oil and grease, and the Contractor shall furnish all power, personnel, chemicals, fuels, oil, grease, and auxiliaries necessary for initial testing of the equipment for proper operation, efficiency, and capacity.

After the 7-day acceptance test has been run by the Owner, and the results comply with the Contract requirements, the Contractor shall dowel the equipment in accordance with the manufacturer's recommendations.

The costs of all work performed in the Subsection by factory trained representatives shall be borne by the Contractor. When available, the Owner's operating personnel will provide assistance in the field testing.

The period of inspection, initial start-up operation, and field adjustment shall be as required to achieve satisfactory installation and operation of the items furnished. The period for instruction of the Owner's personnel shall be called for in the individual Equipment Specifications.

140060 MOTORS, GENERAL

Motors shall be manufactured in accordance with NEMA MG-1 Standards and shall be as specified herein or as specifically excepted in the individual equipment specifications.

140061 MOTOR STANDARDS

Unless otherwise specified for specific application, motors shall be: Type - Induction, squirrel cage; Polyphase Design "B"; Environment Protection - Open, splashproof, with stainless steel rodent guards, encapsulated winding for motors less than 100 horsepower and sealed windings for 100 horsepower and above; Speed - Constant, where two speed are specified they shall be dual winding; Rating - 208 V, 3 phase, high efficiency, high power factor, 40 degrees C ambient, Class "B" insulation.

140062 SPECIAL CONDITIONS

Altitude rating shall be the responsibility of the Contractor. Sound (noise) limits, when applicable, shall be as specified elsewhere. Aluminum frame motors must be individually reviewed for acceptance and they shall be manufactured with specially processed steel bearing inserts in each end shield and supplied with special long life bearings. Motors controlled by variable speed drive units shall each be protected by internal motor thermostats for overtemperature protection.

140063 HORSEPOWER RATING

Motor horsepower ratings noted in individual equipment specifications or indicated on the Plans are estimated only and it is the responsibility of the equipment manufacturer and of the Contractor to coordinate and furnish motors, electric circuits, starters, and other equipment of ample horsepower capacity to operate the equipment furnished without exceeding the nameplate full-load current at rated nameplate voltage. Full-load amps information shall be furnished with submittal.

140064 PAYMENT

No separate payment will be made for this item. Payment for all work under this section shall be included in Item 1200-1, Pumps and Item 1407-1, Odor Control System.

140700 ODOR CONTROL SYSTEM

General An odor control system shall be constructed for removing hydrogen sulfide and organic odors which are vented from the wastewater pump station wet well. The system shall be modular, compact, and corrosion resistant, and shall be designed to contain 260 pounds minimum of odor removing and odor oxidizing media for treatment of air up to a rate of 100 cfm.

The odor control system shall be the unit responsibility of one supplier. The odor control system shall consist of media, containers, inlet nozzles, blowers and motors as shown on the Plans and specified herein.

140700.1 MEDIA

General Two types of media in two separate layers shall be supplied with the odor control system. The bottom layer shall consist of 18 inches of carbon-based odor removing media with a total weight of approximately 195 pounds. The top layer shall consist of 6 inches of dry chemical odor oxidizing media with a total weight of approximately 65 pounds.

140700.1.1 Carbon-based media

General Carbon-based media shall consist of manufactured, generally spherical porous pellets. Pellets shall be formed from a combination of powdered activated carbon, alumina, and other binders, suitably impregnated with caustic chemicals to enhance the capacity of removal of hydrogen sulfide (H_2S). Impregnants shall be applied during pellet formation, such that the impregnant is uniformly distributed throughout the pellet volume. Carbon-based media shall be capable of absorbing and removing odor-causing compounds throughout the entire pellet volume.

Performance Carbon-based media shall meet the following test performance conditions when performed on a 3-inch deep test media bed, contained in a 1.02-inch diameter tube:

- Bed bulk density representative of field conditions;
- Test airstream containing 5.0 (+0.5) ppm H₂S (by weight);
- Air relative humidity 50% ±10%;
- Airflow through test bed 12,100 ml/min;
- Superficial velocity 75 fpm;
- Superficial residence time 0.199 second.

Acceptance criteria: Discharge air containing a maximum of 450 ppb H₂S at 48 hours from start of test.

Physical Properties

- Average crush strength: 40%;
- Average abrasion: 3.0;
- Bulk density: 50 lb/ft³;
- Average pellet nominal diameter: 1/8 inch.

Pressure Drop Characteristics Pressure drop of air at 70 degrees Fahrenheit when flowing through a 12-inch deep field-packed media bed shall not exceed the following limits:

<u>Superficial velocity, fpm</u>	<u>Pressure drop, inch w.c.</u>
50	0.30
100	1.10

140700.1.2 Dry Chemical Media

General Dry chemical odor oxidizing media shall consist of pelletized activated alumina (Al₂O₃) suitably impregnated with potassium permanganate (KMnO₄) during pellet formation such that the impregnant is totally available for reaction. Odor oxidant media shall be totally inorganic, non-toxic, non-flammable and shall not support bacterial or fungal growth. Media shall be capable of removing odorous, irritating, acidic and other gases from air reacting chemically with the sorbed gases to prevent and later desorption. Media, when installed in appropriate containers, shall be listed UL Class 2.

Performance Dry chemical media shall demonstrate oxidation efficiency for removal of gaseous hydrogen sulfide (H₂S) according to the following test parameters when performed on a 3-inch deep test bed, contained in a 1.02-inch diameter tube:

- Bed bulk density representative of field conditions;
- Test airstream containing 5.0 (+0.5) ppm H₂S (by weight);
- Air relative humidity 50% ±10%;
- Airflow through test bed 12,100 ml/min;
- Superficial velocity 75 fpm;
- Superficial residence time 0.199 second.

Acceptance criteria: Discharge air containing a maximum of 150 ppb H₂S at 48 hours from start of test.

Physical Properties

- Moisture content: 15% average by weight;
- KMnO_4 content: 4% average by weight;
- Bulk density: 50% lbs/ft³;
- Average crush strength: 40%
- Average pellet nominal diameter: 1/8 inch.

Pressure Drop Characteristics Pressure drop of air at 70 degrees Fahrenheit when flowing through a 12-inch deep field-packed media bed shall not exceed the following limits:

<u>Superficial velocity, fpm</u>	<u>Pressure drop, inch w.c.</u>
50	0.30
100	1.10

Acceptable Products Dry chemical media shall be Puralum WW or equal.

140700.2 CONTAINER

Container shall have a volume of 55 gallons and shall be constructed of polyethelene. The container shall measure approximately 24 inches in diameter by 36 inches high.

140700.3 INLET NOZZLE

The odor control system shall have an inlet nozzle for connection to the wet well vent piping and for distributing the vented air uniformly into the odor-absorbing media. The inlet nozzle shall be corrosion-resistant. Connections to the vent piping shall be threaded.

140700.4 BLOWER

The odor control system shall have an integral top-mounted blower with a capacity of 100 cfm. The outlet air vent shall be located at the top of the unit and shall be equipped with a low-efficiency particulate filter. The blower shall be powered by an electric motor with the following characteristics:

Horsepower, not less than	3/4
Volts	208
Phase	1
Hertz	60

The motor shall be totally enclosed fan cooled. The motor housing shall be constructed of 14-guage cold rolled steel and shall have a polyurethane finish to resist alkaline and acid formation.

140700.5 SPARE PARTS

The Contractor shall provide sufficient media to allow one (1) complete change. Media shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.

140700.6 PAYMENT

Payment for odor control system shall be made at the unit price for Item 1407-1, Odor Control System.

DIVISION 15 - PIPING, VALVES AND SPECIALTIES

150000 GENERAL

DIVISION 15 applies to those applicable items located within the lift station compound (within the masonry fence) and force main in its entirety.

Piping shall be installed as indicated on the Plans. The Contractor shall submit to the Engineer, for review and acceptance, his detailed proposed piping layouts.

Any pipe which does not meet specifications or has been rejected, shall be removed from the jobsite and disposed of by the Contractor at no extra cost to the Owner.

Where new fittings are to be cut into or attached to existing piping or where connections are to be made to existing piping, the Contractor shall furnish and install the necessary sleeves, flanges, nipples, couplings, fittings, or other devices needed to accomplish the cutting-in or connections, whether indicated on the Plans or not.

Lines under low head shall be laid flat or with a continuous grade so that there will be no air traps or humps in them, except at the ends where means for venting shall be provided.

In no case shall copper or copper alloy pipe or fittings carrying water or water based solutions or slurries be attached to cast-iron or steel pipe except by means of a dielectric coupling expressly made for this purpose and service.

All pipe which will operate under pressure shall be properly blocked at all fittings where the pipeline changes direction, changes size, or ends, using concrete thrust blocks in trenches and suitable anchors in structures. Concrete thrust blocks shall be sized so as to give bearing against undisturbed vertical earth banks sufficient to absorb the thrust from line pressure, allowing on earth bearing of 200 pounds per square foot per foot of depth below natural grade. (Earth bearing value may be increased, if substantiated by soils analysis.) The line pressure shall be the product of the nominal cross sectional area of the pipe and the test pressures as specified for each type of pipe. The concrete shall be placed, unless indicated otherwise on the Plans, so that the pipe joints and fittings will be accessible.

150010 EXPOSED PIPING

Where not detailed, exposed pipe shall be installed in straight runs parallel to the axes of the structures. Pipe runs shall be horizontal and vertical except that gravity drain lines shall be sloped down in the direction of flow not less than 1/8 inch per foot.

No exposed piping shall be erected until all equipment to which the pipe is to be attached has been installed and it can be determined where piping and fittings shall be located to make a neat efficient arrangement.

The Plans shall be taken as diagrammatic for piping that is not shown in detail. Sizes of piping and their locations are indicated, but it is not intended to show every offset and fitting nor every structural difficulty that will be encountered during the installation of the work.

The alignment of pipes shall be varied from that indicated on the Plans, without extra expenses to the Owner where necessary to avoid structural or mechanical difficulties or to avoid the work of other trades. The Contractor shall furnish such parts and pieces as may be necessary to provide a complete and operable system.

Pipework shall be suspended and supported in such manner as to prevent sagging or overstressing of pipe and connections and, also, so that no item of the piping system shall transfer any load or stress to any equipment.

Piping shall be made up with a sufficient number of unions or flanged joints to permit ready breaking of lines as necessary for inspection and maintenance, in addition to such joints as are definitely indicated on the Plans.

Pipe and fittings shall be assembled so there will be distortion or springing of the pipelines. Flanges, unions, flexible couplings, and other connections shall come together at the proper orientation. The fit shall not be made by springing any piping nor shall orientation alignment be corrected by taking up on any flange bolts. Flange bolts, union halves, flexible connectors, and similar devices shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to fit.

150011 WALL AND SLAB PENETRATIONS

Unless indicated otherwise on the Plans, no pipe shall pass through or be built into any reinforced masonry or concrete wall, floor, ceiling, roof pilaster, column, pier, or beam, unless it is inside of a sleeve; and such sleeves shall have an inside diameter not less than the outside diameter of the pipe plus on (1) inch, except that for pipe smaller than two (2) inches the ID of the sleeve shall be not less than twice the OD of the pipe. Such sleeves shall be placed not closer than three diameters center to center, nor shall they impair the strength of construction. the arrangement of sleeves shall be such that pipe can be pulled out of a sleeve and replaced without disturbing the structural member. Ends of sleeves shall be flush with surfaces of concrete, masonry, or plaster.

150020 BURIED PIPING

All pipelines laid in open trenches shall conform to the MAG Uniform Standard Specifications, Part 600.

Gravity pipelines shall be laid to the lines and grades indicated on the Plans, and shall be laid upgrade. Where not otherwise indicated on the Plans, all buried lines shall be laid with a minimum of 3-foot cover without air traps or humps. Where two lines of similar services run parallel to each other, they may be laid in the same trench as close together as possible and still provide adequate room for jointing.

Before excavation is started for any run of underground piping, the Contractor shall locate and expose all existing structures, piping, conduit, etc., which intersect the line of the piping, to avoid possible damage to these during excavation operations and so that it may be determined if there will be any conflicts in location. In the event of conflicts in location or grade or both, between new piping and existing piping, the Contractor shall make adjustments in location or grade of new piping acceptable to the Engineer.

Unless otherwise indicated on the Plans or specified, where pipe of any type is to be encased in concrete, the encasement shall provide a minimum of 6 inches of concrete completely around the pipe, shall fill the bottom of the trench from bank to bank, if not formed and shall be reinforced with four continuous longitudinal reinforcing bars, one in each corner of the encasement. concrete shall be Class C. The length of encasement indicated on the Plans, or specified, shall be the minimum length, and the encasement shall terminate at each end at a joint in the pipe. Reinforcing bars shall be No. 4 for encasement of pipe 36 inches and smaller and No. 6 for encasement of pipe larger than 36 inches.

Where buried ductile iron, reinforced concrete, asbestos cement, vitrified clay, or similar rigid pipe enters a structure, it shall be by means of a coupling or wall piece cast into the wall, having a mechanical push-on, or similar flexible joint as specified or indicated on the Plans at the outside face of the wall. An additional similar joint shall be installed in the line at the edge of the structure excavation where the pipe trench leaves undisturbed ground. For steel pipe a single joint may be used located not more than 2 feet from the outside face of the wall.

At the close of the day's work, and at such other times when the pipe is not being laid, all openings in the end of the pipeline shall be closed with an accepted plug.

150021 LAYING OF PIPE AND FITTINGS

In laying pressure pipelines, the deflection in a standard joint shall not exceed the manufacturer's recommendation. Horizontal and vertical deflections of not more than the recommended combined angle, including curves as indicated on the Plans, shall be made by deflections in standard pipe joints within 10 feet of the indicated stations. Five degree beveled joints may be used. Deflections of more than 5 degrees shall require special bends or fittings. Departure from and return to established alignment and grade shall not exceed 1/16 inch per linear foot of pipe and at no point shall the maximum departure from established line and grade be greater than 1 inch.

The laying of all pipe shall be in finished trenches free from water or debris. The joining of pipe sections shall be such as to produce watertight lines. Pipe shall be laid on an unyielding foundation with uniform bearing under the full length of the barrel. If the pipe bears top or bottom markings, it shall be placed with the markings in the proper position. All adjustments to line and grade shall be made by scraping away or filling in under the pipe. Pipe shall not be dropped or pointed to fit grade. If the joints are the type which require external grouting, banding, or pointing, space shall be provided under and immediately in front of the bell end of each section laid of such shape and size as to permit sufficient room for the grouting, banding, or pointing of the joints.

Each section of pipe shall be lowered into the trench, utilizing a sling or other device, in a manner that shall prevent injury to the pipe, coating, lining, or joints. Under ordinary conditions of laying, the work shall be so scheduled that the bell end of the pipe faces in the direction of laying. In placing pipe in the trench, the pipe shall be held by the lowering

device at the balancing point of the section. It shall not be dragged on the bottom of the trench but shall be supported while being fitted into the adjacent section. Supporting the pipe on blocks, or blocking of any nature either temporary or otherwise, will not be allowed.

It is the responsibility of the Contractor, when the pipeline and appurtenances are finally laid, to see that all joints are protected and that any damage to the coating or lining of the pipe and fittings has been adequately repaired or replaced in order to preserve their integrity for corrosion protection.

150025 LAYING OF DUCTILE IRON PIPE

Trenching, bedding, and backfill shall be in accordance with MAG Uniform Standard Specifications, Part 600.

The handling, storage, and installation of ductile iron pipe shall be in accordance with the requirements of these Specifications and AWWA C 600.

150027 LAYING OF PVC PIPE OR CPVC PIPE

Trenching and backfill shall be in accordance with MAG Uniform Standard Specifications, Part 600.

The handling, storage, bedding, and installation of PVC pipe shall be in accordance with the manufacturer's recommendations and ASTM D 2774.

150029 LAYING OF VITRIFIED CLAY PIPE

Trenching, bedding, and backfill shall be in accordance with MAG Uniform Standard Specifications, Part 600.

The handling, storage, and installation of vitrified clay pipe shall be in accordance with the requirements of ASTM C 12.

150030 CLEANING AND TESTING

The interior of all pipelines, above or below grade, shall be thoroughly cleaned of all adhering matter and other debris. No testing of any pipeline shall be started until the cleaning is complete and accepted by the Engineer.

Special precautions required in the cleaning of a particular pipeline shall be as stated in the various parts of this Division of these Specifications.

All pipelines, above or below grade, shall be tested to the pressures indicated in the various parts of this Division of these Specifications. Any piping for which test pressure is not specified shall be tested under a pressure of 25 psi above the operating head.

Pipe underground may be tested before backfilling unless otherwise specified, and pipes to be encased in concrete or under concrete slabs shall be tested before the encasement or slabs are placed.

The Contractor shall furnish all necessary personnel, supplied, equipment, bulkheads, and whatever additional equipment is required to make any and all test specified and shall make any and all repairs, including relaying, if necessary, to any and all pipelines failing to pass the testing requirements of these Specifications.

The Contractor shall give the Engineer a list of the scheduled pipeline tests by noon of the day preceding the scheduled test of tests. the Contractor shall notify the Engineer by written memorandum of his readiness (not just his intention) to test a line or portion of line. All bulkheads, thrust block, anchors, temporary connections, pumps, etc., shall be in place before the Contractor's notification of readiness is given to the Engineer. After testing, all pipes shall be flushed or blown out and left clean.

In testing with water, the test pressure specified shall be the pressure at the lowest point in the piping concerned. In testing with water, the lines shall be examined and any visible leaks repaired. In testing with air, the lines shall be examined and tested with soap suds and any leaks repaired. Testing shall be repeated until the lines are in satisfactory condition.

Despite any previous testing, any leaks developing before the end of the one year guarantee period shall be repaired by the Contractor at no additional expense to the Owner.

150033 LIQUID PIPING TESTS

All liquid piping shall be tested with water at the pressure specified.

150060 PIPING SCHEDULE

Where not specifically noted on the Plans or otherwise specified, pipe shall be installed in accordance with the following schedule.

Pipe listed as "above ground" shall include that within buildings, tunnels, or other structures without regard to its elevation. "Underground" piping shall be taken to mean only that piping actually buried in the soil or cast in concrete masonry. "Underwater" piping shall mean concrete tanks containing water.

The Contractor may, at his expense, furnish piping of the same material as shown in the PIPING SCHEDULE but of greater pressure rating than that specified.

Where bell and spigot joints are indicated on the Plans or specified, mechanical joints or push-on joints may be used.

The Contractor is responsible for furnishing and installing all necessary piping to make all equipment and other parts of the plan functional. Should the type of pipe for a given use be not indicated, the following paragraphs shall serve as a guide with the acceptance of the Engineer in the selection of the proper pipe to use for a given service.

Steel pipe under 4 inches in size shall be galvanized unless otherwise indicated on the Plans.

Sewage piping may be ductile-iron pipe, or vitrified clay pipe.

PIPING SCHEDULE

<u>Use</u>	<u>Piping</u>	<u>Joints/Fittings</u>	<u>Test Pressure</u>
Gravity Sewer	Vitrified clay ASTM C-700	Rubber gasket	20 feet
Pressure Sewer	Ductile iron, Class 50	Mechanical joint, flanged	50 psi
Vent	PVC, Sch. 40	Solvent weld	20 feet
Potable Water	Copper, ASTM B 88	Soldered	125 psi

150070 CONNECTION TO IN-SERVICE LINES

Existing pipe to which connections are to be made shall be exposed by the Contractor to permit field changes in line, grade, or fittings, if necessary.

All connections to existing lines shall be constructed according to the Plans.

When shutdown of an in-service line is necessary in order to connect to the new lines, a conference between the Contractor's representative, the Engineer, and operating supervisory personnel shall establish the time and procedures to insure that the shutdown will be for the shortest possible time. If necessary, shutdowns may be scheduled during other than normal working hours, at no additional cost to the Owner.

