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SPECIFICATIONS

CAMELBACK RANCH DRAINAGE PUMP STATION

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PRELIMINARY

SECTION 01300

SUBMITTAL PROCEDURE

1.0 GENERAL

Where required by the specifications, the Contractor shall submit descriptive information which will enable the Engineer to advise the Owner whether the Contractor's proposed materials, equipment, or methods of work are in general conformance to the design concept and in compliance with the drawings and specifications, descriptive data, certificates, samples, test results, and such other information, all as specifically required in the specifications.

2.0 CONTRACTOR'S RESPONSIBILITIES

Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment, or method of work shall be as described in the submittal. The Contractor shall verify that the material and equipment described in each submittal conform to the requirements of the specifications and drawings. If the information shows deviations from the specifications or drawings, the Contractor shall, by statement in writing accompanying the information, identify the deviations and state the reason therefore. The Contractor shall insure that there is no conflict with other submittals and notify the Engineer in each case where his submittals may affect the work of another contractor or the Owner. The Contractor shall insure coordination of submittals among the related crafts and subcontractors.

3.0 TRANSMITTAL PROCEDURE

A. GENERAL:

Submittals regarding material and equipment shall be accompanied by a transmittal form. Each submittal transmittal shall be separately and sequentially numbered. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittals for various items may be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.

B. DEVIATION FROM CONTRACT:

If the Contractor proposes to provide material or equipment which does not conform to the specifications and drawings, he shall indicate so under "deviations" on the transmittal form accompanying the submittal copies. He shall prepare his reason for a change, including cost differential, and shall request a change order to cover the deviations.

C. SUBMITTAL COMPLETENESS:

Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

4.0 REVIEW PROCEDURE

When the contract documents require a submittal, the Contractor shall submit the specified information as follows:

1. One mylar reproducible and one blueline print of all submittal information exceeding 8-1/2 inches x 11 inches.
2. Seven copies of all the submittal information 8-1/2 inches x 11 inches in size.

Unless otherwise specified, within 30 calendar days after receipt of the submittal, the Engineer shall review the submittal and return the marked-up reproducible original noted in 1 above. Three marked-up copies of the submittal noted in 2 above shall be returned to the Contractor. The returned submittal shall indicate one of the following actions:

1. If the review indicates that the material, equipment, or work method is in general conformance with the design concept and complies with the drawings and specifications, submittal copies will be marked "APPROVED". In this event, the Contractor may begin to implement the work method or incorporate the material or equipment covered by the submittal.
2. If the review indicates limited corrections are required, copies will be marked "NOTE MARKINGS AND CONFIRM". The Contractor may begin implementing the work method or incorporating the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.
3. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "REVISE AND RESUBMIT". Except at his own risk, the Contractor shall not undertake work covered by this submittal until it has been revised, resubmitted, and returned marked either "APPROVED" or "NOTE MARKINGS AND CONFIRM".
4. If the review indicates that the material, equipment, or work method is not in general conformance with the design concept or in compliance with the drawings and specifications, copies of the submittal will be marked "REJECTED". Submittals with deviations which have not been identified clearly may be rejected. Except at his own risk, the Contractor shall not undertake work covered by such submittals until a new submittal is made and returned marked either "APPROVED" or "NOTE MARKINGS AND CONFIRM".

5.0 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

Review of drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, shall not relieve the Contractor of his responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the Engineer or the Owner, or by any officer or employee thereof, and the Contractor shall have no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment so reviewed. A mark of "APPROVED" or "NOTE MARKINGS AND CONFIRM" shall mean that the Owner has no objection to the Contractor, upon his own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

** END OF SECTION **

SECTION 01660

TESTING, BALANCING AND START-UP OF
EQUIPMENT AND SYSTEMS

A. GENERAL

All equipment materials, equipment, water holding tanks, installation, and workmanship included in this contract, shall be tested and inspected to prove compliance with the contract requirements. All costs of testing including temporary facilities and connections shall be borne by the Contractor. For the purpose of this article, "equipment" shall mean any mechanical, electrical, or instrumentation devices and items with one or more moving parts. Installed leakage tests and other piping tests shall be as specified in SECTION 15060.

No tests specified herein shall be applied until the item to be tested has been inspected and approval given for the application of such test. Tests and inspections shall include:

1. The delivery acceptance tests and inspections.
2. The installed tests and inspections of items as installed.

Tests and inspections, unless otherwise specified or accepted, shall be in accordance with the recognized standards of the industry. Testing equipment shall be furnished by the Contractor and shall be appropriate for the use intended. Testing equipment shall be calibrated as often as necessary to insure equipment being tested complies with the specifications.