150100 DUCTILE-IRON PIPE

Wherever cast-iron pipe is called out on the Plans, or specified herein, ductile-iron pipe shall be used in its place.

Ductile-iron pipe shall conform to the requirements of ANSI A 21.50 and ANSI A 21.51 (AWWA C 150 and AWWA C 151). Ductile-iron pipe fitted with threaded flanges shall conform to ANSI 21.15 (AWWA C 115). Unless indicated otherwise on the Plans, ductile-iron pipe shall be thickness Class 50.

150110 JOINTS

Where so indicated or specified, joints shall be made with flexible couplings or with mechanical coupling for grooved or shouldered end pipe. Unless otherwise noted, joints that are not buried in the ground and those that are indicated on the Plans or in the Specifications to be flanged shall be flanged joints. All other joints shall be mechanically restrained mechanical joints, or mechanically restrained push-on joints. Concrete thrust blocks shall be used only when specifically detailed or accepted by the Engineer. Mechanical joint, or push-on joint pipelines shall have flanges where necessary for valves and cleanout connections.

150111 FLANGED JOINTS

Flanges may be cast integrally with the pipe, in which case they shall conform to ANSI B 16.1 as to diameter, thickness, drilling, etc., or they may be screwed on the threaded ends of the pipe. Screwed-on flanges shall conform to ANSI B 16.1 as to material, diameter, thickness, drilling, etc., but shall have long hubs threaded specially for ductile-iron pipe. Screwed-on flanges shall be attached to the pipe by the pipe manufacturer, and after attachment the faces of the flanges and the ends of the pipe shall be refaced so that the end of the pipe will be even with the face of the flange and both will be perpendicular to the axis of the pipe. Bolt holes on the 2 flanges on a piece of pipe shall be in perfect alignment. Bolts shall conform to ANSI B 16.1 except that flanges underground, in concrete valve boxes, or in water may be cast-iron bolts and nuts, and all bolts and nuts under these conditions shall be painted with an asphaltic coating as specified in AWWA C 104, of at least 10 mils thickness.

Cast-iron bolts and nuts shall be made of material having at least 50,000 psi tensile strength. The cast-iron bolts used with mechanical joints will be acceptable.

Where cap screws or stud bolts are required, flanges shall be provided with tapped holes for such cap screws or stud bolts.

All flange bolts shall be cut and finished to project not less than two threads, and not more than 1/4-inch beyond outside face of nut after joint is assembled.

Where indicated on the Plans, buried flanged joints shall be polyethylene encased in accordance with MAG Section 610.5, Polyethylene Corrosion.

150112 MECHANICAL JOINTS

Mechanical joints shall be in accordance with ANSI A 21.11 (AWWA C 111).

150120 FITTINGS

Except as otherwise provided, fittings for ductile-iron pipe shall be as specified in ANSI A 21.10 (AWWA C 110), of the same pressure rating as the pipe with which they are used.

150130 LINING AND COATING

Section 150130 - Lining for Ductile Iron Pipe for Sanitary Sewer Lines

Coal Tar Epoxy Lining:

Coal tar epoxy lining compound must be a catalyzed two-component coal tar epoxy compound capable of a least 40 mils dry film thickness in an application process whereby delamination will not occur. The material must also meet the following minimum performance requirements:

- a. A direct impact resistance as measured by ASTM D 2794 at 35 mils dry film thickness on ductile iron panels. The material shall pass 60 inch-pounds of impact.
- b. An abrasion resistance of 25 liters of sand per mil as measured by ASTM D 968.

c. The coal tar epoxy used shall meet the requirements of Military Specification DOD-P-23236A (SH), Type I, Class 2.

All coal tar epoxy lining shall be done by the pipe manufacturer at the location of manufacture of the pipe, or by a qualified applicator selected and inspected by the pipe manufacturer to do the lining. In the latter case, the applicator may do the coal tar epoxy lining at his place of business and shall have a five-year history of doing this particular type of lining for ductile iron or steel pipe.

The pipe manufacturer shall be solely responsible for both the quality of the pipe and the quality of the lining.

All surface areas which will be exposed to sewer liquids and/or gases shall be cleaned so as to remove all deleterious materials. After cleaning, the lining compound shall be applied to all surface areas which will be exposed to the sewer liquids and/or gases. The lining compound shall be applied so as to obtain a continuous and relatively uniform and smooth integral lining.

The lining in the barrel area shall have a nominal thickness of 40 mils and a minimum thickness of 35 mils. However, the lining in the bell area may transition from a 35 mil minimum thickness at the edge of the barrel area to a 10 mil minimum thickness at the edge of the gasket socket. The 10 mil lining shall extend into the gasket socket area to a point where the gasket would overlap the lining when it is compressed due to pipe assembly during construction. The 10 mil lining shall also continue from inside the barrel area, around the spigot end of the pipe and along the outside of the pipe to a point where the center of the gasket of the next pipe section would contact the edge of the lining on the spigot end of the previous pipe section. This is a minimum requirement. The thickness of linings shall be determined by using a dry film thickness magnetic gauge at four quadrants.

Because of the extremely rough profile of ductile iron pipe and to insure adequate protection, the amount of material required to achieve the desired film thickness shall be calculated and that amount shall be applied to the surface.

Lining material must pass the following immersion tests (35 mil minimum dry film thickness) without disintegration, blistering, or cracking:

<u>Test</u>	<u>Temperature</u>	<u>Duration Hours</u>	
		<u>Polyethylene</u>	<u>Coal Tar Epoxy</u>
10% Sulfuric Acid	70 F	432	2,160
36% Hydrochloric Acid	70 F	720	432
3% Sulfuric Acid	112 F	---	384
25% Sodium Hydroxide	112 F	---	1,560

Each piece of pipe shall be tested and shall have an absence of holidays when tested by a suitable holiday detector. In all cases, the barrel area of the pipe shall be tested using both a voltage of 7500 volts and a dry conductive probe.

Where coal tar epoxy is used in the bell area or on the exterior of the spigot end, that area shall be tested using both a voltage of 67.5 volts and wet sponge.

The pipe manufacturer shall issue a certification that states that the lining meets the Specifications. This certification shall state specifically the following items:

- a. All ductile iron pipe and fittings have a coal tar epoxy interior lining of 40 mils (35 mils minimum) in the barrel area, 10 mils minimum in the bell area and 10 mils minimum on the exterior of the spigot end.
- b. Each piece of pipe and each fitting have been checked for holidays utilizing a testing voltage of 7500 volts with a dry conductive probe in the barrel area and a testing voltage of 67 1/2 volts with a wet sponge in both the bell area and the exterior of the spigot end, and no holidays were found.
- c. The coal tar epoxy lining shall extend from the bottom of the gasket socket in the bell to a point on the exterior of the spigot end of the pipe where the next pipe gasket would overlap the lining.
- d. All coal tar epoxy used meets the current Specifications.

When pipe is supplied that cannot meet the certification requirements for holiday testing and minimum lining thickness in the bell area or on the exterior of the spigot end, neoprene caulking will be required when the pieces of pipe are assembled during construction.

This caulking must be applied in sufficient quantity and at the proper location such that when the spigot end of the pipe is inserted into the bell end of another pipe, an impermeable seal is developed between the spigot end of one pipe section and the barrel to bell transition point of the other pipe section. The use of caulking is only a substitute for certification requirements must be complied with. It should also be noted that the Engineer may require the use of neoprene caulking during construction of all ductile iron pipe when deemed appropriate.

If the Contractor makes a field cut of coal tar epoxy lined pipe, he shall comply with the recommendations of the pipe manufacturer in applying a coal tar epoxy coating to the pipe end and in allowing proper drying time before pipe assembly. In all cases, as a minimum, a 10 mil coating of coal tar epoxy shall be applied to the pipe end and shall overlap the coal tar epoxy lining by four inches and extend around the end of the pipe and along the outside of the pipe a minimum of ten inches. the coating shall be allowed to dry before assembly. In addition, the overlapped surface of the coal tar epoxy lining shall be roughed up to produce a 3 to 5 mil profile over the entire surface. The end result of this process is to secure proper adhesion for the coal tar epoxy.

Holiday testing may be required by the Engineer after pipe assembly when deemed appropriate. The testing and repair requirements shall follow the procedures called for in these specifications.

Repair:

Repair of the damaged section of the coal tar epoxy lining shall be in accordance with the lining manufacturer's recommendations or as specified above so that the repaired area is equal to the undamaged lined area in all respects. All damaged lined areas and holidays shall be repaired immediately.

There will be no other provisions for repair of ductile iron pipe.

150140 HANDLING OF PIPE AND FITTINGS

All ductile-iron pipe shall be carefully handled during loading, unloading, and installation. No pipe shall be dropped from cars or truck to the ground. All pipe shall be carefully lowered to the ground by mechanical means. In shipping, pipe and fittings shall be blocked in such manner as to prevent damage to castings or cement lining. Any broken or chipped lining shall be carefully patched. Where it is impossible to repair broken or damaged lining in pipe because of its size, the pipe shall be rejected as unfit for use.

All mechanical joint pipe shall be laid with 1/8-inch space between the spigot and shoulder of the pocket.

150160 CORROSION PROTECTION

Ductile-iron pipe buried in soil shall be protected against external corrosion by loose polyethylene sleeves in accordance with AWWA C 105.

150170 TESTING

All pipelines for which testing is not otherwise specified shall be tested for watertightness by subjecting each section to Hydrostatic Pressure and leakage Tests in accordance with applicable provisions of AWWA C 600, except as modified below. The Contractor shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pump, measuring device, and all other equipment necessary for making the tests, except pressure gauges. the Owner will furnish the water required for the first test, if more than one test is required, the Contractor shall pay for the water required to make additional tests. Each section of a new line between sectionalizing valves or between the last sectionalizing valve and the end of the project shall be tested separately as required in AWWA C 600, and/or as modified in these Specifications, except that any such section less than 500 feet in length may be tested with the adjacent section if both sections of line have the same pipe class rating. The duration of each test shall be at least 2 hours.

150171 PRESSURE TEST

All pipelines shall be tested by subjecting each section to a pressure, measured at the lowest end of the section, of at least 125 percent of the class rating or design pressure of pipe under test.

The test may be made before or after backfilling. however, if mechanical compaction is to be used in the backfilling operations as spelled out in AWWA C 600, the test shall not be made until the backfilling is completed and compacted. All connections, blowoffs, hydrants, and valves shall be tested with the main as far as is practicable.

The test section shall be slowly filled with potable water, and all air shall be vented from the line. the rate of filling shall be as acceptable to the Engineer, with at least 24-hour notice required before tests are scheduled. While the test section is under test pressure, a visual inspection for leaks shall be made along the pipeline, and all visible leaks repaired. The pressure test shall not begin until the pipe has been filled with water for at least 24 hours to allow for absorption.

See Section 150060, PIPING SCHEDULE, for test pressures.

150172 LEAKAGE TEST

Leakage test shall be made after pressure test has been satisfactorily completed and all backfilling and compaction is completed to top of trench. the Contractor shall furnish the necessary apparatus, and assistance to conduct the test.

To pass the leakage test, the leakage from the pipeline shall not exceed the leakage allowed by the following formula:

$$L = \frac{ND(P)^{0.5}}{4500}$$

in which L = allowable leakage in gallons per hour.

N = number of joints in the pipeline being tested, this "N" being the standard length of the pipe furnished divided into the length being tested, with no allowances for joints at branches, blowoff, fittings, etc.

D = nominal diameter of pipe in inches.

P = average observed test pressure of the pipe being tested equal to at least 100 percent of the class rating of pipe being tested, in pounds per square inch gauge, based on the elevation of the lowest point in the line or section under test and corrected to the elevation of the test gauge.

Should the test on any section of the pipeline show leakage greater than specified above, the Contractor shall locate and repair the defective pipe, fittings, or joint until the leakage is within the specified allowance of 2-hour duration. All repairs and retests, if required, shall be made without additional cost to the Owner.

Connections to the existing pipelines or existing valves shall not be made until after that section of the new construction has satisfactorily passed the hydrostatic tests.

150800 COPPER PIPE AND TUBING

Except as otherwise specified or indicated on the Plans, copper pipe and tubing shall be as follows: copper pipe for the conveyance of water or as aqueous solutions shall conform to the requirements of ASTM B 88 as detailed below.

Copper lines shall be neatly supported as indicated on the Plans or at such intervals as to prevent sagging. Tube shall be cut square with hacksaw or disc cutter and shall be reamed full size and burrs removed. If necessary, a sizing tool shall be used to correct any distortion. The outside surface of the end of the pipe and the inside surface of solder fittings shall be cleaned with steel wool until the metal is bright. Soldering flux shall be applied to the cleaned surfaces of pipe and fittings in a thin, uniform, complete coating. After the pipe has been inserted in the fitting as far as it will go, the fitting shall be twisted on the pipe to help spread the flux uniformly. The fitting shall be heated until it reaches the correct temperature to melt the solder. the flame shall then be removed and the solder

applied to the edge of the fitting or to the solder hole in the fitting, if there is one, and the joint completely filled with solder. When the solder has congealed to a plastic state, the excess metal shall be removed with a cloth or brush. Joints shall not be quenched after soldering.

All copper lines shall be cleaned with high-pressure air after first disconnecting piping at instruments, filters, pressure reducers, valve operators, and other special devices.

All copper lines shall be tested in the same manner as the piping system to which they connect.

150810 ASTM B 88 TUBING

All exposed copper pipe or tubing conforming to ASTM B88 shall be Type L hard-drawn, rigid, seamless copper water tubing.

Copper tubing buried in the ground or in plastic conduit shall conform to the same specification but shall be Type K soft-annealed.

Fittings shall be Hoke "Gyrolok," Crawford Fitting Company "Swagelok," or equal, or solder type forged or wrought copper. Solder shall be ASTM B 32, Alloy Grade 5A.

Copper pipe connected to ferrous pipe or valves, or other non-copper items shall be connected by means of dielectric insulating unions or fittings.

When making connections to meters or other devices having iron pipe size threaded fittings, special thread to tube adapters shall be used. Such adapters shall be Crawford Fitting Company "Swagelok," Hoke "Gyrolok," or equal.

150830 INSTALLATION

Copper tubing shall be installed in neat, straight runs, supported at close enough intervals to avoid sagging. All details indicated on the Plans shall be followed.

Cuts shall be made with a tubing cutter, or with a 32-tooth hacksaw, and shall be square. The inside of the tube shall be reamed and burrs removed from the outside, holding the end of the tubing downward during these operations so chips or filing cannot fall into the tubing. Flaring shall be done with a flare block and yoke type screw feed flaring tool. After removing the tubing from the block, both surfaces of the flare shall be inspected for splits, cracks, or other imperfections; and if there are any imperfections, the imperfect flare shall not be used. In assembling the fittings, all contacting surfaces shall be thoroughly clean. Tubing shall not be sprung into place, and connection shall seat freely before sleeve nuts are tightened.

Copper tubing connected to meters, etc. shall be carefully graded in one direction. All lines shall be left clean.

151800 PLASTIC PIPE, TUBING, AND FITTINGS

Except as otherwise specified herein, or indicated on the Plans, plastic pipe, tubing, and fittings shall be as follows:

Extruding and molding material shall be virgin material containing no scrap, regrind, or rework material except that, where permitted in the referenced standard specifications, clean rework material generated from the manufacturer's own operations may be used as long as the end product meets the requirements of this Specifications. Pipe and tubing, except for drainage pipe, shall meet the requirements of the National Sanitation Foundation Testing Laboratories Inc. and shall bear the "nSf" seal.

All plastic pipe delivered to the jobsite shall be plainly marked as to nominal pipe or tubing size, type, class, schedule or pressure rating, and manufacturer.

Fittings shall be of the same material as the pipe and of equal or greater pressure rating, except that drainage waste and vent (DWV) fittings need not be pressure rated; and all fittings shall conform to the appropriate ASTM Specification. In general, fittings for rigid pipe shall be socket type for solvent or fusion welding, and fittings for nonrigid pipe shall be insert or flare fittings as specified or acceptable to the Engineer.

Transitions from plastic to metal of IPS pipe shall be by molded transition fittings, not by threading the plastic pipe. Unions 2-1/2 inches in diameter and smaller shall be socket end screwed unions, and unions 3 inches and over shall be made up of socket flanges with 1/8-inch full face soft rubber gasket. Unions shall be located where indicated on the Plans and elsewhere as directed by the Engineer for adequate access to the piping system for inspection and cleaning.

152100 PIPING SPECIALTIES

The Contractor shall furnish and install, wherever shown on the Plans, as called for in these Specifications, or as required for proper operation of equipment, all items specified under this heading including gaskets, bolts, calking materials, handers, supports, guides, anchors, and such incidental materials and equipment as are required to make the items complete and ready for use.

152110 FLEXIBLE PIPE COUPLINGS

Where shown on the Plans or specified, or elsewhere as approved by the Engineer for the Contractor's convenience, flexible coupling shall be furnished and installed.

Flexible coupling shall be galvanized when on galvanized pipe or on pipe which is epoxy or cement lines, or when underground. When flexible type couplings are used as expansion joints, the ends of the pipe shall be separated to allow for expansion.

For cast-iron pipes, flexible couplings shall be Dresser; Smith-Blair; Baker; or equal.

For steel pipes, flexible couplings shall be Dresser Style 38; Smith-Blair 411; or equal, except where other styles are required for special conditions. Where indicated on the Plans, flexible couplings shall be suitable for connecting pipes which have different outside diameters.

Flanged coupling adapters shall have not less than two (2) anchor studs each.

Where flexible couplings are installed underground, Type 316 stainless steel bolts shall be used. the entire coupling shall be given a 20-mil coat of T.C. Mastic as manufactured by the Tape Coat Company, Inc.; Vitumastic No. 50 as manufactured by Koppers Company, Inc; or equal.

Grooved-end couplings, to be used where indicated on the Plans, shall be as manufactured by Victaulic Company of America, Gustin-Bacon Group, or equal. Bictaulic couplings for cast-iron pipe shall be Style 31. Couplings for steel pipe shall be Style 77. Gustin-Bacon Group couplings shall be as recommended by the manufacturer for the type of pipe. Adapter bands shall be welded to the ends of the steel pipe as necessary to permit proper installation of couplings.

Gaskets for all couplings shall be neoprene rubber, or equal.

152130 EXPANSION AND VIBRATION CONTROL

Piping shall be installed in such a manner that equipment vibration will not be transmitted through the piping system and normal expansion and contraction with temperature changes will not induce damaging stresses in the piping or connected equipment. Where anticipated expansion is greater than can be absorbed by the normal piping configuration, provision shall be made as indicated on the Plans by loops, bends, and expansion joints to absorb the excess.

Care shall be taken in packing, shipping, and installing expansion joints to prevent damage to joint bellows of sliding surfaces. Care shall also be taken against damaging joints during pressure test. Expansion joints shall be locked against movement in any direction until the pressure test is completed.

Any visible damage to an expansion joint, whatsoever, shall be sufficient cause for the Engineer to reject said joint. A rejected joint shall be replaced with a like joint in a new and undamaged condition at no extra cost to the Owner.

152134 RUBBER EXPANSION JOINTS

Rubber expansion joints shall be installed where shown on the Plans and as specified herein. Expansion joints shall be made of neoprene rubber and complete with control units and galvanized steel split retaining rings. Expansion joints shall be suitable for a working pressure of 125 psi. Expansion joints in pump suction piping and where required shall be suitable for a working pressure of 90 psi and 30 inches Hg vacuum. The rubber material shall be reinforced with imbedded steel rings and a strong synthetic fabric. Expansion joints shall have flanged ends with drilling to match that of piping.

Expansion joints shall be Mercer Rubber Company, Style 500 or 700; Red Valve Company Inc., Type J-1; equivalent U.S. Rubber Company or Belmont; or equal.

152617 DRAINAGE

Floor drainage system shall be furnished and installed as indicated on the Plans. Floor drain piping shall be extra-heavy cast-iron soil pipe with extra-heavy cast-iron solid pipe fittings.

152618 EQUIPMENT AND FLOOR DRAINS

Equipment drains shall be Zurn Z-317-1, Josam 300-E2 combination drip drain, less clamping collar, or equal, with adjustable strainer head, floor level grate, and 6-inch diameter funnel extension and shall have inside caulking outlet and nickel bronze top. All other floor drains shall be Zurn Z-215, Josam 30000A universal floor drain with adjustable strainer, less clamping collar, or equal, and shall have inside caulking outlet and nickel bronze type A strainer. Sizes of equipment drains and of floor drains shall be as indicated on the Plans. Strainers with 3-inch drains shall be 6-inch diameter, and strainers with 4-inch drains shall be 8-inch diameter.

153000 VALVES

The contractor shall furnish all valves where indicated on the Plans, as called for in these Specifications, or as required for proper operation of the equipment in general. Unless otherwise indicated on the Plans or specified in other sections of these Specifications, valves shall conform to the requirements as specified herein

All valves installed in a given line shall be designed to withstand the test pressure for that particular line and shall be fabricated with ends to fit the piping.

Valves shall be manufactured by a manufacturer whose valves have had successful operational experience in comparable service.

The valve manufacturer shall furnish detailed technical information as required by the Engineer for evaluating the quality of the valves and as required by the Contractor for proper valve installation. The technical information shall include complete dimensions, weights, and material lists. No valve will be accepted for installation until the required information has been received and reviewed.

The Contractor shall furnish four sets of complete installation operation and maintenance instructions for each type of valve furnished. Instructions shall be bound in a cover.

Wherever stainless steel is specified in this section, it shall be AISI Type 316, or 304 unless otherwise specified.

Bolts shall conform to ANSI B 16.1 except that underground, in concrete valve boxes, or in water may be cast-iron bolts and nuts, and all bolts and nuts under these conditions shall be painted with an asphaltic coating as specified in AWWA C 104, of at least 10 mils thickness. Cast-iron bolts and nuts shall be made of material having at least 50,000 psi tensile strength. The cast-iron bolts used with mechanical joints will be acceptable.

The zinc content of bronze or brass used in any valve parts shall not exceed 6 percent. The aluminum content of bronze shall not exceed 2 percent.

The method of connection of valves to each piping system shall be as detailed on the Plans. In general, unless otherwise indicated on the Plans or specified, all valves 3-inch size and larger shall have flanged ends and shall be designed for bolting to flanged pipe, and all valves less than 3-inch size shall have screwed ends.

The Contractor shall furnish to the pipe supplier, after flanged valves and flanged check valves are selected, the face-to-face dimensions of all flanged valves and check valves to be installed in flanged pipelines so that the pipe may be fabricated to the proper length.

Where proper operation and utilization of equipment and facilities requires installation of valves not indicated or specified, the Contractor shall provide and install, upon acceptance by the Engineer, valves similar and comparable to valves specified for similar and comparable duty in other parts of the project, without additional cost to the Owner.

153010 INSTALLATION OF VALVES

The Contractor shall furnish all labor, materials, and equipment necessary to install the valves complete in place at the locations indicated on the Plans in accordance with the details and these Specifications.

The Contractor shall furnish all incidental materials necessary for installation of the valves such as flange gaskets, flange bolts and nuts, valve boxes and covers, and all other materials required for the complete installation.

The Contractor shall provide the necessary concrete bases or supports and blocking to support the valves installed.

Manually operated valves shall be provided with tee handles, wrenches or handwheels as appropriate or as indicated on the Plans. Valves shall be installed in all cases so that handles clear all obstructions when moved from full-open to full-closed position.

153300 ECCENTRIC PLUG VALVES

Plug valves, unless otherwise specified or indicated on the Plans, shall be nonlubricated eccentric plug valves. Valves shall be equipped with a lever operator for valves of 4-inch size and smaller and with a worm gear operator for valves of 6-inch size and larger. Each valve shall be furnished with an operating wrench or worm gear operator.

Eccentric plug valves shall be semi-steel, (ASTM 126, Class B) eccentric type with neoprene or Buna N faced plug. The body seats in all valves of 3-inch size and larger shall have an overlay of not less than 90 percent nickel and all surfaces contacting the plug gate. The stem bearing and bottom bearing shall be of stainless steel material. All internal parts except the body and plug shall be 300 Series stainless steel, Monel, or nickel.

Eccentric plug valves shall be designed and constructed for 150 psi working pressure. Eccentric plug valves shall be Dezurik, Homestead "Ballcentric", Dresser X-Centric, or equal.

Eccentric plug valves shall have ends as required by the piping details as indicated on the Plans. Plug valves in screwed pipelines may be screwed or flanged at the Contractor's option. The resilient face of the plug shall be of material which will operate satisfactorily at a temperature of 185 degrees F continuous and 215 degrees F intermittent for all valves. Valves shall be clearly marked to indicate their open and closed positions.

153400 CHECK VALVES

Except as otherwise specified, shown on the Plans, or approved by the Engineer, check valves shall be as follows: Check valves shall be for 125 pound or better service suitable for operation in either horizontal or vertical position.

153410 SWING CHECK VALVES

Swing check valves shall be of sizes indicated on the Plans and of a pressure rating as specified below. All check valves shall be designed for operation in either horizontal or vertical position.

Check valves 2-1/2 inches in size and smaller shall be 200 pound, Y-pattern, bronze, regrinding, swing check valves with screwed ends, Crane No. 36; Kennedy Figure No. 444; or equal, except check valves in welded steel pipes shall be 150 pound flanged Crane No. 38, Lunkenheimer No. 596; or equal.

Check valves 3 inches in size and larger shall be iron body, bronze mounted, flanged-end, swing check valves, special Mueller A-2600 as manufactured by Mueller Company; H341 and H342 Ludlow-Rensselaer as manufactured by Patterson-Ludlow Division of Benner Industries Inc. with no parts made of brass or bronze containing over 6 percent zinc and no aluminum, and rated at 175 pounds per square inch, or equal. Hinge pins shall be stainless steel. Valves shall be equipped with outside lever and weight. The lever and weight shall be so constructed and so positioned that it can operate without interference by any piping, supports, or equipment.

153440 BACKFLOW PREVENTERS

Backflow preventers shall be furnished and installed where indicated on the Plans. The backflow preventers shall be reduced pressure chamber type Clayton RP as manufactured by Cla-Val Co., Newport Beach, California; Beeco 6-C as manufactured by Hersey Products Inc., or equal.

153700 HOSE VALVES

Where hose valves, other than fire hydrants or fire hose valves, are shown on the Plans or specified, they shall be as follows, or equals. Inlets shall be iron pipe thread and outlets shall be American National 1-inch straight hose thread. Nonfreeze box hydrants (street washers) and yard or post hydrants shall be set over a gravel filled drainage pocket not less than 2 cubic feet in volume. All hose valves except street washers shall have integral or nozzle type vacuum breakers.

153710 PLAIN HOSE VALVES

Hose valves not otherwise designated shall be Jenkins Figure 112, Crane No. 58, or equal angle hose valves. For yard hydrants they shall be mounted on 1-inch IPS risers with concrete splash blocks as detailed on the Plans. Each valve shall be provided with a nozzle type vacuum breaker.

154500 VALVE AND GATE OPERATORS

All valve operators other than T-wrenches or keys, and portable operators intended for operating more than one valve, or type of valve, shall be furnished by the valve or gate manufacturer as an integral part of the valve or gate. All similar operators shall be of one manufacturer.

All other operators shall have a means of determining the valve position. These may be tail rods on hydraulic cylinders, dial indicators calibrated in number of turns or percentage of opening, or other means acceptable to the Engineer. Dial indicators shall have the full-open and full-close positions clearly indicated.

All manual or power operators shall be sized to deliver the maximum force that may be required under the most severe specified operating conditions including static and dynamic forces, seat and wedge friction, seating and unseating forces, etc., with a safety factor of 5 unless otherwise specified. All operators shall be capable of supporting the weight of any suspended shafting unless such shafting is carried by bottom thrust bearings. Shaft guides with wall mounting brackets shall be furnished and installed as required.

Where specified or indicated, crank or handwheel operated geared valve operators or lifts, shall be positioned and equipped for alternate operation by means of a tripod mounted portable gate operator.

Operators for all valves and gates shall turn counterclockwise to open and shall have an arrow and legend so indicating cast on the handwheel or chain wheel rim, crank, or other prominent place on the operator. All operators shall have suitable and adequate stops, capable of resisting at least twice the normal operating force, to prevent overrun of the valve or gate in open or closed position.

Gearing on worm gear operators shall be self-locking, and the gear ratio shall be such that a torque in excess of 160 foot pounds will not have to be applied to operate the valve at the most adverse conditions for which the valve is designed.

Traveling nut operator shall be designed such that a torque in excess of 100 foot pounds will not have to be applied to operate the valve at the most adverse condition for which the valve is designed. Limit stops shall be installed on the input shaft of all manual operators in the OPEN and CLOSED positions. The vertical axis of the operating nut shall not move as the valve is opened or closed.

154530 GEARED VALVE OPERATORS

All manually operated plug valves 6 inches and larger shall be provided with geared operators. These operators shall be mounted on the valves at the factory. Valves shall have handwheel operators. Operator shall have cut gears, either spur or worm, and shall be sized to operate the valve at the most adverse design condition with a pull at the handwheel of not more than 40 pounds.

154600 PIPE HANGERS AND SUPPORTS

The Plans do not, in all cases, show where or how pipe is supported; however, it is intended that all pipe and fittings shall be properly supported, suspended, or anchored as required to prevent sagging, overstressing, or longitudinal movement of certain piping, and to prevent thrusts or loads on or against pumps, meters, and other equipment.

Exposed piping shall be supported at the base of all risers, at intervals not to exceed 5 feet on all horizontal runs of pipe 2 inches and smaller, and at intervals not to exceed 10 feet on all horizontal runs of pipe larger than 2 inches. Piping 4 inches and larger through fill, backfill, or disturbed ground shall be supported at intervals not to exceed 10 feet with supports as detailed on the Plans. Plastic pipe and tubing, copper pipe and tubing, and rubber hose and tubing shall be supported at close enough intervals to prevent noticeable sagging, or shall be carried in trays.

All elbows to be supported from the floor shall be furnished and installed as base elbows, whether so indicated on the Plans or not. Supports for the base fittings shall be adjustable metal supports or concrete piers as indicated on the Plans. Rise clamps shall be Elcen Figure 29, Grinnel Figure 261, or equal.

Plastic pipe valves, and headers shall be securely anchored to prevent any apparent movement during operation of valves. Plastic pipe shall be anchored between expansion loops and/or direction changes to provide for uniform expansion. Anchors and supports shall be in accordance with the manufacturer's published instructions

Concrete pipe supports shall be cast where indicated on the Plans. Vertical corners shall be neatly chamfered. As a minimum of cradling, the concrete shall extend 1.4 of the pipe diameter above the pipe invert and at least 6 inches along the pipe shell.

hanger rods, supports, clamps, anchors, expansion joints, brackets, and guides shall conform to the requirements of ANSI B 31.1 and the MSS Standard practice SP-58 and SP-69; and shall be sized in accordance with the manufacturer's recommendation, or as indicated on the Plans.

Supports, clamps, clevises, brackets, or any devices bearing against copper pipe shall be copper plated, copper throughout, or insulated, except trays which shall be galvanized.

Where concrete supports are used under piping, the supports shall be poured 1 inch low, then the next day or later, the pipe grouted in place with nonshrink grout. Nonshrink grout shall be used under floor flanges to give level bearing. Floor flanges shall be bolted to the floor with at least 2 bolts, of as indicated on the Plans.

Special details are indicated on the Plans for special supports for heavy pipe and specials. Such supports shall be of heavy or sturdy design to carry the loads imposed thereon.

No use shall be made of chains, plumbers' straps, wire, or other such devices for suspending, supporting, or clamping pipe of any size or type.

The Contractor shall submit to the Engineer, for review and acceptance, a schedule of hanger, support, and guide types and where they will be used prior to his assembling of any exposed piping.

154610 ANCHOR BOLTS AND INSERTS

Anchor bolts and concrete anchors shall be in accordance with Section 500 of MAG Standard Specifications.

Where indicated on the Plans, continuous concrete inserts, Unistrut Series P3200, or Elcen "Speed Strut" Figure 1150 of the lengths indicated of specified shall be furnished and installed. Where not otherwise indicated or specified, inserts in concrete ceilings and beam soffits may be malleable iron inserts, Grinnel Figure 152 or 282; Bergen-Patterson Part 108; Unistrut Series P3200; or equal. Wall and side beam inserts shall Unistrut Series P3200, Elcen "Speed Strut" Figure 1150, or equal.

Support members shall be Unistrut Series P-1000, Elcen "Speed Strut" Figure 600, or equal.

Brackets shall be brackets of the model number as called for on the Plans, and made from Unistrut Series P-1000, Elcen "Speed Strut" Figure 600, or equal.

Under no circumstances will the use of Slugin or similar anchors relying on the deformation of a lead alloy or similar element for their holding power be permitted.

With the Engineers written permission powder driven studs may be used for the securing of conduit and small pipe to structural metal, but their use will not be permitted in concrete, masonry, and similar materials.

154900 PAYMENT

Payment for work under this section, contained entirely within the pump station compound (including 6 in. DIP force main and fittings within 5 feet of the pump station), will be made at the lump sum bid for Item 1500-1 Piping, Valves, and Specialties.

Payment for force main more than 5 feet outside of pump station compound will be made per Section 615.

DIVISION 16 - ELECTRICAL

16010 GENERAL REQUIREMENTS

GENERAL PROVISIONS

Minimum sizes of equipment, electric devices, etc., are indicated but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that may be encountered during the installation of the work.

All work indicated on the Plans is approximately to scale, but actual dimensions and detailed drawings should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is directed since actual locations, distances, levels, etc., will be governed by field conditions.

Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for a decision.

CONSTRUCTION SPECIAL PROVISIONS

The alignment of equipment and conduit shall be varied due to architectural changes, or to avoid work of other trades, without extra expense to the Owner.

The Contractor shall furnish and install all parts and pieces necessary to the installation of equipment in accordance with the best practice of the trade and in conformance with the requirements of these Contract Documents.

All items not specifically mentioned in these Contract Documents or noted on the Plans or accepted shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

The Contractor shall lay out and install electrical work prior to placing floors and walls. He shall furnish and install all sleeves and openings through floors and walls required for passage of all conduits. Sleeves shall be rigidly supported and suitably packed or sealed to prevent ingress of wet concrete.

The Contractor shall furnish and install all inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, sleeves, etc., are improperly placed or installed, the Contractor shall do all necessary work, at his own expense, to rectify the errors.

All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 50 degrees C, and specifically rated for an altitude of 1,200 feet.

The Contractor shall submit shop drawings, data and details to the Engineer on all controls, fixtures, wiring, electrical equipment, conduit, etc., for review and acceptance prior to use of any components in the work.

SUMMARY

Furnish all materials, equipment, labor and services required for the installation of all electrical work and as required to provide a complete and operable electric system as indicated by drawings and/or specified herein, including but not limited to the following:

<u>SUBJECT</u>	<u>SECTION</u>
Boxes and fittings.....	160500
Cabinets	160500
Conductors.....	160500
Conduit and Raceways	161100
Distribution Equipment	164000
Distribution Panels.....	164000
Dry Type Transformers	164000
Electric and Telephone Utilities.....	160100
Fuses	164000
Grounding.....	164000
Lighting	165000
Lighting Controls.....	165000
Motor Control Centers.....	164000
Panelboards.....	164000

Safety Disconnect Switches.....	164000
Standby Electric Generating System.....	166270
Switches and Receptacles	160500
Temporary Power.....	160100
Testing.....	169500
Wiring Devices.....	160500

Incidental items not indicated on drawings, nor mentioned in specifications that can legitimately and reasonably be inferred to belong to the work described or be necessary in good practice to provide a complete system, shall be furnished and installed as though itemized here in every detail.

Service

The Contractor shall provide and install conduit wire and electrical service metering equipment in accordance with APS's requirements and as indicated on the Plans for 240 volts, 3 phase electrical supply.

Temporary Power

The Contractor shall furnish, install and maintain all temporary power and lighting systems needed for construction. This temporary system shall include weatherproof panel(s) for the Contractor's main breakers and distribution system. Ground fault interrupting equipment shall be installed. All connections shall be watertight utilizing Type SO portable cable. The Contractor shall remove all temporary power equipment and devices after construction is completed.

Related Work Specified Elsewhere

Administrative procedures governing the work of Division 16 - Electrical: MAG Section 100 - General Requirements.

Power Distribution and Feeders

Provide trenching and backfill, primary and secondary conduit(s), cable tray, junction or pull box(es) and transformer vault equipment pad(s), etc., as indicated and/or required by drawings and specifications in strict accordance with these documents.

Codes, Permits and Fees

Comply with all applicable laws, ordinances, rules, regulations, codes, or rulings of governmental units having jurisdiction as well as standards of the National Fire Protection Association.

Contractor shall obtain and pay for permits, fees, inspections, meters, utility connections and extensions and the like associated with work in each section of Division 16.

Installation procedure, methods, and conditions shall comply with the latest requirements of the National Electrical Safety Code, Federal Occupational Safety and Health Act (OSHA). All work must be inspected and approved by facilities electrical engineer and foreman.

Examination Of Premises

Examine the construction drawings and premises prior to bidding. No allowances will be made for not being knowledgeable of existing conditions.

Standards

The following standard publications of the latest editions and supplements thereto shall form a part of these specifications. All electrical work must, at a minimum, be in accordance with these standards:

- Institute Of Electrical And Electronic Engineers (IEEE)
- State Of Arizona Fire Code
- National Fire Protection Association Standards (NFPA)
- Underwriters' Laboratories, Inc. (UL)
- Certified Ballast Manufacturers Association (CBM)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NEC)
- American Society For Testing And Materials (ASTM)
- Insulated Cable Engineers Association (ICEA)
- National Electrical Contractors Association (NECA)

Guarantee

The Contractor shall guarantee all material furnished by him and all workmanship under this contract for a period of one year from the date of final acceptance of work under this contract. Any defects developing within this period traceable to materials furnished as a part of this contract or workmanship performed hereunder shall be made good at the Contractor's own expense. The Contractor shall accept this condition and fully understand its provisions prior to this contract being awarded and no claim for extra compensation will be allowed for correcting faulty work or replacing defective material.

Materials

All materials shall be new and in good condition, the product of substantially established and recognized manufacturers, and subject to approval of the Engineer. All materials shall comply with applicable code and standard provisions as stated in each particular section, and where applicable, shall comply with power company specifications and local codes. Replace or repair any nonconforming, damaged items at no extra cost to the Owner.

Perform all labor in a thorough and workmanlike manner to the satisfaction of the Owner. Contractor shall staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. Superintendent must be qualified to supervise all of the work of this section.

Materials provided under the contract for which the UL label is not normally available shall be mounted in separate enclosures and wired to the labeled units in an acceptable manner.

Alternate Materials and Equipment

Should the Electrical Contractor desire to furnish equipment which he considers equal to that specified, he shall submit samples of this equipment to the Engineer for written approval prior to any action with a written statement explaining the reason for substitution and stating the net dollar credit or extra cost to the Owner.

Approval Of Materials & Equipment

Refer to Instructions to Bidders, for description of material and equipment approvals.

Workmanship - Codes

All work shall be performed by skilled tradesmen in accordance with the best practices of the trade and shall include all items of fabrication, instruction or installation as regularly furnished or required for completion. When completed, all work shall be functional, durably built and installed and shall present a neat, workmanlike appearance to the satisfaction of the Engineer and the Owner.