The form of evidence of satisfactory fulfillment of delivery acceptance test and of installed test and inspection requirements shall be, at the discretion of the Engineer, either by tests and inspections carried out in his presence or by certificates or reports of tests and inspections carried out by approved persons or organizations. The Contractor shall provide and use forms which include all test information, including specified operational parameters, and acceptable in content to the Engineer.

B. DELIVERY ACCEPTANCE TEST AND INSPECTIONS

The delivery acceptance test and inspection shall be at the Contractor's expense for any materials or equipment specified herein and shall include, but not be limited to, the following:

1. Test of items at the place of manufacture during and/or on completion of manufacture, comprising materials test, hydraulic pressure tests, electric tests, performance and operating tests, and inspections in accordance with the relevant standards of the industry and, more particularly, detailed in individual clauses of these specifications to satisfy the Engineer that the items tested and inspected comply with the requirements of this contract. Tests shall be in accordance with individual sections of these specifications or as required hereafter. In any case, all installed equipment and structures shall be tested.

2. Inspection of all items delivered at the site in order that the Engineer may be satisfied that such items are of the specified quality and workmanship.

C. INSTALLED TESTS AND INSPECTION

All equipment shall be tested by the Contractor, after installation, to the satisfaction of the Engineer. Tests shall be carried out in accordance with the specifications and related standards. Any changes, adjustments, or replacement required as a result of the tests shall be carried out by the Contractor as part of the work.

At least 45 days before the time allowed in his construction schedule for commencing testing and start-up procedures, the Contractor shall submit to the Engineer, in duplicate, details of the procedures he proposes to adopt for testing and start-up of all equipment to be operated singly and together, excepting when such procedures have been covered in the specifications. The water required for such tests shall be obtained by the Contractor. After all equipment has passed all other installed tests, the Contractor shall, as a final test, treat wastewater through all portions of the plant, for a minimum continuous period of 5 days during which all equipment and instrumentation shall operate as specified and as a complete system. A partial completion certificate previously issued for any portion of the plant prior to final testing shall not relieve the Contractor of the requirement to perform the final test on the entire system.

During the testing of equipment, the Contractor shall make available experienced factory-trained representatives of the manufacturers of all the various pieces of equipment, or other qualified persons who shall instruct the Owner's personnel in the operation and care thereof. Instructions shall include step-by-step trouble-shooting procedures with all necessary test equipment. Instruction shall be in sufficient detail to satisfy the Engineer that above requirements have been met. All manufacturers' instructions shall be provided in writing.

Installed tests and inspection of equipment shall be carried out by the Contractor at his risk and shall include, but not be limited to:

1. Inspections to show that all the equipment as installed is in good working order.

2. Static tests on all safety circuits, using simulated emergency conditions, to demonstrate that all devices have been properly adjusted and calibrated.

3. Electrical tests for insulation, ground leakage, resistance, and high voltage, as specified in SECTION 16980 of these specifications.

4. Running tests to prove that all equipment is capable of continuously, safely, and reliably performing the operation and functions required by the contract under specified service conditions, including all modes of operation for which the equipment is designed, as nearly as possible similar to those specified. Emergency operation may be simulated if operation under these conditions will damage equipment.

5. In-place performance tests to generate and record all data necessary to demonstrate that all equipment and systems comply with manufacturer's submittal data and the capacity, efficiency, vibration, and other performance requirements of the contract.

If, under test, any portion of the work shall fail to fulfill the contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the work as are affected thereby, shall, if so required by the Engineer, be repeated within reasonable time and in accordance with the specified conditions. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner as a result of repeating such tests.

Where, in the case of an otherwise satisfactory installed test, any doubt, dispute, or difference would arise between the Engineer and the Contractor regarding the test results of the methods or equipment used in the performance by the Contractor of such test, then the Engineer may order the test to be repeated. If the repeat tests using such modified methods or equipment as the Engineer may require, substantially confirms the previous test, then all costs shall be borne by the Owner. Where the results of any installed test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by the Contractor at his own expense.

** END OF SECTION **

SECTION 01730

OPERATING AND MAINTENANCE

1.0 SCOPE

Operating and maintenance information shall be provided for all equipment and shall consist of the names and addresses of the manufacturer, the nearest representative of the manufacturer's equipment and parts, as well as the following items of information:

1. **Lubrication Information:** This shall consist of the manufacturer's recommendations regarding the lubricants to be used and the lubrication schedule to be followed.
2. **Control Diagrams:** Diagrams shall show internal and connection wiring.
3. **Start-Up Procedures:** These instructions consist of the equipment manufacturer's recommendations for installation, adjustment, calibration, and trouble-shooting.
4. **Operating Procedures:** These instructions consist of the equipment manufacturer's recommended step-by-step procedures for starting, operating, and stopping the equipment under specified modes of operation.
5. **Preventative Maintenance Procedures:** These instructions consist of the equipment manufacturer's recommended steps and schedules for maintaining the equipment.
6. **Overhaul Instructions:** These instructions consist of the manufacturer's directions for the disassembly, repair, and reassembly of the equipment and any safety precautions that must be observed while performing the work.
7. **Spare Parts List:** This list consists of the Manufacturer's recommendation of number of parts which should be stored by the Owner and any special storage precautions which may be required.
8. **Exploded View:** Exploded or cut views of equipment shall be provided if available as a standard item of the manufacturer's information. When exploded or cut views are not available, plan and section views shall be provided with detailed callouts.
9. **Specific Information:** When items of information not included in the above list are required, they will be provided as described in the specification for the equipment.

2.0 TRANSMITTAL PROCEDURE

Three copies of the specified operating and maintenance information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears on the drawings. The information shall be organized in the binders in numerical order by the equipment numbers assigned on the

drawings. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.

If manufacturer's standard brochures and manuals are used to describe operating and maintenance procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

3.0 PAYMENT

Acceptable operating and maintenance information must be delivered to the Engineer before the Contractor can be paid for more than 80 percent of the purchase value of that equipment as given on the invoice. Acceptable operation and maintenance information for the project must be delivered to the Engineer prior to the project being 75 percent complete. Progress payments for work in excess of 75 percent completion will not be made until all specific acceptable operation and maintenance information has been delivered to the Engineer.

Transmittal forms as described in SECTION 01300 shall be used to accompany submission of operating and maintenance instruction.

4.0 FIELD CHANGES

Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

** END OF SECTION **

SECTION 02151

SHORING AND BRACING

PART 1 - GENERAL

1.01 SCOPE

This section includes furnishing materials, services, equipment and labor necessary to provide sheeting, shoring, bracing, and other support where required for the protection of structures, excavations, and the safety of personnel. Shoring, bracing, and supports shall be furnished, placed, maintained, and removed by the Contractor. If so noted, sheeting and shoring systems shall be left in place after backfilling.

1.02 SEQUENCING

When construction sequence of structures requires transfer of bracing to completed portion of any structure, the Contractor shall secure written acceptance of the Owner prior to installation of such bracings.

PART 2 - PRODUCTS

There are no products included in this section.

PART 3 - EXECUTION

3.01 GENERAL

The design, planning, installation, and removal of all sheetings, shoring, and bracing shall be such as to maintain the required trench or excavated section and maintain the undisturbed state of the soils adjacent to the trench at and below the excavation bottom. Sheeting and bracing shall prevent any movement of earth which could in any way diminish the width of the excavation to less than the dimension required for construction or otherwise endanger the work or adjacent structure or construction. The Contractor and his subcontractors shall comply with OSHA standards at all times.

3.02 SUPPORT

Horizontal strutting shall not be used below the barrel of a pipe, and the use of a pipe as support for trench making will not be permitted.

3.03 SHEETING

Where possible, sheeting shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it becomes necessary to excavate beyond the sheetings, care shall be taken to avoid trimming behind the face along which the sheeting will be driven. Care shall be taken to prevent voids outside the sheeting, but if voids occur, they shall be immediately filled with sand, and compacted. The Engineer may direct that sheeting and bracing be cut off at any specified elevation.

3.04 REMOVAL

A. If indicated on the drawings, or directed by the Engineer, in writing, sheeting and bracing shall remain in place to be embedded in backfill or concrete. Trench sheeting below the top of pipe shall be left in place.

B. All sheeting and bracing not left in place shall be carefully removed in such a manner as to prevent subsequent settlement of pipe or additional

backfill loadings which might overload the pipe. All voids left or caused by the withdrawal of the sheeting shall be backfilled immediately using materials and compaction methods as specified in SECTION 02220.

** END OF SECTION **

SECTION 02220

EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope. Earthwork includes providing equipment, labor, and materials required or necessary to excavate, fill, backfill, and grade for the construction of structures, pipelines, levees, embankments, channels, fills, roads, and graded areas as specified. The cost of soil analyses, including compaction tests, will be borne by the Owner. Cost of retesting, required because of initial failure to comply with these specifications, shall be borne by the Contractor.

1.02 JOB CONDITIONS

Contractor shall perform his work in such a manner as to not harm the undisturbed condition of the underlying or adjacent soils or damage or prevent the proper placement of fill. Should natural soils or fill be damaged or disturbed by the operations of the Contractor, which precludes the site utilization planned, the Contractor shall correct such damage or disturbance in a way which will provide satisfactory future behavior of the planned pipelines and structures. Corrections required may include, but not be limited to, the removing of natural and fill foundation soils, both laterally and vertically, and replacing with concrete to the required grades, or the constructing of alternate methods of support, or by being liable for the additional cost of constructing alternate methods of support. Cost of such repair, rehabilitation, or modification will be borne by the Contractor.