Equipment Purchases

Arrange for purchase and delivery of all materials and equipment immediately after approval of shop drawing submittal. All materials and equipment must be ordered in ample quantities for delivery at the proper time. No allowances for extras for extending construction schedule will be permitted.

Provide all materials of similar class or service by one manufacturer.

Submittals

Submit six (6) copies of shop drawings, catalogues, data sheets, pamphlets or any other descriptive literature necessary to convey information shall be submitted for review prior to placing purchase orders for all equipment provided under Division 16.

Include sufficient technical data related to the material or products, including dimensions, weights, mounting means, operational limits, performance curves, wiring diagrams, control sequence or other descriptive data necessary to describe fully the item proposed and its operational characteristics.

Index all submittals and reference to these specifications.

Record Documents

Prior to completion of the Contract, the Contractor shall furnish the Engineer with a set of electrical plans marked with any changes, deviations or additions to any part of the electrical work.

Each conductor shall be identified as required by the Contract Documents. This identification shall be indicated on the record documents drawings to enable rapid and accurate circuit tracing by maintenance personnel.

Cooperative Work

Contractor shall correct, without charge, any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration.

Cooperative work includes general supervision and responsibility for proper location and size of work related to Division 16, but provided by others such as installation of sleeves, inserts and anchor bolts for work in Division 16.

Verification Of Dimensions

Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify manufacturer's certified fabrication drawings for dimensions, etc., and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

Drawings are essentially diagrammatic, and many offsets, bends, special fittings, and exact locations are not indicated. Carefully study drawings and premises in order to determine best methods, exact locations, routes, building obstructions, etc., and install apparatus and equipment in available locations. Install apparatus and equipment in manner and locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

Cutting and Patching

Cut existing work and patch as necessary to properly install new work. As the work progresses, leave necessary openings, holes, chases, etc., in their correct location. If the required openings, holes, chases, etc., are not in their correct location, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Engineer.

Coordination Of Work

All items of work by other trades which are necessary for completion of work under this division of the specification shall be the responsibility of the General Contractor. The General Contractor shall thoroughly understand the scope of work required of each trade and shall appropriately coordinate subcontractors, suppliers, etc., and arrange for such work to be performed in an orderly course of the project. Where work of this trade joins that of other trades, there shall be no discrepancies.

Special attention shall be given to coordination between Electrical and Mechanical Subcontractors, and in particular the control wiring of devices responsibility.

Plan and install work in such manner as to conform to the structure, avoid obstructions. Consult general contract drawings for conditions affecting this work and verify spaces in which work will be installed. Notify Engineer immediately of possible conflicts. Where interferences with structural, mechanical, or other features exist, or where job conditions require reasonable changes in locations and arrangement of indicated equipment, conduit, outlets, or wiring, Contractor shall make such changes without extra cost to Owner.

Study the suppliers' detailed shop drawings and wiring diagrams of all equipment to determine exact locations and sizes of sleeves, anchor bolts, supports, hangers, openings, conduits, and outlets and provide such items as necessary to complete the installation. In particular, verify all motor and control outlet locations and conduit sizes with the supplier of motor driven equipment, and secure roughing-in dimensions and electrical characteristics of all equipment before installation of work. Wire factory outlet boxes in equipment complete and all connections complete.

Coordination Of The Electrical System

The Contractor shall verify all actual equipment and motor full-load and locked-rotor current ratings. The necessary minimum equipment, wire, and conduit sizes are indicated on the Plans. If the Contractor furnishes equipment of different ratings, the Contractor shall coordinate the actual current rating of equipment furnished with the branch circuit conductor size, the overcurrent protection, the controller size, the motor starter, and the branch circuit overcurrent protection. The branch circuit conductors shall have a carrying capacity of not less than 125 percent of the actual full-load current rating. The size of the branch circuit conductors shall be such that the voltage drop from the overcurrent protection devices up to the equipment shall not be greater than 2 percent when the equipment is running at full-load and rated voltage.

The motor running overcurrent protection devices shall be rated or selected to trip at no more than 125 percent of the motor full-load current rating for motors marked to have a temperature rise not over 40 degrees C or motors marked with a service factor not less than 1.15 and at no more than 115 percent for all other types of motors. The motor controller size shall be coordinated to the current rating and horsepower size of the installed motor.

The motor-branch-circuit overcurrent protection device shall trip open in 30 seconds or less on locked-rotor current of the motor. This device shall also protect the motor-branch-circuit conductors and the motor control apparatus against overcurrent due to short-circuits or grounds. The motor control circuits shall have overcurrent protection of the type indicated on the Plans.

Closing-In Of Uninspected Work

Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it and when inspected, tested and approved, restore all work to original proper condition.

Identification Of Equipment

All electrical equipment shall be labeled, tagged, stamped, or otherwise identified by function, voltage, level of service, etc., as follows:

Branch Circuit Panelboards:

Panel Identification shall be stenciled with 2" high white paint letters on inside face of door and with 1" x 4" laminated (white on black) Micarta nameplate on trim. Letters shall be not less than 3/8" high.

Panel circuit directory shall be a two-column typewritten card set under glass or transparent substitute. Each circuit shall be identified by the room number and/or area which it serves. This information shall be supplied to the contractor prior to job completion. Circuit breaker identification shall be by permanently installed metal numbers or plastic number under acrylic plastic. "Paste-on" numbers will not be accepted.

Distribution Panels:

Identification shall be with 1" x 4" laminated (white on black) Micarta nameplates on each major component, i.e., Primary Switch Section, Transforming Section and Main Distribution Section, each with name and/or number of unit and other pertinent data as required. Letters shall be not less than 3/8" high.

Circuit breakers and disconnect switches shall be identified by number and name with 3/8" by 1-1/2" laminated Micarta nameplate with 3/16" high letters mounted adjacent to circuit breaker or switch.

Identify all flexible conduit under raised floors with Panduit #MP-200, 3/4" x 2" plastic marker plates. Use black indelible felt-tip marker to designate panel and circuit number. Fasten marker plates to each conduit at exit point from panel box or wireway and at outlet box. Use two T & B Ty-Wraps to secure each plate to conduit.

Identify all outlet boxes below raised floors with red, embossed Dymo tape designating panel and circuit number. Fasten box with double-backed adhesive tape.

Wiring Of Equipment Furnished Under Other Section

General:

All electrical wiring, including power wiring and control wiring including all raceways, wiring, outlet and junction boxes, and labor for installation of the wiring and equipment shall be included in this section of the specifications.

All control devices furnished by others shall be installed under this section.

Wiring diagrams complete with all connection details shall be furnished by supplier of control devices.

Equipment Rough-In

Rough-in all equipment, fixtures, etc., as designated on the drawings and as specified herein. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in connections.

Be responsible for providing all outlets and services of proper size at the required locations.

Minor changes in the contract drawings shall be anticipated and provided for to comply with the rough-in drawings.

Equipment Furnished By Others

Rough-in and make final connections to all equipment shown on the drawings and/or specified for equipment furnished by other disciplines.

Equipment Final Connections

Provide all final connections for the following:

All equipment furnished under Division 16.

Electrical equipment furnished by others.

Inserts, Anchors, Mounting Sleeves

Inserts and anchors must be:

Furnished and installed for support of work under this division.

Adjustable concrete hanger inserts installed in new concrete work as manufactured by Grinnell or approved equal.

Installed in locations as approved by the Owner.

Expandable lead type anchors installed in existing concrete with minimum surface damage, as manufactured by Ackerman-Johnson, Pierce or Phillips.

Toggle bolts, or "molly-anchors" where installed in concrete block walls.

Complete with 3/16" or heavier steel back-up plate where used to support heavy items. Through-bolts or back-up plate shall be concealed from view, except as otherwise indicated.

Mounting of equipment that is of such size as to be free-standing and that equipment which cannot conveniently be located on walls, such as motor starters, etc., shall be rigidly supported on a framework of galvanized steel angle or Unistrut.

Furnish and install all sleeves as required for the installation of all work under all sections of Division 16. Sleeves through floors, roof, and walls shall be sealed to preserve the fire rating of the structure.

Repair, Cleanup and Project Closeout

Any damage to buildings, piping, conduit or equipment shall be repaired by skilled tradesmen of the trades involved, at no additional cost to Owner. This item shall include the repair or replacement of any damaged materials, equipment or work of other trades in

which this Contractor is required to make connections, if such work or equipment is damaged as the result of this Contractor's construction operations, faulty work, errors in wiring, connecting, fusing, testing, energizing with wrong potential or polarity, or other such causes.

After installation and prior to final inspection, all equipment shall be cleaned of all dust, dirt and debris collected during construction operations and left in a neat, orderly arrangement.

General Wiring

Drawings, in general, indicate the location of equipment. Exact locations of motors, and other devices, are to be determined in field. Provide an electrical feed for all equipment, not smaller than shown or NEC size where size is omitted from drawings, together with a suitable circuit protective device for each in panel. Verify panel schedules and layout shown at takeoff period, maintaining number of spare branches indicated.

Conductors for branch circuit lighting, receptacle, power and miscellaneous systems must be a minimum of #12 AWG. Wire indicated specifically to be larger than #12 wire must be increased the entire length of the circuit.

A full size equipment grounding conductor, shall be installed in all feeder and branch circuit conduits, unless specified otherwise.

Verify location and mounting height of all receptacles, wall mounted fixtures, switches, and other equipment before rough-in. See drawings for pertinent information. Refer questionable cases to the Architect.

Where located adjacent in walls, outlet boxes shall not be placed back to back, or shall extension rings be used in place of double boxes, all to limit sound transmission between rooms. Provide short horizontal nipple between adjacent outlet boxes, which shall have depth sufficient to maintain wall coverage in rear by masonry material.

In those isolated instances in which construction conditions will not permit staggered outlet boxes, approval of Owner must be obtained. After installation of conductors, box shall be filled with fiberglass to limit sound transmission in all back to back instances of installation.

Complete rough-in requirements of all equipment to be wired under the Contract are not indicated. Coordinate with respective trades furnishing equipment or with Owner as the case may be for complete and accurate requirements to result in a neat, workmanlike installation.

Provide proper size and type of feeds from proper sources for all such items indicated, checking drawings of all trades to ensure inclusion of all items.

Storage and Handling

All material, equipment, devices, etc., when installed either partial or complete shall be properly protected throughout the remainder of the project construction. Failure to do so shall be sufficient cause of rejection of any items.

Corrosion Protection

Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the Contractor shall isolate these metals as required with neoprene washers, 9 mil polyethylene tape, or gaskets. Where fastening conduit, electro plated, or equivalent fasteners and stainless steel bolts shall be used.

Factory finishes damaged and/or rusting shall be restored to original new condition.

All electrical panels, switchgear, motor control centers, etc., shall be shipped in sealed dust and moisture-proof plastic sheet enclosures and the seal maintained until units are installed. Said units shall be in new condition, no dirt, dust, water, grease, rust, damaged parts, components, etc. All relay, starter, circuit breaker, switches, etc., contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, etc., before testing and energizing.

Once equipment is installed, it shall be protected at all times with plastic sheet covers until the area is secure from dirt, dust, workers, paint spray, water, etc. Heat shall be provided to eliminate condensation.

Equipment Lists and Maintenance Manuals

Prior to completion of job, Contractor shall compile a complete equipment list and maintenance manuals. The equipment list shall include the following items for every piece of material equipment supplied under this section of the specifications.

Name, model and manufacturer.

Complete parts drawings and list.

Local supply for parts and replacement and telephone number.

Local service organization for equipment and telephone number.

All tags, inspection slips, instruction packages, etc., removed from equipment as shipped from the factory, properly identified as to the piece of equipment it was taken from.

Maintenance manuals shall be furnished for each applicable section of the specifications and shall be suitably bound with hard covers and shall include all available manufacturers' operation and maintenance instructions, together with 'as-built' drawings and lists hereinbefore specified and all other diagrams and instructions necessary to properly operate and maintain the equipment. The equipment lists and maintenance manuals shall be submitted in duplicate to the Owner for approval not less than 10 days prior to the completion of the job. The maintenance manuals shall also include the name, address and phone number of the Contractor and all subcontractors involved in any of the work specified herein. The maintenance manuals shall be finally provided in six copies.

Equipment Identification

All equipment shall be properly and permanently identified by means of descriptive engraved identification plates as follows:

All separately mounted circuit breakers, motor starters, disconnect switches, relays and all apparatus used for the operation or control of power circuits, lighting appliances or equipment.

Each disconnect switch in the S.E.S., switchboards or MCC's shall be labeled indicating the equipment it serves. Example: "Air Conditioning Unit #1", "Main Disconnect Switch", etc.

Each panelboard shall be labeled indicating panel number, bus voltage and phase. Example: Panel A, 120/208v, 3HP, 4W.

All nomenclature shall be submitted to the ENGINEER for approval prior to engraving. All plates shall be permanently attached with sheet metal screws.

Plates shall be made of 3/32 inch thick laminated white bakelite with black core, engrave to core to produce black lettering on white background. Lettering shall be 3/16 inch minimum size. The nameplates shall be fastened to the various devices with round head brass screws.

Automatic Equipment Warning Signs

Permanent warning signs shall be mounted at all mechanical equipment, which may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Sign shall read:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

High Voltage Warning Signs

Permanent and conspicuous warning signs shall be mounted on all equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 600 volts.

Signs shall be in accordance with OSHA regulation, and shall be suitable for exterior use. The warning signals shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

Signs shall be 7 inches high by 10 inches wide, colored red and white, on not less than 18 gauge vitreous enameling stock. Sign shall read:

**WARNING
HIGH VOLTAGE
KEEP OUT**

Substitution Of Products

The condition that a specific manufacturer may not produce a system or piece of equipment, which meets the operational parameters required by the specifications, does not mitigate the intent, nor does it relieve the Contractor from total compliance as interpreted by the Engineer. Should a significant variance from the specifications in relation to the operational parameters or major discrepancies as to size of equipment occur, a letter identifying all such deviations shall be forwarded to the Engineer. If this letter fails to address one or more item(s), and the submittal is approved, it in no way relieves the Contractor from full compliance with the Specification. The Owner and Engineer reserve the right to order removal of all equipment, which they deem unsatisfactory, and have installed in its place equipment that meets or satisfies the intent of the specifications.

160500 BASIC MATERIALS AND METHODS

PART 1 - GENERAL

The applicable portions of Electrical General Conditions, General Conditions and Division 1 - General form a part of this specification.

All materials, equipment, and parts comprising any unit or part thereof specified or indicated on the Plans shall be new and unused, of current manufacture, and of highest grade consistent to the State of the Art. Damaged materials, equipment and parts are not considered to be new and unused and will not be accepted.

Field verification of scale dimensions on Plans is directed since actual locations, distances and levels will be governed by actual field conditions. The Contractor shall also review architectural, structural, yard, mechanical and other Plans, and the accepted electrical and mechanical shop drawings, and shall adjust his work to conform to all conditions indicated thereon.

The fabricator of major components, such as distribution panelboards, switchgear, motor control centers, shall also be the manufacturer of the major devices therein.

All cables shall be properly coated with pulling compound recommended by the cable manufacturer before being pulled into conduits so as to prevent mechanical damage to the cables during installation.

Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

Fasteners used with wiring devices shall be aluminum or stainless steel and all screws, nuts, bolts, etc., shall be stainless steel.

Scope

This section of the specifications covers the furnishing and installation of the following:

- Ballasts
- Boxes and fittings
- Conductors
- Wiring devices
- Cabinets/Enclosures
- Relays & Timers
- Float Switch
- Auto Dialer

Applicable Codes and Standards

All materials and workmanship shall comply with the applicable portions of the latest edition of the following codes and standards:

- National Fire Protection Association (NFPA)
- National Electrical Code (NEC)
- American National Standards Institute (ANSI)
- National Electrical Manufacturers Association (NEMA)
- Underwriters' Laboratories, Inc. (UL)

PART 2 - PRODUCTS

Ballasts shall be ETL/CBM certified for the purpose intended with built-in thermal protector that disconnects the ballast permanently prior to actual ballast failure.

Ballasts shall be high efficiency, high power factor, constant wattage type and shall be fused.

Ballasts shall be Advance, Universal or equal.

Boxes and Fittings

General use junction and pull boxes shall be the galvanized steel type for dry locations for use with E.M.T. and the cast metal, threaded hub type shall be used for wet or damp locations for use with rigid or intermediate metal conduit.

Minimum size box shall be 4 inch square by 1-1/2 inch deep (2-1/2 inch deep for telephone outlet). Larger sizes shall be provided as necessary to comply with NEC space requirements.

Conduit fittings for rigid or intermediate metal conduit shall be threaded galvanized couplings. Box terminations shall be made with double lock nuts and approved plastic bushings. Outdoor box terminations shall be watertight type.

Conduit fittings for E.M.T. shall be the two piece steel compression type couplings and connectors up to and including 2 inches. Steel set screw (2 screws per termination) type above 2 inches. All connectors shall have insulated throats.

Conduit fittings for P.V.C. conduit shall be schedule 40 or 80 solvent weld couplings and connectors. Provide threaded male and female adapters as required.

All couplings and connectors shall be concrete-tight type where used in masonry or concrete and shall be raintight where installed in wet locations.

Connectors for liquidtight flexible metallic conduit shall be as manufactured by Ideal or approved equal.

Conductors

All wire and cable for secondary power and lighting distribution shall be new, annealed soft-drawn copper, 600 volt insulated and shall be UL listed for types listed below for use in accordance with the NEC.

For all applications unless noted or specified otherwise: Types THHN or THWN, 75 degrees C wet.

For all applications where conduit or wireways are exposed to direct sunlight or any other exterior exposure: Type XHHW, 75 degrees C wet, 90 degrees dry.

For all applications where conduit or wireways are indoor or not exposed to direct sunlight and dry conditions: Type THHN or XHHW, 90 degrees may be used at appropriate ampacities of the devices.

Conductors shall not be less than #12 AWG, unless otherwise noted. Conductor sizes indicated on homeruns on the drawings is the minimum size for the entire circuit up to the connection of the last load. Conduit sizes may be reduced according to the N.E.C. as the quantity of conductors are reduced unless noted otherwise.

Conductors #10 and smaller shall be solid, #8 and larger shall be stranded.

All wire and cable shall be color coded as follows:

120/208 V, 3 Phase, 4W System

A Phase - Black Neutral - White
B Phase - Red Ground - Green
C Phase - Blue

No. 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape.

Where these colors cannot be provided in the wire and cable insulation or jacket, color coding tape of the color designated above shall be continuously applied in sufficient quantity for permanency at all exposed terminals, loops and splices.

Wire Joints and Connectors

For connections to circuit breakers and wiring devices: Conductor sized #12 and #10, formed clockwise around binding post or screw. For #8 or #6, box lug with screw or crimp on ring terminal as manufactured by Ideal or approved equal.

For terminations of #4 or larger: Compression solderless type of Ideal "shur-stake", "IlSCO" or approved equal.

For circuit wiring connections to fixtures or devices or circuiting joints: Conductor sizes #12 through #8, threaded pressure type with insulator, Ideal "wing-nut" or approved equal.

Connectors for #8 and larger shall be of the mechanical compression type as manufactured by T & B, OZ, Blackburn, Burndy or IlSCO.

Control wiring and all other stranded wiring to screw posts shall be provided with T & B "STA-KON" terminals, or as noted on Drawings.

Wiring Devices

Unless otherwise specified or indicated on the Plans, device boxes, condulets and junction boxes shall be heavy-duty cast and shall be compatible with the location and conduit system being used, rigid steel or rigid copper free aluminum and shall be as manufactured by Crouse-Hinds, Appleton or equal, with stainless steel cover screws and with cover gaskets. Device boxes shall be FD type.

Duplex receptacles shall be rated 20A, 125VAC, NEMA type 5-20R, Hubbell #5362-I or approved equal.

Clock receptacle shall be rated 15A, 125VAC, NEMA type 5-15R with .040 brass plate. Hubbell #5233 or approved equal.

All special purpose receptacles shall be as indicated on the drawings.

Light switches shall be rated 20A, 120-277 volt and shall be single pole, double pole or three-way, as required. Hubbell #1222-I, 1223-I or 1224-I or approved equal. Switches shall be horsepower rated for 1 H.P. at 120V and 2 H.P. at 277V. Locking key type shall be provided as indicated on drawings.

Device plates for interior finish shall be #302 stainless steel, unless noted otherwise.

Duplex receptacles shall be 2-pole, 3-wire grounded, 120 volts, industrial, rated at 20 amperes, and shall be as manufactured by Hubbell, General Electric or equal. Special receptacles, covers, etc., shall be as specified herein or as indicated on the Plans.

Enclosures shall be weatherproof, utilizing a yellow "fiberglass" lift cover plates or accepted equal.

GFI outlets shall be rated at 20 amperes at 125 volts AC as manufactured by Leviton, Bryant or equal.

Outdoor receptacles shall be provided with weatherproof cast aluminum; double lift, cover for F.S. type boxes mounted horizontally - single lift for F.S. type boxes mounted vertically.

Push-Button Stations

Push-buttons, selector switches and pilot lights shall be heavy-duty, oiltight Square D Company, General Electric Company or equals. Control stations shall be in NEMA 4 enclosures for outdoor and NEMA 12 for indoor installations.

"Start-Lockout-Stop" push-button stations shall be installed adjacent to every motor unless specifically indicated otherwise.

Cabinets/Enclosures

All cabinets shall be manufactured of code gauge steel (14 gauge steel minimum), with seams that are continuously welded. Cabinets shall comply with NEMA types as indicated on the drawings. Doors shall use butt type hinges and lockable flush handle latches. Cabinets shall be manufactured by Hoffman or approved equal.

This specification includes enclosures to house electrical controls, instruments, terminal boards, etc. If not indicated otherwise, they shall be NEMA 12 for indoor and NEMA 4 for outdoor installations.

Doors shall have full length piano hinges with the door removable by pulling the hinge pin. They shall be as manufactured by Hoffman, Fischer & Porter or equal.

A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket.

Finish shall be white enamel interior, light grey enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Plans should be checked for special conditions.

Tapes

Plastic insulating tape shall be "Scotch 33+" as manufactured by 3M or approved equal. Tapes shall be approved for the voltage application, with minimum 3 layers.

Color coding tape shall be pressure sensitive, vinyl, 5 mil adhesive. Slipknot #45.

RELAYS & TIMERS

Control Relays

Control relays shall be General Electric, Westinghouse, Square D Company or equal, industrial 600 volt, 10 amperes type with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Each relay shall have a minimum of 4 reversible pole contacts. The coils shall be sealed by pressure molding.

Intrinsically Safe Relays

Intrinsically safe relays shall allow the use of any type of remote pilot device located in Class 1 hazardous areas by providing a pilot circuit incapable of releasing sufficient electrical energy to ignite gases and vapors classified in Groups A, B, C and D.

The unit shall have an output relay with double pole, double throw contacts rated at least 16 amperes at 120 volts AC, resistive load and 24 volts DC. They shall operate on the AC supply voltage indicated on the Plans.

They shall be Cutler-Hammer, BW Series, or equal.

Timers which require pins or other removable trip devices shall be provided with at least one pin or trip device for each possible time setting.

Reset timers and repeat cycle timers shall be heavy-duty industrial timers as manufactured by Eagle, Paragon or equal.

Twenty-four hour timers shall be heavy-duty industrial timers as manufactured by Paragon, Tork or equal.

Timing relays shall be heavy-duty industrial 600 volt, 10 amperes as manufactured by Square D Company, Westinghouse or equal.

Instrumentation Class Cable

Instrument cable shall have the number of twisted pairs indicated on the Plans and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum.

The jacket shall be flame retardant Flamenal or Okoseal, 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with Okoseal or Vulkene, 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

Instrumentation cables shall be installed in separate raceways. This includes through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures.

The instrumentation cable shall be Type TC as manufactured by General Electric, Okonite or equal.

Float Switch

Float switch shall be direct acting and consist of a 316 type stainless steel housing, mounting clamp, a flexible three-conductor cable with a synthetic rubber jacket and a mercury switch. The float housing shall be a sphere of at least 5-1/2 inches in diameter.

The mercury switch shall be embedded in a metal housing inside the float. The cable shall be No. 14 AWG with 105 strands per conductor, made specifically for underwater use and heavy flexing service.

The mercury switch shall be connected to two of the three conductors of the cable. The third conductor shall be an internal ground and shall be colored green. The switch shall have a 20 ampere rating at 115 volts AC. An additional synthetic rubber jacket shall act as a hinge between the float and where the cable is held by the stationary clamp. This clamp shall be stainless steel with an adapting fitting and two yokes for mounting on a vertical 1-inch pipe.

A liquid rise of 1-inch from the reset position shall operate the float switch, and reset shall occur when the liquid level drops to 1-inch. Operating temperature shall be 0 degrees F to + 180 degrees F.

Weight and buoyancy shall be such that contaminants like a cake of grease will not result in the float switch changing operating level more than 1-inch.

A cast aluminum, NEMA 4 junction box shall be supplied for termination of the float cable(s), to allow conventional wiring and conduit to be run from the junction box to a control panel. It shall have terminal blocks for the required number of circuits and shall accept sealed fittings furnished with the float switch. The float switches and assemble shall be manufactured by Consolidated Model 9G, or equal.

Auto Dialer

The Contractor shall provide and install an automatic dialing, remote monitoring unit as manufactured by RACO, Chatterbox Model CB-4, compatible with similar units previously provided to the City of Phoenix by RACO.

The unit shall be enclosed in a vandal proof NEMA 4X enclosure together with padlock and keys(3).

Emergency power batteries shall be provided for 24 hour duration. A local alarm relay output shall be provided. The unit shall accept four dry contact inputs to indicate alarm condition when these remote contacts are in the closed position. A custom extended vocabulary shall be provided. The auto dialer shall operate on 120 volts AC, 60 hertz and be complete with battery charger.

Anti-condensation heaters shall be provided, surge protection equipment shall be provided for phone, power and signal lines. The unit shall operate at a temperature of 20 degrees F to 130 degrees F, 0-95 percent humidity noncondensing. The unit shall operate over a standard telephone leased line. Programming shall be performed by the manufacturer to the City of Phoenix' requirements. Loss of power indication shall be provided.

PART 3 - EXECUTION

Outlet Boxes

To be generally installed at locations shown on drawings. Study the general building drawings and suppliers' shop drawings in order that outlets are located correctly for the equipment as furnished and installed.

Install rigid and true. Firmly fasten to the structure of building with suitable metal bar hangers or grout into masonry. Set edge of boxes flush with finished surfaces. Gang where possible.

Installation of pull boxes shall be such that access to the pull boxes is not restricted by obstructions such as pipes, valves, ladders, etc. Exact locations and sizes shall be submitted to the Engineer for review and acceptance prior to fabrication and installation.

Additional pull boxes shall be installed as required to meet cable manufacturer's pulling tension requirements.

Covers shall be secured with 316 stainless steel screws or bolts with coated threads.

Conductors

Conductors shall be installed only after the entire conduit and raceway system is complete and cleaned. All conductors shall be pulled into conduit system directly from reels with appropriate pulling devices and accessories. Conductors shall be lubricated with Ideal "yellow #77" or approved equal wire lubricant.

All splices, taps and terminations shall be made electrically and mechanically positive with appropriate terminals and connectors as previously specified. All splices and taps shall be electrically insulated to a rating equivalent to the conductor insulation.

All conductors in panelboards and switchboards shall be suitably bundled and tied with Ideal double lock cable ties or approved equal. Conductors shall be identified by circuit at all terminations and junctions.

In addition to color coding all conductors, each conductor shall be identified in each pull box, manhole, panelboard, cable tray, and termination with circuit identification markers. This identification is applicable to all power, control, alarm, and instrumentation conductors and these markings shall be recorded on the Record Documents. Markers shall be slip-on PVC sleeve type as manufactured by Brady, Seaton, or equal.

Markers for other cabling shall be B-292 vinyl as manufactured by Brady, Seaton, or equal.

The pulling tension and side-wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

Terminations of control conductors shall be terminal board type with set-screw pressure connectors. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation. Conductors, including grounding conductors, of different sizes shall be spliced and then soldered or welded. Splices in wet locations and all splices below grade shall be waterproof heatshrink type as manufactured by Ray-Chem, Elastimold, Thomas-Betts or equal.

Cabinets

Cabinets shall be installed surface mounted or recess mounted as indicated on the drawings.

Surface mounted cabinets shall be installed rigid and true, bolted directly to the wall or mounting supports as applicable.

16110 CONDUITS, RACEWAYS AND FITTINGS

PART 1 - GENERAL

The applicable portions of Electrical General Conditions and Division 1 - General Conditions and Division 1 - General form a part of this specification.

Size of the conduit shall be as indicated on the drawings, but in no case shall be smaller than 3/4". All conduits underground shall be a minimum of 1".

Conduit sizes shall be such that the required number and sizes of wires can be easily pulled in and the Contractor shall be responsible for the selection of the conduit sizes. Conduit sizes shown on the drawings are minimum sizes in accordance with appropriate tables in the National Electrical Code. If because of bends or elbows a larger conduit size is required, the Contractor shall so furnish without further cost to the Owner.

The Contractor shall be entirely responsible for the proper protection of this work from the other trades on the job. When conduit becomes bent, or holes are punched through same, or outlets moved after being roughed-in, the Contractor shall so furnish equal to that originally installed without further cost to the Owner.

Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

Each length of conduit shall be stamped with the name or trademark of the manufacturer and shall bear the Underwriters' label.

Scope

This section of the specification covers furnishing and installing of Conduits, Raceways and Fittings.

Applicable Codes And Standards

All materials and workmanship shall comply with the applicable portions of the latest edition of the following codes and standards:

National Electrical Code (NEC)
American National Standards Institute (ANSI)
National Electrical Manufacturers Association (NEMA)
Underwriters' Laboratories, Inc. (UL)

PART 2 - PRODUCTS

Conduits and Raceways

Conduit and Raceways shall include the following types and shall be used where specified, herein or indicated on the drawings:

Rigid Metal Conduit, Galvanized
Intermediate Metal Conduit, Galvanized
Electrical Metallic Tubing
Non-Metallic Conduit
Flexible Metallic Conduit
Liquidtight Flexible Metallic Conduit

Rigid Metal Conduit, Galvanized

- shall be zinc coated, hot dip galvanized
- weights and dimensions shall be within tolerances regulated by UL
- conduit interior shall be treated with a corrosion protective coating

Manufacturers

Triangle, Jones-McLaughlin, National Electric, or approved equal.

Couplings and connectors shall be steel or malleable iron, threaded, rain and concrete tight. NO THREADLESS or SET SCREW fittings shall be used. DIECAST fittings shall not be used.

Intermediate Metal Conduit, Galvanized

- shall be zinc coated, hot dip galvanized
- weights and dimensions shall be within tolerances regulated by UL
- conduit interior shall be treated with a corrosion protective coating

Manufacturers

Triangle, Allied or the approved equal.

Couplings and connectors shall be steel malleable iron, threaded, rain and concrete tight. NO THREADLESS or SET SCREW fittings shall be used. DIECAST fittings shall not be used.

Bushings and locknuts shall be malleable iron with sharp, clean cut threads.

Electrical Metallic Tubing

- shall be electro - galvanized steel

Manufacturers

Triangle, Allied or approved equal.

Couplings and connectors shall be steel, compression type, rain and concrete tight. NO INDENT shall be used. SET SCREW fittings shall have 2 set screws per entry and used on sizes 2" and larger. DIECAST fittings shall not be used.

Non-Metallic Conduit

- Shall be schedule 40 PVC electrical conduit, 90 degrees C rated, UL listed.

Conduits shall be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested. Encasement shall be reinforced as indicated on the Plans. Conduit supports shall be installed at 2-1/2 foot intervals.

Manufacturers

Carlson, Cantex, Pacific Western or approved equal.

All fittings shall be schedule 40 or 80 approved for the intended use.

Flexible Metallic Conduits:

- shall be zinc coated, hot dip galvanized.
- shall be of continuous steel strip, spirally wound and interlocked.

Manufacturers

Anaconda

In lengths not exceeding 6'-0" shall be used to interconnect lay-in fluorescent fixtures and junction boxes.

Connectors shall be steel, clamping type with insulated throat.

Liquidtight Flexible Metallic Conduit:

- same as Flexible Metallic Conduit.
- shall have a copper conductor spiralled with the steel strap for grounding.
- shall have a 20 mil PVC coating over the metallic conduit.

Manufacturer - Anaconda Sealtite "UA" or approved equal.

In lengths not to exceed 4'-0" shall be used to connect motors, transformers and be grey in color.

For computer devices, the flexible conduit shall be coated with a blue PVC jacket.

Connectors shall be steel or malleable iron, liquidtight with insulated throat.

Bushings and locknuts shall be malleable iron with sharp, clean cut threads. Bushings shall have insulated throat.

PART 3 - EXECUTION

General

Conduit shall be continuous from outlet to outlet, or junction box, and shall be so arranged that wire may be pulled in with the minimum practicable number of junction boxes.

All conduits shall be concealed in the walls, ceiling spaces, or floor slabs wherever possible. All conduit runs shall be exposed in mechanical equipment rooms, electrical equipment rooms, and electrical closets. No conduit shall be run exposed in finished areas without the specific approval of the Engineer.

UL listed PVC conduit may be used for underground feeders, underground branch circuits and underground special systems conduit. All non-metallic conduit installed below concrete floors may be installed in the fill, however, a portion of the concrete floor material must be placed around conduit for rigid support. All non-metallic conduit outside the fill shall be buried a minimum of 24 inches below grade directly in earth.

All non-metallic conduit shall be provided with code size copper bond wire inside the conduit for electrical continuity, and shall be installed in strict accordance with NEC Article #250.

Change in direction of runs shall be accomplished by using factory bends or field bending. Field bends shall be made by experienced personnel using the proper heating device along with duct end plugs on sizes 2" and larger. The duct is to be heated to the proper bending temperature, form bent and set with long radius bends.

Stubups through the floor, which are concealed in equipment, such as switchboards and transformers, may be PVC with end bell terminations 2" above concrete floor. Exposed stubups shall be accomplished with rigid steel wrapped with #50 scotch-wrap, plastic covering 1/2 lapped to 3" above concrete. These steel stubups shall be terminated with a suitable grounding bushing and ground wire.

All raceways which are not buried or embedded in concrete shall be supported by straps, clamps, or hangers to provide a rigid installation. Exposed conduit shall be run in straight lines at right angles to or parallel with walls, beams, or columns. In no case shall conduit be supported or fastened to other piping systems or installed to prevent the ready removal of other pipe.

It shall be the responsibility of the Contractor to consult with all other trades before installing conduit and boxes. Any conflict between the location of conduit and boxes, piping, or structural steel supports shall be adjusted before installation. In general, large pipe mains, waste, drain, and lines which pitch, and all structural steel shall be given priority.

Conduits entering or exiting concrete shall be PVC coated or equivalent.

Conduit runs shall be straight and true; elbows, offsets and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends or with fittings of the conduit type. Conduit type fittings shall be Crouse-Hinds, Appleton or equal with wedge nut covers.

Conduit runs shall not interfere with the proper and safe operation of equipment and shall not block or interfere with ingress or egress, including equipment removal hatches.

Exposed conduits shall be securely fastened with regulation clamps or straps. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit and motors or control equipment. The maximum length of flexible conduit shall be 5 feet. Where flexible conduit is used, it shall be grounding type, weatherproof and watertight as manufactured by American Brass Company, General Electric or equal. All conduits located outdoors or in wet locations shall be weathertight.

Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel galvanizing or other coating is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

All conduit shall be thoroughly reamed after the threads have been cut to remove burrs. All joints shall be made with acceptable sealing compound and shall be watertight. Bushings or conduit fittings shall be used at all conduit terminals. The total of all bends in any run between pull boxes or junction boxes shall not exceed 360 degrees. Pull boxes shall be installed at points acceptable to the Engineer. Conduits brought into pull boxes, conduits, and other openings shall be capped until used to prevent the entrance of moisture. All spare conduits shall be capped and shall contain a suitable plastic pulling tape.

Joints shall be set up tight. Hangers and fastenings shall be secure and of a type appropriate in design and dimensions for the particular application.

After installation of complete runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be incorporated as part of the contract.

Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects or obstructions remain in the conduit prior to pulling in conductors.

Couplings, connectors and fittings shall be threaded and shall be certified types specifically designed and manufactured for the purpose. They shall be installed expertly to provide a firm mechanical assembly and electrical conductivity throughout.

Shop drawings shall be submitted as requested by the Engineer for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit.

The electrical contractor shall provide all necessary sleeves and chases required where conduits pass through floors or walls.

All empty conduits shall be provided with nylon pull cord.

The ends of all conduits shall be securely plugged, and all boxes temporarily covered to prevent plaster or dirt from entering the conduits. All conduit shall be thoroughly swabbed out with a dry swab to remove moisture and debris before conductors are drawn into place.

Bending

Changes in direction shall be made by bends in the pipe wherever possible, and these shall be made smooth and even without flattening the pipe or flaking the finish. Bends shall be of as long radius as possible, and in no case smaller than the corresponding trade elbow. Long-radius elbows shall be used where necessary.

Not more than four 90 degree bends will be allowed in one raceway run. Where more bends are necessary, a conduit body or pull box shall be installed. All bends in 1" and smaller shall be made with a conduit bender and all larger sizes shall have machine bends.

Bushings and Locknuts

Where conduits enter boxes, panels, cabinets, etc., they shall be rigidly clamped to the box by locknuts on the outside and inside, with a bushing on the inside of the box.

All conduits shall enter the box squarely.

Insulated Bushings

Furnish and install as required by NEC. The use of insulated bushings does not preclude the use of double locknuts to fasten conduit to the box.

Stubs

All conduit stubbed up from or through floor slabs for connections to machines and equipment shall be rigid type with coupling installed flush with finish floor to permit future conduit removal. Couplings shall be sealed with a flush, threaded pipe plug.

Supports

Conduits shall be supported at intervals not greater than 8 feet and within 3 feet of any bend and every outlet or junction box, panel, etc. This shall apply to vertical runs as well as horizontal runs.

Where conduits are run individually, they shall be supported by approved pipe straps or beam clamps. Straps shall be secured by means of toggle bolts on hollow masonry, expansion shields and machine screws or standard preset inserts on concrete or solid masonry, machine screws or bolts on metal surfaces, and wood screws on wood construction.

No perforated straps or wire hangers of any kind will be permitted.

Where individual conduits are suspended from the ceiling, they shall be supported by hanger rods and hangers.

Conduits installed exposed in damp locations or on water-bearing walls shall be mounted on 1" channel under each conduit clamp, to prevent accumulation of moisture around the conduits.

Where a number of conduits are to be run exposed and parallel, one with another, they shall be grouped and supported by trapeze hangers.

All concrete inserts and pipe clamps shall be galvanized.

All steel bolts, nuts, washers, and screws shall be galvanized or cadmium-plated.

16400 SERVICE ENTRANCE SECTION AND DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

General

The applicable portions of Electrical General Conditions, General Conditions and Division 1 - General form a part of this specification.

Scope

This section of the specification covers the furnishing and installation of:

- Distribution Panels
- Panelboards
- Dry Type Transformers
- Motor Control Center
- Safety Disconnect Switches
- Service Entrance Section
- Fuses
- Grounding

Furnish and install where indicated on the drawings dry type transformers with a 240 volt, 3 phase, 3 wire primary and a 208 volt, 3 phase, 4 wire secondary. The transformer(s) shall be 60 hz with kVA rating as shown on the drawings.

All cable terminations shall be temperature rated for 75 degrees C (min.).

Applicable Codes and Standards

All materials and workmanship shall comply with the applicable portions of the latest edition of the following codes and standards:

- National Fire Protection Association (NFPA)
- National Electrical Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- Underwriters' Laboratories, Inc. (UL)
- Local city or state codes
- Power company standards

PART 2 - PRODUCTS

SWITCHBOARD(S) & POWER DISTRIBUTION EQUIPMENT

General

The Switchboard and circuit breaker distribution sections shall consist of a completely enclosed, self-supporting, metal-clad structure, containing distribution circuit breakers, copper bus bars, supports and equipment as shown on the One Line Diagram. It shall consist of U.L. Listed Devices and shall be labeled per UL and conform to NEMA Standards.

Terminal blocks shall be Square D Co., Buchanan or equal. Terminal blocks shall be of the size required for conductors therein and a minimum of 50 percent spares shall be provided in each terminal box.

Enclosure Construction

Framework to be fabricated on a base of die-formed steel or commercial channel welded or bolted to rigidly support the unit. Framework to be code guage steel, rigidly welded and bolted. Each switchboard section to have an open bottom and individual removable top plate. Top and bottom conduit area is to be clearly shown and dimensioned on the shop drawings. Front plated used for mounting meters and/or selector switch devices, to be hinged with wiring installed and laced for flexibility at hinged side. Closure plates to be removable and small enough for easy handling by one man. The paint finish will be grey enamel ASA 49 over a rust inhibiting phosphate primer.

Bussing

Shall be copper and of cross-sectional area to continuously conduct rated full load current to conform to U.L. Standards. Bus bars to be rigidly braced for a Short Circuit Current Rating of 42,000 RMS symmetrical amperes. Main horizontal bus bars between sections to be located on the back of switchboard. End section to have bus bar provisions pre-drilled to facilitate bolted splice plates for future addition of a switchboard section. The horizontal main bus bars, supports, connections, and joints are to be bolted with grade 5 carriage bolts and Belleville washers. Provide equipment ground bus. All maintenance of incoming and branch terminations shall be possible with front access only.

Fusible Switches

Quick-make, quick-break, suitable for use on service described and be sized as shown on the Drawings. Units to be listed and approved by UL for general service entrance use and, where applicable, are to be dual horsepower rated. Each switch to be enclosed in a separate steel enclosure with a hinged cover interlocked with the operating handle to prevent opening cover when switch is in ON position. The interlock is to be constructed so that it can be released with a screwdriver without interrupting service and have padlocking provisions in the OFF position. The operating handle position is to give positive switch OFF and ON position indicated.

Fused switches in distribution panelboard and switchboard are to accept only Class "R" type current-limiting fuses and reject all other class or type. Breakers shall be supplied having fault current ratings as shown on drawings.

Molded-Case Circuit Breakers

Circuit breakers for mounting in MCC's or Switchboards or for separate mounting shall be of the air-break type, quick-make and quick-break, 600 volt, with number of poles as indicated on the Plans. The minimum frame size shall be 100 amperes.

Each pole of these breakers shall provide inverse time delay and instantaneous circuit protection.

The breakers shall be operated by a handle and shall have a quick-make, quick-break switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close and trip simultaneously.

Breakers must be completely enclosed in a molded case. Noninterchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be of nonwelding silver alloy. Arc extinction must be accomplished by means of arc chutes.

The minimum interrupting ratings of the circuit breakers shall be at least equal to the available short circuit at the line terminals.

Circuit breakers shall conform to the applicable requirements of NEMA Standards Publication No. AB1.

Circuit breaker ratings, modifications, etc., shall be as indicated on the Plans.

Molded case circuit breakers shall be ambient compensating that provides inverse time delay overload and instantaneous short circuit protection by means of a thermal magnetic element. Compensation shall be accomplished by a secondary bimetal that will allow the breaker to carry rated current between 25 degrees C and 50 degrees C with tripping characteristics that are approximately the same throughout this temperature range.

On breakers with interchangeable, thermal, adjustable magnetic trip, the accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.

Motor Circuit Protectors

Circuit breakers protecting motors rated 7.5 horsepower or less shall be motor circuit protectors, all other circuit breakers shall be molded case circuit breakers.

Circuit breakers shall be as manufactured by Westinghouse, General Electric or equal.

Electrical circuits shall be protected by motor circuit protectors (MCP) as manufactured by Westinghouse Electric Corporation, General Electric, or equal.

The MCP shall be operated by a handle and shall have a quick-make, quick-break switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping shall be clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously.

MCP's must be completely enclosed in a molded case. MCP's shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be of nonwelding silver alloy. Arc extinction must be accomplished by means of arc chutes.

Each pole of these MCP's shall provide instantaneous short circuit protection by means of a single adjustable magnetic only element. The single adjustment screw shall adjust all poles simultaneously.

Provision shall be furnished in the MCP for locking the maximum achievable trip setting to values less than maximum obtainable trip setting. Each adjustment shall have 8 main setting points and mid-setting points following a linear scale so that each point has a significant value within calibration tolerances.

MCP's shall be suitable for use with current limiters, having 100,000 ampere interrupting capacity and a built-in trip indicator, that are fully coordinated with the MCP so that the MCP will open all 3 phases if the limiter operates. Current limiters shall be so constructed that they can only be replaced by an identical or similar limiter having the same interrupting capacity.

The minimum interrupting ratings of the MCP shall be at least equal to the available short circuit at the line terminals.

MCP ratings, modifications, etc., shall be as indicated on the Plans.

Modular Overload Relays

Where called for on the Plans, modular overload relays shall be provided with the motor starters. The modular overload relays shall be 3-pole solid state devices set by one plug-in heater and shall protect all 3 phases of the motor in ambient temperatures ranging from -20 degrees to +70 degrees C.

The jam modules shall plug in the modular overload relays and shall provide for instantaneous trip of the overload relay should the current exceed a preset value at any time after the motor has accelerated. The modules shall be adjustable to any value between 150 percent and 400 percent of the motor full-load current.

The underload modules shall plug in the MOR and shall provide for overload relay trip whenever the current falls below a set value after the motor has accelerated. The modules shall be adjustable between 50 percent and 90 percent of the full load value of the motor full load current.

Each module shall provide individual trip indication and reset for each trip condition, visible without opening the motor control center compartment door. Each module shall provide an auxiliary contact for remote trip indication.

All solid state circuits shall be completely protected from damage arising from line transients and voltage spikes.

They shall be as manufactured by Westinghouse, Square D Co., or equal.

Additional Features

- Provide 1 can of spray touch-up paint per section to match existing paint.
- Provide lifting eyes on each split.
- Enclosures shall be NEMA 1 for indoor or NEMA IIIIR, rainproof for outdoor and/or wet areas.
- Dimensions: Due to room restrictions services through 1000 amps shall be 15" deep for NEMA I - 28" deep for NEMA IIIIR. Sections shall be maximum of 38" wide and utilize separate pull section per Supplying Power Company requirements.

Combination motor starters shall be mounted in the switchboard.

Starters Size 2 and larger shall have arc quenchers on all load breaking contacts. Starters shall be suitable for the horsepower ratings specified, except the Contractor shall verify the motor ratings and coordinate the starter and overload trip ratings with the actual horsepower ratings of the motors installed. Extended overload reset buttons shall be mounted so as to be accessible for operation without opening the door of the enclosure.

Magnetic contactors shall be factory adjusted and shall be chatter free. Magnetic contactors shall have bimetallic type overload relays in each line conductor as indicated on the Plans.

Starters shall be furnished complete with a 120-volt control transformer unless otherwise noted.

Where above normal ambient temperatures are anticipated, circuit breaker trip elements and starter overload trip elements shall be supplied to meet such conditions and shall be acceptable to the Engineer.

Control fuses shall be furnished where indicated in the schematics.

The magnetic contactors shall not be smaller than the size indicated on the Plans. Starters shall be sized to handle motors furnished even if motors should be larger than indicated on the Plans.

The minimum size starter shall be NEMA Size 1.

Across-the-line full voltage magnetic starters for up to 600V shall have electrical characteristics indicated on the Plans.

Magnetic starters shall have: NEMA 12 enclosures unless otherwise noted; positive, quick-make, quick-break mechanisms; padlockable enclosure doors; 3 overload relays +/-15 percent adjustment from nominal heater rating on the overload relay; cover mounted reset button; and at least 3 auxiliary reversible contacts in addition to the hold-in contact.

Magnetic starters shall be built in accordance with the latest NEMA Standards and shall be manufactured by Westinghouse Electric Corporation, General Electric or equal.

Manufacturers:

Square D
General Electric
Westinghouse
Cutler-Hammer

BRANCH BREAKER PANELBOARD

Panelboard shall be mounted within the switchboard dead front, dead rear. Busses shall be full panel height. Panelboards shall have flush catch and lock (Corbin Cylinder Locks) and operate from one key.

Panels shall have a minimum width of 20 inches. Door hinges and front clamps shall be completely concealed when door is in closed position. Circuit breakers shall be automatic, molded case, quick-make, with handles indicating tripped position and indicating breaker size. Breakers shall be ambient compensated. Minimum interrupting capacity 10,000 amperes symmetrical, or as indicated on drawings.

Each panelboard shall be labeled with identification plates indicating panel number, bus voltage and phase. Example: panel A, 120/208V, 3PH., 4W. Plates shall be mounted on front of door with metal screws (typical for all plate mountings). Contractor shall provide typewritten index cards for all panelboards.

Manufacturers:

Square D
General Electric
Westinghouse
Cutler-Hammer

DRY TYPE TRANSFORMERS BELOW 600 VOLTS

Transformers shall comply with the latest NEMA and ANSI standards and shall be of the premium high efficiency quiet type.

Transformers shall be encased in a sheet steel enclosure. The 10kVA and smaller transformers shall be non-ventilated, and above 10kVA shall be ventilated, self-cooled. The core and copper coil assembly shall be completely isolated from the enclosure by means of neoprene rubber isolation pads or other acceptable vibration isolators.

Insulation

Transformers up to 30kVA shall have a 185 degree C insulation system and shall not exceed 115 degree C rise above a 40 degree C ambient under full load conditions. Above 30kVA, transformers shall have a 220 degree C insulation system and shall not exceed 150 degree C rise above a 40 degree C ambient under full load condition. Above 30kVA transformers core and coil shall be mounted on rubber vibration isolators designed for the purpose.

Transformers shall be capable of operating at 100 percent of nameplate rating continuously while in an ambient temperature not exceeding 40 degree C.

Taps

Transformers rated 25kVA and below shall have 2-5 percent taps below normal. Transformers rated 30kVA and larger shall have 6-2 1/2 percent, four below and two above normal.

Sound Output

Sound outputs of transformers shall not exceed the following levels, based on NEMA standard testing procedures:

<u>KVA RATING</u>	<u>DECIBEL SOUND OUTPUT</u>
0-9	40
10-50	45
51-150	50
151-300	55
301-500	60

Shielding

Where designated on the one-line diagrams or elsewhere in the drawings provide transformers with Electrostatic Shielding. The attenuation ratio of the shielding shall be a minimum of 120:1.

Manufacturers:

- Square D
- General Electric
- Westinghouse
- Cutler-Hammer
- Acme Electric Company
- Or Approved

factor only (resistance banks only) is not acceptable, since kW output is affected by the higher generator efficiency at unity power factor, and the KVAR for motor starting and regulation loads varies with power factor. Tests shall include:

- a. Single step load pickup per NFPA 110-1985, paragraph 5-13.2.6.
- b. Transient and voltage dip responses and steady state voltage and speed (frequency) checks.
- c. Fuel consumption (No load, 1/4, 1/2, 3/4 and Full load).
- d. Generator temperature rise by resistance method.

The Engineer shall have the option of witnessing these tests. A summary of these test results shall be available upon request.

3. Field Tests After Installation

- a. The complete installation shall be initially started and checked out for operational compliance by factory-trained representative(s) of the engine-generator set(s) manufacturer. The engine lubrication oil and as recommended by the manufacturer for operation under environmental conditions specified, shall be provided by the engine-generator set(s) supplier.
- b. Upon completion of initial start-up and system checkout, the supplier of the system shall perform a field test, with the Engineer notified in advance, to demonstrate load carrying capability and voltage and frequency stability.
- c. With the emergency load at normal operating level, a power failure is initiated by opening all switches or breakers supplying the normal power to the building or facility. Records shall be maintained throughout the tests of time-of-day, coolant temperature, cranking time until prime mover starts and runs, time required to come up to operating speed, voltage and frequency overshoot, time required to achieve steady-state condition with all switches transferred to the ambient air temperature, kilowatts, power factor, battery charger rate at 5 minute intervals for the first 15 minutes, and at 15 minute intervals thereafter. Continue this load test for 6 hours observing and recording load changes and the resultant effect on voltage and frequency. Return normal power, record the time delay on retransfer for each switch (set for 15 minutes minimum) and the time delay on prime mover cooldown period and shutdown.

Upon completion of the above test, allow the prime mover to cool for 5 minutes. Then apply full rated load (nameplate kW) consisting of building load supplemented by a load bank if required. Unity power factor is suitable for on-site testing, provided that rated load tests at power factor have been performed by the manufacturer prior to shipment. This full-load pickup shall be in one step immediately upon reaching rated r/min.

PART 2 - PRODUCTS

Engine-Generator Set:

1. The engine-generator set shall be rated for 20kW, 25kVA, at 0.8pf, 60Hz, 3-phase, 4 wire, 208 Wye/120 volt, 50 degC, 1200 ft. altitude on a continuous standby basis at 125 degree F. The engine-generator set shall be mounted on a heavy duty steel base to maintain proper alignment between components, and each set shall incorporate vibration isolators of the type and quantity as specified by the set manufacturer, whether mounted internally or externally to the set.
2. Engine: Engine shall be stationary, liquid-cooled, turbocharged, spark ignited for natural gas (1000 BTU/Cu ft. minimum). Design shall be four cycle, 6 cylinders, displacement. Engine shall be capable of driving the generator of this rating on a continuous standby basis for the duration of normal source interruptions per SAE J1349 conditions.
3. Engine equipment shall include the following:
 - a. A 12 volt DC, solenoid shift, electric starter as required by the manufacturer.
 - b. Positive displacement, mechanical full pressure lubrication oil pump, full flow lubrication oil filters with replaceable elements pressure relief valve, dipstick oil level indicator, and oil drain valve with hose extension.
 - c. Maximum engine rpm shall not exceed 1800 rpm.
 - d. An oil cooler adapter with 190 degree thermostat.
 - e. Dry element air cleaner with replaceable element.
 - f. Fuel gas regulator, air/gas valve, turborcharger and throttle body or turbocharger, intercooler and throttle body.
 - g. Engine speed isochronous electronic governing system to control generator frequency within +/-0.25% of rated frequency under steady state load conditions, and capable of parallel operation with load sharing controls.
 - h. Engine protection devices shall have sensing elements located on the engine to initiate the following preliminary alarms and engine shutdowns:
 - Low coolant temperature alarm
 - Low lubrication oil pressure alarm
 - High coolant temperature alarm
 - Low lubrication oil pressure shutdown
 - High coolant temperature shutdown
 - Overspeed shutdown
 - Overcrank lockout
 - i. Provide low coolant level shutdown, which shall activate high engine temperature lamp and shutdown.

- j. Engine starter battery charging alternator with solid-state voltage regulator.
 - k. Engine mounted thermostatically controlled water jacket heater(s) for each engine to aid in quick starting. Heater(s) shall be rated 2000 watts, 208 volts, single phase, 60Hz.
4. Engine Cooling System:
- a. Engine shall be radiator cooled by engine mounted radiator system including belt-driven pusher fan, coolant pump and thermostat temperature control. Performance of components shall be as required by set manufacturer. Radiators shall be provided with a duct adapter flange permitting the attachment of air discharge duct directing the discharge of radiator air through the wall.
 - b. The Contractor shall provide 50% ethylene glycol antifreeze solution to fill engine cooling system.
5. Engine Exhaust System:
- a. Exhaust muffler shall be provided for the engine size as recommended by the manufacturer. Muffler shall be of the critical type. Contractor shall mount muffler so its weight is not supported by the engine.
 - b. Flexible exhaust connection shall be provided as required for connection between engine exhaust manifold and exhaust line, in compliance with applicable codes and regulations.
 - c. Provide an exhaust condensation trap with manual drain valve to trap and drain off exhaust condensation and to prevent condensation from entering the engine.
 - d. Provide a suitable rain cap at the stack outlet. Provide all necessary flanges and special fittings for proper installation.
 - e. Contractor shall mount and install all exhaust components as shown on drawings and as required to comply with applicable codes and regulations. All components shall be properly sized to assure proper operation without excessive back pressure when installed as required. Make provisions as required for pipe expansion and contraction.
6. Engine Fuel System:
- a. Contractor shall provide all fuel system piping sized per drawings or as required for proper fuel flow of natural gas to the engine. Contractor shall provide all supply lines and regulators, along with all fittings. Provide connections for connecting fuel system to engine in compliance with applicable codes, regulations and manufacturer's recommendations.

7. Generator:

- a. Generator shall be single-bearing, self-aligning, four-pole, synchronous type, revolving field, with amortisseur windings, with direct drive centrifugal blower for proper cooling and minimum noise, with temperature compensated solid-state voltage regulator, with brushless rotating rectifier exciter system. No brushes will be allowed. Generator shall be directly connected to engine flywheel housing and driven through a flexible coupling to insure permanent alignment; gear driven generators are not acceptable under this specification. Insulation shall meet NEMA standards for Class H, but the design shall be for a Class F Temperature Rise. The maximum temperature rise shall not exceed 100 degrees at 50 degree C ambient. Generator design shall prevent potentially damaging shaft currents.

Generator rating: The generator shall have a minimum rating of 20kW at 0.8 power factor. The generator shall be 480 Wye/277 volt, 3 phase, 4 wire at 1800 RPM, and shall be capable of operation at 125% of rated speed without damaging the unit.

- b. The three-phase, broad range, reconnectible generator shall have 12 leads brought out to allow connection by user to obtain any of the available voltages for the unit.
- c. Voltage regulator shall be solid-state design and shall function by controlling the exciter magnetic field between stator and rotor to provide no load to full load regulation of rated voltage within +/- 1% during steady-state conditions. The engine-generator set and regulator must sustain at least 90% of no load voltage for ten(10) seconds with 250% of rated load at near zero power factor connected to its terminals.
- d. The generator, exciter, and voltage regulator shall be designed and manufactured by the engine-generator set manufacturer so that the characteristics shall be matched to the torque curve of the prime mover. This design shall allow the prime mover to use its fullest power producing capacity (without exceeding it or over compensating) at speeds lower than rated, to provide the fastest possible system recovery from transient speed dips. A system that routinely selects a linear-type (straight line) constant volts/hertz characteristic, without regard for the engine power and torque characteristics, will not meet this specification. These characteristics shall be demonstrable as follows:
1. With engine-generator set operating at rated speed, voltage and load, reduce engine speed to half rated by manually overriding the engine speed governor control. Engine-generator set must recover to full speed with the rated load connected when the engine speed governor control is returned to its normal mode.
 2. Calculations must demonstrate that the exciter and voltage regulator will permit utilization of at least 80% of maximum available prime mover torque at all engine speeds between 50% and rated speed, and with rated unity power factor load connected to its terminals.

- e. Exciter shall be three-phase, full-wave, rectified, with heavy-duty silicon diodes mounted on the common rotor shaft and sized for maximum motor starting loads.
 - f. Generator design shall be of the self-protecting type, as demonstrated by the prototype short-circuit test as described under "Testing" herein. All other generator performance criteria shall be equal to that of the specified equipment.
8. Engine-generator Set Control:
- a. Provide a lighted, unit mounted control module that is factory built, wired, tested and shock-mounted by the generator manufacturer.
 - b. Engine-generator set control shall include the following for each unit:
 - 1) Gauges and meters: oil pressure gauge, coolant temperature gauge, charge rate ammeter and running time meter.
 - 2) Manual selector switch: RUN-STOP-REMOTE
 - 3) Remote, two-wire controls start-stop terminals
 - 4) Manual reset field circuit breaker
 - 5) Automatic engine shut down for the following fault conditions:
 - a) Overcrank
 - b) Overspeed
 - c) Low lube oil pressure
 - d) High engine temperature
 - 6) Indicator lamps shall be provided to signal the following functions:
 - a) FAULT - indicates Overcrank, Overspeed, High Coolant Temperature, or Low Oil Pressure.
 - b) OVERCRANK - indicates the starter has been locked out because cranking time was excessive.
 - c) OVERSPEED - indicates engine has shut down because of excessive r/min.
 - d) HIGH ENGINE TEMPERATURE - indicates engine has shut down because of critically high temperature.
 - e) LOW OIL PRESSURE - indicates engine has shut down because of critically low oil pressure.
 - f) LOW COOLANT TEMPERATURE - indicates engine temperature is marginally low for starting.

- g) SWITCH OFF (flashing) - indicates control switch is in the "STOP" position.
- h) Provide two additional fault condition lamps to be designated later.
- 7) Each engine-generator alarm function shall be furnished with form C contacts for remote data event recording on an existing Remote Environmental Monitoring Operating System.
- 8) A fault reset switch shall be provided to clear fault indications and allow restarting of the engine after shut down faults. The control design shall be such that the fault indication shall remain until reset. The fault indicator memory shall not be dependent on the presence of either A-C or D-C voltage and shall retain the fault status memory even through complete removal and replacement of the starting batteries. The fault reset function shall operate only when the RUN-STOP-REMOTE switch is in the STOP position.
- 9) A voltage adjusting rheostat shall be provided to adjust the generator voltage.
- 10) AC voltmeter, 90 degree scale, 2-1/2" (61.25mm) flange, 2% switchboard meter.
- 11) Four position volt meter phase selector switch to read line voltage in each phase with OFF position.
- 12) AC ammeter, 90 degree scale, 2-1/2" (61.25mm) flange, 2% switchboard meter.
- 13) Four position current meter phase selector switch to read line current in each phase with OFF position.
- 14) Frequency meter 45-65 Hz., 90 degree scale, 2-1/2" (61.25mm) flange, +/-0.6 Hz panel meter.

9. Auxiliary Equipment:

- a. Starting Battery: One (1) battery system shall be supplied for the engine and shall be mounted in a battery rack within the weather enclosure set skid base.
- b. Battery Charger(s): A voltage regulated battery charger shall be provided for the engine-generator set. Charge shall be equipped with float, taper and equalize charge settings. The charger power shall be supplied from the normal source; contractor shall provide circuits as required.
- c. Vibration Isolators: The engine-generator set shall be mounted on vibration isolators either internal or external to the set skidbase.

- d. A 120 VAC heater with thermostat shall be provided within the engine-generator set control panel to eliminate condensation. Contractor shall provide 120 volt circuit from normal utility source as required.
- e. A 120 VAC space heater shall be provided within engine-generator enclosure to eliminate condensation. Contractor shall provide 120 volt circuit from the normal source as required.
- f. Remote Audible Annunciator: Provide remote audible annunciator for engine-generator set with light emitting diode (L.E.D.) indicators. Annunciators shall include the following:
 - 1) Control Switch Not In Auto Position
 - 2) Overcrank
 - 3) Low Lube Oil Pressure
 - 4) High Coolant Temperature
 - 5) Low Coolant Temperature
 - 6) Overspeed
 - 7) High Coolant Temperature Pre-Alarm
 - 8) Low Lube Oil Pressure Pre-Alarm
- g. Main Line Circuit Breakers: Two generator mounted main line molded case circuit breakers shall be installed as load circuit interruption and protection devices. They shall operate both manually for normal switching function and automatically during overload and short circuit conditions. The breakers shall be 100Amp and 125Amp, with 14K asymmetrical interrupting rating.

The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breakers shall meet standards established by Underwriter's Laboratories, National Electric Manufacturer's Association, and National Electrical Code.

Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.

- h. Weatherproof Enclosure: Weatherproof enclosure shall be provided and shall totally enclose the engine/generator set. Enclosure shall be constructed of 16 gauge formed steel construction, modular design with fixed open air intake and discharge louvers for operation of the engine generator at rated capacity with all doors closed. All doors shall be hinged and have key lock latches. Enclosure to be of walk-in height (not less than 6'-0") and of sufficient width and length to allow for servicing of engine generator without removal of enclosure panels.

The engine generator enclosure shall include the following equipment mounted, installed and wired within the enclosure for a complete operation package:

- 1) Engine generator assembly
- 2) Exhaust system
- 3) Batteries, battery rack and cables
- 4) Battery charger

- 5) Jacket water heater
- 6) Main line circuit breaker
- 7) Generator control panel
- 8) 60 amp distribution breaker panel 120/208V, AC, prewired circuits to battery charger and jacket water heater.

Enclosure shall be primed and painted as manufacturer standard.

- i. Radiator mounted automatic load bank: Provide a 50kW, 480v, two(2) step dummy load for weekly automatic exercising of the standby engine-generator system.

Manufacturers:

Onan
Kohler, Or
Approved Equal

AUTOMATIC TRANSFER SWITCHES

General

Automatic transfer switches shall be furnished in ratings of 20 and 150 AMPS with full load current rating at 480V, 3 pole, 3 phase, 60 hertz and shall be listed under UL 1008. The transfer switches shall be capable of switching all classes of load and shall be rated for continuous duty when installed in a nonventilated enclosure constructed in accordance with Underwriters' Laboratories, Inc., Standard UL 508.

Construction and Performance

The transfer switch shall be double throw, actuated by a single electrical operator momentarily energized and connected to the transfer mechanism by a simple over-center linkage with a minimum transfer time of 500 msec.

The transfer switch shall be capable of successfully transferring in either direction with 70% of rated voltage applied to the switch terminals.

The normal and standby contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and standby positions without the use of hooks, latches, magnets, or springs and shall be silver alloy protected by arching contacts and barriers.

Interlocked molded case circuit breakers will not be acceptable.

The transfer switch shall be equipped with a safe manual operator designed to prevent injury to operating personnel if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact opening and closing speed as the electrical operator to prevent a flashover from slowly switching the main contacts.

If the standby power source should fail, the switch shall return immediately to the normal source if normal is available, however, it shall be possible to manually switch to the standby power source for testing purposes even when the normal source is available. All relays, timers, control wiring and accessories shall be front accessible.

Transfer switch, complete with timers, relays and accessories, shall be listed by UL in their Electrical Construction Materials Catalog under Standard UL-1008 (Automatic Transfer Switches) and approved for use on standby systems.

When conducting temperature rise tests to paragraph 17 of UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance test.

The transfer switch shall have a short circuit withstand capability in excess of the protection devices used in conjunction with them.

To establish conformance with the above, the manufacturer shall produce certified test reports from an independent testing laboratory to verify that identical samples have been subjected to 3 phase short circuit currents at 480 V AC for a minimum of 3 cycles duration without contact damage or contact welding and without the use of current limiting fuse protection. Oscillograph traces are to be supplied to verify that the test parameters have been met.

The transfer switch, including all parts and supports, shall meet a seismic loading equal to their weights multiplied by a force factor, C_p , of 1.00. The directions of force, simultaneously and separately, shall be in any horizontal and vertical planes. The switches shall be capable of normal operation during and after seismic loading. Seismic loading shall not cause false operation.

The force factor, C_p , shall be as defined in the Uniform Building Code.

Sequence of Operation

Engine starting contacts shall be provided to start the generating plant should the voltage of the normal source drop below 70% on any of two phases, or 80% on the third phase, after a non-adjustable time delay of 3 seconds to allow for momentary dips. The transfer switch shall transfer to standby as soon as the voltage and frequency have reached 90% of their rating.

After restoration of normal power to 90% of rated voltage, an adjustable time delay period of 0-30 minutes shall delay retransfer to normal power until it has had time to stabilize. If the standby power source should fail during the time delay period, the time delay shall be bypassed and the switch shall return immediately to the normal source.

After the switch has retransferred to normal, the engine generator shall be allowed to operate at no load for an adjustable period of time to, allow it to cool before shutdown.

The transfer switch shall include a test switch to simulate normal power failure, pilotlights on the cabinet door to indicate the switch closed on normal or standby, and four auxiliary contacts (25A at 120 V AC) on the main shaft, two closed on normal and two open on normal.

Additional Features

This transfer switch shall be furnished with a weekly clock and excersizer with "no-load" and "load" selector switch (The engine will normally be tested without the building load: however, a dummy load bank is specified for proper compression of the engine.)

Each transfer switch shall contain the following accessories:

- Normal 0-3 second adjustable time delay to override harmless normal dips and outages.
- Two pilot lights to indicate transfer switch position, normal and standby.
- Two auxiliary contacts, one opens and one closes after normal power fails for engine starting.
- Four auxiliary contacts, two normally open and two normally closed, mounted on the same shaft as the main contacts, for remote indicating and or control.
- Relays which prevent transfer to standby until voltage of generating plant has reached 90% of rated value and frequency has reached 97% of rated value.
- An integrally mounted In-phase monitor shall be provided on each transfer switch to prevent transfer or retransfer until the phase angle between the two power sources is within ten electrical degrees within a frequency differential of two hertz.

Acceptable Manufacturers:

- Asco
- Russelectric
- Zenith
- Others, Approved as Equal

PART 3 - EXECUTION

Installation of the Engine-Generator Set and Accessories shall be in full accordance with the Engine-Generator manufacturer's recommendations. The Engine-Generator manufacturer shall be responsible for shipping the Engine-Generator and Accessories to the jobsite (FOB jobsite, truck bed).

169500 TESTING

PART 1 - GENERAL

General

The applicable portions of Electrical General Conditions, General Conditions and Division 1 - General form a part of this specification.

This section of the specification provides for all materials, equipment, labor and technical supervision to perform and complete the electrical acceptance tests as required and herein specified, for Contractor and Owner furnished equipment.

Tests of all electrical systems shall be made in accordance with local code procedures and/or other codes or regulations having jurisdiction, but shall not be less than the minimum procedures outlined in these specifications and/or on the drawings. Tests shall be conducted in the presence of the Owners Representative.

Acceptance of the tests by the Owner's Representative, shall not be construed as relieving the Contractor of his responsibility for keeping the system in repair and proper operating condition until final acceptance is made by the Owner's Representative and of the provisions of the 'guarantee' as set forth elsewhere in the Project Documents.

Acceptance tests as herein specified are defined as those tests and inspections required to determine that the equipment involved may be energized for final operation tests.

Final Acceptance will not only depend on equipment reliability as determined by the subject tests, but will also depend on complete operational tests on all electrical equipment to demonstrate that the equipment will perform the functions for which it was designed.

These specifications intend that the workmanship, methods, inspections and materials used in erection and installation of the subject equipment shall conform with the accepted engineering practices, IEEE Standards, the National Electrical Code and the specific equipment manufacturers instructions.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Upon completion of the electrical work, the entire installation shall be tested by the Contractor and demonstrated to be operating satisfactory.

To be acceptable the tested equipment must withstand the full voltage for a period of one minute without breakdown. These tests shall be conducted on 208 Wye/120v and 480 Wye/277v systems.

TESTS

General

Prior to de-energizing existing electrical/mechanical equipment, the contractor shall observe and record bus phasing with conductor color coding and terminal connection arrangements so that proper phasing may be restored with confidence.

Tests and adjustments shall be made prior to acceptance of the electrical installation by the owner.

All equipment or wiring provided which tests prove to be defective or operating improperly shall be corrected or replaced promptly by the Contractor at no additional cost to the Owner.

The electrical work shall be free from improper grounds and from short circuits. The correctness of the wiring shall be verified first by visual comparison of the conductor connections with connection diagrams. Individual circuit continuity checks shall next be made by using electrical circuit testers. Last, the correctness of the wiring shall be verified by the actual electrical operation of the electrical and mechanical devices. Any deviation from the wiring indicated on the Plans or accepted drawings shall be corrected and indicated on the Plans.

After the installation is complete, voltage and ampere readings shall be taken at the mains of each panel and with all connected equipment turned on. Any unusual phase unbalance (>20%) shall be corrected by the Contractor at no additional expense to the Client. Plans shall be marked in red to reflect all such changes.

Perform an insulation resistance test on all switchboard busses, bus ducts, motor and feeder conductors, including neutrals, using a megohmmeter. Apply 1000 volts DC to each conductor and maintain for 15 seconds or until reading stabilizes. Minimum value for each conductor shall be 20 megohms at 30 degrees C. Furnish written report of test data to the Owner.

Switchboards

Dielectric Withstand Testing shall be performed on all equipment rated at 800 amperes or more prior to energization of this equipment. Utilize a 60 hertz alternating potential test voltage of 1000 volts plus twice the rated voltage of the devices to be tested. Tests shall be performed between the following:

- 1) Line and Load terminals with the switch open.
- 2) Current carrying parts and the frame of the enclosure with the switch open.
- 3) Poles of opposite polarity with the switch closed.

Wiring

Wiring shall be tested for continuity, short circuits and/or accidental grounds. All systems shall be entirely free from grounds, short circuits and any or all defects.

Insulation test shall be applied to all feeders and subfeeders size #2 AWG or larger, as necessary, to detect possible damage incurred during installation procedure. Such test shall be made with a magnetic generator instrument according to the manufacturer's recommendations. Test readings shall be provided to the ENGINEER prior to job close-out to be forwarded to the Owner.

Apply 1000 volts DC to each conductor and maintain for 15 seconds or until reading stabilizes. Minimum value for each conductor shall be 20 megohms at 30 degrees C. Contractor shall furnish written reports of test results to the ENGINEER to review, accept and forward to the Owner.

Motors

Motors shall be operating in proper direction of rotation and control devices shall be functioning properly. Check all motor controllers to determine that properly sized overload devices are installed and check all other electrical equipment for proper operation. Confirm proper electrical phase rotation by instrument designed for the purpose prior to rotational testing.

Ground Resistance Measurements

The ground resistance of each ground rod and/or grounding plane shall be measured and certified by the Contractor. The Contractor shall submit in writing to the ENGINEER upon completion of the project, the measured resistance of each ground rod and ground system, indicating the location of the rod and grounding system and soil conditions at the time the measurements were performed. When the building water service is used as a grounding electrode, measurements shall be made of this connection. Ground resistance measurements shall be made in normally dry weather, not less than 24 hours after a rainfall, and with the ground under test isolated from other grounds. The resistance to ground shall be measured using the fall-of-potential method described in IEEE No. 142.

169600 PAYMENT

Payment for standby generator will be made at the lump sum bid for Item 1600-1, Standby Generator.

Payment for control panel will be made at the lump sum bid for item 1600-2, Control Panel.

Payment for switchboard will be made at the lump sum bid for Item 1600-3, Switchboard.

Payment for underground conduit and wire will be made at the lump sum bid for Item 1600-4, Underground Conduit and Wire.

Payment for incidental wiring, fittings and devices will be made at the lump sum bid for Item 1600-5, Incidental Wiring, Fittings, and Devices.

Payment for service conduit, wiring and pad for APS, and U.S. West telephone conduit will be made at the lump sum bid for Item 1600-6.

DIVISION 17 - INSTRUMENTATION

170002.10 CIRCULAR CHART RECORDER

The circular chart recorder shall be capable of recording up to four points on a 10-inch chart. The chart recorder shall be fully programmable in order that the recorder can be configured to accept DC voltages, thermocouple, RTD inputs and, specifically, a 4-20 ma DC input signal from an associated magmeter. All necessary signal conversion equipment shall be provided. All nonlinear inputs shall be linearized and provision must be supplied for special linearizations. The chart speed must be programmable from 1-4096 hr/resolution. The ranges and representation on the applied charts. In addition to the recording function, the recorder shall have provisions for individual 16-character tags and

messages per channel. In addition to the chart recording, there shall be a vacuum-fluorescent display that will show the appropriate tag or description and the displayed process variable being measured. The recorder shall also have assignable alarms for each pen. There will also be red LED displays to show the status of the alarms. The recorder shall also have an RS232/RS422 data communications port.

The recorder shall have the capability of integrating and totalling up to four variables such as in the case of flow measurements. These integrating counters shall be 9 digits displayed on the vacuum fluorescent display and shall be selectable as reset or nonreset type.

The recorder shall be suitable for wall mounting and shall be in a NEMA 4X enclosure.

The recorder shall be a Chessell Model 390 to be compatible with other Chessell recorders supplied to the City of Phoenix.

All displays shall be in engineering units. The recorder shall have an accuracy of ± 0.5 percent of span, a dead band of ± 0.2 percent of span, and a repeatability of ± 0.2 percent of span. The recorder shall be powered by 120 volts AC.

One year's supply of charts and ink shall be provided. Electrically isolated inputs and electrical zero and span adjustments shall be provided with no mechanical adjustments. Damping and pen speed response shall be adjustable.

170012.10. MAGNETIC FLOW SENSORS

Magnetic flow sensors shall be furnished and installed as required, complete with associated instrumentation, interfaces, cabling, and, as a minimum, shall consist of the following:

170012.11. MAGNETIC FLOWMETER

Magnetic flowmeter shall be high impedance pulsed DC type constructed with polyurethane liners and 316 stainless steel electrodes suitable for the intended use and capable of withstanding a partial vacuum of 10 feet negative head. No ultrasonic cleaning equipment shall generally be required. Should the manufacturer require ultrasonic cleaning it shall be of the continuous cleaning type integral with the magmeter.

Unless otherwise indicated on Plans, the power supply to the meters shall be 120 volts, 60 hertz. It shall be installed in accordance with DIVISION 16 of these Contract Documents and in conformity with the recommendations of the manufacturer of the meter. These meters shall be splashproof and shall be able to withstand accidental submergence in water (30 feet). The meters shall be coated with a corrosion-proof epoxy paint.

The output of the meter shall be linear and directly proportional to the average velocity of the fluid flowing through the meter tube. Neither turbulence nor variation in velocity profile within the flowing fluid shall affect the accuracy of the transmitter in its ability to measure the average flow. The meter shall also not be affected by a concentric buildup of slime which has the same conductivity as the flowing fluid.

The unit shall be self-zeroing with no adjustment necessary or provided.

Each magnetic flowmeter shall be grounded to a 10 foot long by 5/8-inch diameter copper clad ground rod, or an individual concrete encased group electrode, or an existing grounding electrode conductor.

Stainless steel grounding rings shall be provided to bond liquid to meter, if required by the manufacturer.

Meter sizes and calibrations shall be as shown on Plans and/or elsewhere in these Contract Documents.

The standard calibrated accuracy of the entire system, including readout, shall not be less than ± 0.5 percent of maximum flow or 1 percent of rate for all metered velocities between 3 and 30 feet per second. The meter shall give no "ghost readings" under a condition of zero flow. The repeatability of the scale reading shall not be less than 0.5 percent of full scale reading and shall not be affected by fluctuations of line voltages of ± 10 percent or frequency of ± 1 percent.

A 4-20 ma DC signal, together with power supply, shall be provided.

A 1/2 percent rate accuracy for scaled pulse signal for high accuracy billing register metering shall be provided as required elsewhere in the Contract Documents.

The flowmeters shall be Krohne, Foxboro; Fischer & Porter; or equal. The manufacturer shall have had a meter of the same design and similar size continuously metering like fluid for a period of time to the satisfaction of the Engineer.

170012.12. SIGNAL CONVERTERS

The signal converter assemblies shall be mounted in NEMA 4X enclosures or NEMA 4 enclosures with corrosion-proof epoxy paint. They shall have a 4-20 ma DC and pulse output to be used to totalize, indicate, and control. All converters shall be mounted where they are easily accessible for repair and calibration. If it is required that the flowmeter be mounted in an area where accessibility may be difficult, the electronics portion should be remotely located for ease of service.

Where called for on the Plans, a local flow indicator shall be provided, scaled in engineering units.

Cable and conduit between flowmeters and signal converters shall be furnished and installed. The size and type of cable and conduit shall be in accordance with the meter manufacturer's recommendations.

The signal converters shall be the same manufacturer as the magmeter.

170012.13. CALIBRATOR

One portable secondary calibrator shall be furnished for the magnetic flowmeters. The calibrator shall be a passive device designed to simulate the flow signal from the flowmeter. It shall have a multi-position switch and/or fully adjustable vernier dial for different flow velocities. An electrical adaptor shall be provided for use with the calibrator, for use with low conductivity systems.

The calibrator shall be of the same make as the flowmeters and shall be specifically designed for the type of flowmeter furnished. It shall be the same manufacturer as the magmeter.

179000 PAYMENT

Payment for circular chart recorder will be made at the lump sum bid for Item 1700-1, Circular Chart Recorder.

Payment for magnetic flowmeter signal converter, and calibrator will be made at the lump sum bid for Item 1700-2, Magnetic Flow Sensor.

No separate pay item shall be contained in the Proposal for magnetic flow meter or calibrator. These items shall be included in the price bid for Magnetic Flow Sensor.

Ferro Resonant Isolation Transformers

Ferro resonant isolation transformers shall be provided for all solid state devices and elsewhere where indicated. Regulation shall be ± 3 percent for an input range of ± 10 percent. Common mode noise rejection shall be better than 120 db with transverse mode noise rejection better than 60 db. Voltage spike attenuation shall be better than 250:1.

Isolation transformers shall be as manufactured by Shape Magnetronics, Control Concepts, Inc., or equal.

SAFETY DISCONNECT SWITCHES

Switches of 30 - to 200 - ampere capacity shall be of the enclose quick-make and quick-break type, horsepower-rated, complete with rejecting type fuse clips as required. Switches shall be heavy duty type.

Manufacturers:

Square D
General Electric
Westinghouse
Cutler-Hammer
Or Approved

FUSES

Fuses shall be provided for all switches, including Owner furnished. Fuses shall be rejecting types as designated on drawings by Buss Manufacturing Company designations, or as otherwise specified.

Contractor shall provide 3 spare fuses of every size and type specified, and shall be accounted for prior to project closeout.

GROUNDING

Definitions

Electrical grounding will be grouped into - System Grounding and Equipment Grounding.

Basic Ground shall be interpreted as the earth or the structural metal frame of a building. Sprinkler mains shall not be used for grounding.

Grounding rods hereinafter referred to as ground rods, shall be solid cylindrical rods, 3/4" in diameter and 10 feet in length, or longer, as required to reach specified resistance. Rods shall be of copper clad steel, tinned at the top end for connection, by Copperweld or equal.

It is the intent of these standards to require that all basic grounds have a low resistance, not to exceed 5 ohms. In cases where this required resistance value necessitates construction which is more extensive than that called for under these standards, or by the contract specifications, the contractor shall notify the Owner's Representative before proceeding further with the work.

CONSTRUCTION SPECIAL PROVISIONS

General Requirements

Bare copper bar, cables, or fittings used for grounding shall not be installed in cinder fill or covered with soil containing cinders or other corrosive materials. Cables shall be installed with enough slack to prevent breaking stresses.

All ground cables, bus, etc., in locations where subject to mechanical damage, shall be protected by rigid metal conduit, steel guards, or other suitable shield, as specified by the drawings. In all cases where conduit or other metallic encasement of ground conductors is required, the conductor shall be permanently and effectively grounded to the enclosure at both ends of its length. This requirement applies to all such enclosure regardless of their length.

Where ground conductors pass through floor slabs, building walls, etc., and are not encased in rigid metal conduit as described above, sleeves of PVC and of the required size, shape and length shall be provided, unless otherwise specified or shown on drawings.

All bonding jumpers shall be copper and of a cross-sectional area at least equal to their corresponding grounding conductors. Where attached to equipment, conduits cabinets, etc., suitable approved solderless lugs, compression connectors or clamps shall be used on grounding circuits at any point.

All compression connectors, lugs, etc., used in grounding circuits in any location shall have bolts, nuts, etc., of silicon bronze alloy equal to "EVERDUR" metal. Ground connections, clamps, etc., shall be as manufactured by Burndy Engineering Company, Thomas & Betts Co., Penn-Union Electric Company or approved equal.

Shields of cables shall be grounded through tinned bonding clips similar and equal to Line Material Company Catalog No. 304, which shall be soldered to the sheaths and flexible graded copperbonds installed from clips to ground bus, or other ground, which may be specified. Bonding clips and attachment of bonds to same shall be done only by an experienced cable splicer.

The number, spacing and location of ground rods to be driven shall be as indicated on the drawings or as specified. All connections to ground rods shall be above the ground or floor in which they are located, unless otherwise specified.

Where the ground rod will be inaccessible after construction, the grounding conductor shall be fused to the ground rod by the exothermic process or by brazing.

Fittings for bonding a ground conductor to its own conduit shall be similar and equal to Burndy Engineering Company Type NE tubing to cable connector, or Penn-Union Electric Corporation Type BD reducer connector.

The location of a ground cable to be bonded to building steel, shall be at points where they will not be subject to mechanical damage, but if possible, will be accessible for inspection. Connections to steel shall consist of exothermic welding similar and equal to Burndy Engineering Company's "THERMOWELD" or Erico Products, Inc. "CADWELD KITS".

Where a ground bus is to be bonded directly to building steel, the preferred method of attachment is by welding. Where welding is prohibited, the bus shall be bolted directly to the steel, as approved by the Owner's Representative. Holes drilled through steel members shall not be more than 7/16 inch diameter. Bolts shall be 3/8 inch of silicon bronze alloy and bolt ends shall be peened after assembly. The steel surfaces to which bus is to be bolted shall be cleaned of all paint, ruts, etc., and worked to a bright flat surface. Immediately before bolting terminal to steel member, the contact surfaces of both shall be lightly coated with Alcoa #2 Electrical Joint Compound or approved equal.

Taps and splices in grounding cables shall be made by the thermite process. Thermal welding shall also be used to connect ground cable to building steel when it is ascertained that the weld will not affect the structural properties of the steel.

The neutral terminals of transformers shall be effectively grounded as indicated on the drawings and in these specifications.

The grounding conductor shall be of cable or copper bar, having a cross-sectional area of not less than 30 percent of the area of transformer neutral conductor, or a minimum size of #4/0 stranded cable or 1/4 inch x 1 1/4 inch flat copper, except where specified otherwise. Splices in wire or cable ground leads will not be permitted.

Where primary or secondary circuits having a neutral, or grounded conductor, are distributed between buildings, either overhead or underground, the neutral or grounded conductor shall be permanently and effectively grounded at the available point of access to the conductors which are nearest to their entrance to the building.

The ground conductor shall have not less than 30 percent of circular-mil area of the largest circuit conductor, the minimum permissible size being #8 AWG stranded wire.

All outdoor switch or bus structures and their related cable sheaths, potheads, equipment frames, conduits, etc., shall be effectively grounded as indicated in the drawings and in this specification.

For indoor transformer or switching stations, all equipment structure, potheads, cable sheaths, feeder conduits, equipment frames, instrument transformer secondaries, etc., in transformer and switch rooms shall be connected individually to a continuous rectangular copper bus of the size specified, installed exposed on the walls or equipment structure, as specified or indicated on drawings. Minimum size of the main ground bus shall be 1/4 inch x 1 1/4 inch.

Where driven ground rods are used for outdoor equipment, installed at ground level, at least two (2) 3/4 inch x 10 feet copper clad ground rods or additional sufficient length to obtain allowable ground resistance, shall be driven at locations indicated on drawings or as directed by Owner's Representative.

At least 2 ground leads shall be provided to bond the main ground bus described above, to the building steel or grounding mat. Where the total length of main ground bus in a station or switch room exceeds 100 feet, and for each one hundred (100) additional feet or part thereafter, an additional ground lead shall be provided evenly spaced. These ground leads shall be at least No. 4/0 bare stranded copper cable in continuous unspliced lengths. In

cases where they extend outside of switch room, they shall be encased in 3/4 inch galvanized conduit for mechanical protection. Conduit shall be continuous from point of connection to ground lead to the ground connections at building steel. In all cases, the conductor shall be securely bonded, by approved fittings to its encasing conduit at both ends of each run.

For secondary power system, all metal ducts, bus enclosures, motor frames, steel supports for starters, panels, switches, etc., which are not rigidly secured to, and in contact with the grounded structural metal frame of a building, or conduit system, or which are subject to excessive vibration and loosened ground contacts, shall be securely bonded to building steel or to the conduit system by means of stranded copper jumpers. This jumper shall have a circular-mil cross section of not less than 30 percent of that of the largest conductor entering the enclosure being grounded, with a minimum size of #8 AWG stranded copper being used in any jumper.

Conduits which run to boxes or cabinets having concentric, or eccentric knockouts which partially perforate the metal around the conduit and impair the electrical connection to ground shall be provided with approved bonding jumpers. Jumper shall be connected from a grounding type locknut on the conduit inside the box to a stud or silicon bronze alloy bolt in the cabinet frame.

Conduit expansion joints and telescoping sections of metal raceways not thoroughly bonded otherwise shall be provided with approved bonding jumpers of not less than #8AWG stranded bare copper.

The shielding of insulated cables at splices, shall be individually bonded to the ground bus in each manhole through which it passes. The bond shall consist of a braided copper jumper, connected to the cable sheaths or shielding braids by means of approved, tinned bonding clips installed in accordance with General Requirements and welded to the grounding bus.

PART 3 - EXECUTION

Distribution Panels

Install distribution panels, so that upper most overcurrent operating device is not more than 6 feet 6 inches above finished floor or above raised floor for computer rooms.

Mounting

- Dry wall construction: Toggle bolts
- Concrete and masonry construction: Expansion shields with bolts or screws
- Building structural steel members: Weld preformed channel to structural steel members.

The Contractor shall consider each condition, and if necessary, utilize "unistrut" channels to spread the weight distribution or create a structural framing system supported from the floor and attached to the wall and/or ceiling for additional resistance from overturning.

Dry Type Transformers

Floor Mounted Transformers - Attach floor mounted transformers to concrete floor with expansion shields and bolts with minimum clear space of 12 inches between walls or other equipment for ventilation of transformer.

Mount transformers to wall and floor with isolation pads installed between transformer attachment points and mounting surfaces with isolation sleeves installed around attachment bolts.

Install 18 inch minimum length of flexible conduit between end or metal raceway and transformer on both primary and secondary side connections.

Panelboards

Panelboards shall be installed surface-mounted or recessed-mounted as indicated on the drawings.

Surface-mounted panelboards shall be installed rigid and true, bolted directly to the wall or on mounting supports as applicable.

Recess-mounted panelboards shall be set rigid and true with panel trim flush with finished surface. Contractor shall coordinate wall thickness with tub depth requirements.

Where indicated on the drawings, panelboard trim shall be sanded and painted to match surrounding surfaces.

Safety Disconnect Switches

Safety Disconnect switches shall be installed where indicated on drawings or where required by code. Switches shall be located as close to the equipment as feasible and shall be readily accessible.

Fuses

Fuses shall be installed for all switches. Contractor shall verify fuse sizes and types as adequate for proper overcurrent and fault current protection of specific equipment based on nameplate data of motor or equipment actually provided on the job.

Grounding

All conduit systems, metallic equipment enclosures, motor frames, etc., shall be securely bonded and permanently grounded as required by NEC and local codes.

The cold water pipe ground shall be a solid or stranded, bare or insulated, copper conductor, sized as shown on the drawings, effectively connected to the cold water pipe system at or near the entry into the structure and to the service entrance ground conductor. All other metal pipe systems shall be grounded similarly.

All transformer secondaries shall be grounded by means of a stranded, insulated copper conductor, sized as shown on the drawings, pulled with the feeder to the transformer, and connected to the service entrance ground conductor or bus.

Special or isolated ground systems shall be as detailed on the drawings.

166270 STANDBY ELECTRIC GENERATING SYSTEM

PART 1 - GENERAL

The applicable portions of Electrical General Conditions, General Conditions and Division 1 - General form a part of this specification.

A manufacturer's representative shall conduct a complete system operation test of the Engine and provide training for the Owner's operating personnel. The test shall be certified as 100% operational and installed per the manufacturer's specifications.

The equipment as specified and furnished by the local engine generator supplier/manufacturer shall be warranted by the supplier/manufacturer for a period of years as stated under warranty from the date of acceptance by the Owner.

This engine-generator set will be providing power to a set of duplex 5 Hp wastewater pumps 3-phase at 208 and (1)-3/4Hp single phase at 208 and miscellaneous yard lighting and control and monitoring devices.

Applicable Codes and Standards

All material and workmanship shall comply with the applicable portions of the latest edition of the following codes and standards:

National Fire Protection Association NFPA-70, 37, 20, 99 & 100
National Electrical Code (NEC)
National Electrical Manufacturers Association (NEMA)
NEMA MGI Motors and Generators
Underwriters' Laboratories Inc. Standards (UL)
UL 1008 Standard for Safety for Automatic Transfer Switches

Scope

This specification covers requirements for providing factory built, prototype tested, production tested, field tested, complete and operable standby electric generating system, including all devices and equipment specified herein, shown on the drawings, and/or as required for the service. Materials and equipment shall be new and current, delivered to the site completely wired, tested and ready for installation. This system shall include the following:

1. One standby natural gas engine-generator set rated 20kW, 0.8PF, for 208 Wye/120V, 3Phase, 4W operation.
2. Engine-generator control console shall be resiliently mounted on the generating set and shall include a complete engine start-stop control and monitoring system.
3. Starting batteries with battery charger shall be provided with the engine-generator set.

4. Mounted and loose accessories, control devices, and other equipment as specified herein, and as shown on drawings.
5. Such other components (transfer switches, accessories (Remote Status Panel), parts tests, documents and services, as needed to meet the performance requirements of this specification.

Single Manufacturer

This natural gas engine-generator set shall be manufactured by a single source manufacturer who has been regularly engaged in the production of engine-generator sets for a minimum of ten years. The standby electric generating system described herein, including these components shall be factory built, factory tested and shipped by this single source manufacturer, so there is one source of supply and responsibility for warranty, parts, and service. This manufacturer shall have a local representative who can provide factory trained servicemen, and who has the required stock of replacement parts and technical assistance.

Warranty

A special warranty plate shall be permanently secured to the engine generator and to all major equipment components provided in accordance with the engine generator specifications, i.e., engine generator, circuit breaker, transfer switches, battery charger, etc., to ensure the end-user (Owner) of the system warranty coverage period. Warranty shall include 100% parts and labor on all equipment components furnished by the engine-generator set supplier.

The plate shall be a minimum of 6"x8", manufactured of metal or plastic and shall state the following:

5 Year Extended Warranty

Start-Up date:

Warranty termination date:

24-Hour Emergency Telephone Number:

Preventive Maintenance and Good Housekeeping will be provided by the end user during the five(5) year warranty period.

Safety Standard

The electric generating system must meet all requirements of NFPA 110-1985 including design specifications, prototype tests, one-step full-load pickup and installation acceptance.

The responsibility for performance to this specification includes the entire system and cannot be split up among individual suppliers of components comprising the system, but must be assumed solely by the supplier of the system. The manufacturer shall furnish complete system schematic and wiring diagrams consisting of the engine-generator set and transfer switches (even though mounted in the switchboard assembly) as defined in this specification.

All controls shall be the standard of the manufacturer, who is engaged in the manufacture of engine-generator sets and accessories. The engine-generator manufacturer shall furnish the transfer switches and provide system wiring diagrams that include the transfer switches and the manufacturer's service warranty coverage shall include the transfer switches.

Shop Drawing Submittal Data

Make and model of engine and generator.

Makes and models of switchgear, transfer switches and other major auxiliary equipment, including automatic transfer switch, vibration isolators, radiator, battery charger and silencer (hospital grade).

Manufacturer-produced dimension drawings of the complete engine generator set clearly showing entrance points for each of the interconnections required.

Manufacturer-published kilowatt output curve and published fuel consumption curve.

Unit ventilation and combustion air requirements.

Manufacturer-published transient response data of the complete engine generator set upon 50%, 75% and 100% block loads at 1.0 P.F. Data shall include maximum voltage dips, maximum frequency dips and recovery time periods.

Locations and descriptions of the engine-generator and transfer switch supplier's parts and service facilities within a 50 mile radius of the job site, including parts inventory and numbers of qualified generator set service personnel.

Actual electrical diagrams, including schematic diagrams and interconnection wiring diagrams for all equipment to be supplied.

Drawing showing natural gas connection points.

Engine altitude duration curve.

Generator motor starting curves showing the voltage dips versus starting KVA.

Written five(5) year warranty document (system coverage).

Copy of standard maintenance contract.

Literature

The manufacturer shall have printed literature and brochures describing the standard series specified (not a one of a kind fabrication). Unless specified otherwise herein, all performance and other information shall be as on the manufacturer's printed literature. Performance information shall be the result of test procedures in accordance with nationally recognized standards.

Testing

The intent of this specification is to provide equipment of proven reliability and compatibility. Three separate series of tests shall be performed: Factory Prototype Model Tests, Factory Production Model Tests and Field Tests.

1. Factory Prototype Model Tests: The electric generating system consisting of prime mover, generator, governor, coupling and all controls must have been tested as a complete unit on representative engineering prototype model as required by NFPA 110-1985. The tests, being potentially damaging to the equipment tested, must not be performed on equipment to be sold, but on separate prototype models as specified by NFPA 110-1985, paragraph 3-2.1 thru 3-2.1.2 and their accomplishment certified by means of documentation of the tests accompanying submittal data. These tests shall have included:
 - a. Maximum power level (maximum kW).
 - b. Maximum motor starting capacity (maximum kVA) and voltage dip recovery within seven(7) cycles of applied load.
 - c. Structural soundness (Short-Circuit and Endurance Tests).
 - d. Torsiograph Analysis: The manufacturer of the engine-generator set shall verify that the engine-generator combination, as configured, is free from harmful torsional stresses. The analysis shall include correlation of empirical data from tests on a representative prototype unit. The empirical data must include spectrum analysis of the torsional transducer output within the critical speed range of the engine-generator set. Results of this analysis shall be made available to the specifier on request. Calculations based on engine and generator separately are not acceptable.
 - e. Engine-generator cooling.
 - f. Transient response and steady-state speed control and voltage regulation.
 - g. Generator temperature rise per NEMA MG1-22.40.
 - h. Harmonic analysis and voltage waveform deviation per MIL-STD-705B, method 601.4.
 - i. Three-phase short-circuit test for mechanical and electrical strength. With system operating at rated volts, amps, power factor and speed, the generator terminals must be short circuited ten times on all three phases for a duration of thirty seconds. Engine-generator set must build up and perform normally without manual interventions of any kind such as resetting of circuit breakers or other tripping devices when the short circuit is removed.
 - j. Endurance testing is required to detect and correct potential electrical and mechanical problems associated with typical operation.
2. Factory Production Model Tests: Before shipment of the equipment, the engine-generator sets shall be tested under rated load and power factor for performance and proper functioning of control and interfacing circuits. Testing at unity power