1.03 QUALITY ASSURANCE

A. References. This section references the following documents. They are a part of this section insofar as specified and modified herein. In case of conflict between the requirements of this section and the listed documents, the requirements of this section shall prevail.

- | | |
|---------------|--|
| ASTM C136-76 | Method of Test for Sieve or Screen Analysis of Fine and Coarse Aggregates. |
| ASTM C1556-64 | Method of Test for Density of Soil in Place by the Sand-Cone Method. |
| ASTM D1557-70 | Method of Test for Moisture-Density Relations of Soils, Using 10 lb (4.5-kg) Rammer and 18-Inch (457 mm) Drop. |
| ASTM D3017-78 | Method of Test for Moisture Content of Soil and Soil Aggregates in Place by Nuclear Methods (Shallow Depth). |
| ASTM D2419-74 | Method of Test for Sand Equivalent Value of Soils and Fine Aggregate. |

B. Tests. As part of the Owner's inspection program, the Owner will take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. Contractor shall remove surface material at locations

designated by the Owner and provide such assistance as necessary for sampling and testing by the Owner or his representative(s). The Owner may direct the Contractor to cut inspection trenches in compacted or consolidated backfill to determine that the Contractor has complied with these specifications, in which case, the General Conditions will govern payment.

Tests will be made by the Owner in accordance with the following:

<u>TEST</u>	<u>STANDARD PROCEDURE</u>
Moisture Content	ASTM D3017
Gradation	ASTM C136
Density In-Place	ASTM D1556
Moisture-Density Relationships	ASTM D1557
Sand Equivalent Value of Soils and Fine Aggregate	ASTM D2419

C. **Compaction.** Compaction of soils shall be required. For purposes of this contract, the degree of compaction will be specified as percent compaction. Percent compaction shall be numerically equal to 100 times the ratio of the compacted fill in-place density to the maximum or relative density as determined by the appropriate, specified, moisture-density test. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.

D. **Compaction and Watering Equipment.** Types of equipment and methods employed in moisture conditioning and compacting of backfill to produce the specified degree of compaction shall be the option of the Contractor. Equipment shall be selected and used which shall not damage pipes of structures.

Construction equipment for application of water shall apply water uniformly, under pressure, and in controlled quantities to variable widths of surface. Watering equipment shall have positive shutoff valves so that leakage shall not result when the system is not in operation.

PART 2 - MATERIALS

2.01 CLASS I BACKFILL

A clean-gravel-sand mixture free from organic matter and, when tested in accordance with ASTM C136 shall conform to the following gradation requirements:

<u>SIEVE SIZE</u>	<u>PERCENT PASSING</u>
3 inches	100
1-1/2 inches	80-100
No. 4	50-100
No. 16	40-90
No. 50	10-60
No. 200	0-10

Class I Backfill material shall have a sand equivalent of 35 or greater when tested in accordance with ASTM D2419.

2.02 CLASS II BACKFILL

- A. Free from roots, organic matter, and other deleterious substances. Material containing stones or lumps exceeding 3 inches in greatest dimension will be rejected.
- B. Plasticity index of at least 15 percent.
- C. Remolded coefficient of permeability not exceeding 10^{-8} cm/sec.

2.03 CLASS III BACKFILL

- A. Material consisting of a soil or a soil-rock mixture free from organic matter or other material considered as a hindrance to compactive effort.
- B. Material shall not contain rocks or lumps over 6 inches in greatest dimension and not more than 15 percent shall be larger than 2-1/2 inches.
- C. Materials from the site other than topsoil are generally suitable for use as Class III backfill.

2.04 DRAIN ROCK

- A. Material shall be imported material and shall be clean, washed, sound and durable.
- B. Well-graded crushed rock, crushed gravel or gravel of 2-1/2 inch maximum size.
- C. Percent passing No. 4 sieve: 25-60.
- D. Percent passing No. 200 sieve: 3-11.

PART 3 - EXECUTION

3.01 GENERAL

A. Control of Water. Contractor shall provide the necessary machinery, appliances, and equipment to keep excavations free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public. Any permits required for disposal of dewatering operations and water shall be obtained and paid for by Contractor. Contractor shall have on-hand sufficient pumping equipment and machinery in good working condition for ordinary emergencies, and shall have workmen available for the operation of the pumping equipment. Dewatering systems shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer.

Control of groundwater shall be such that softening of the bottom of excavations, or formation of "quick" conditions or "boils" shall be prevented. Dewatering systems shall be designed and operated so as to prevent the removal of the natural soils.

During excavating, construction of structures, installing of pipelines and sewers, and placing of fill and trench backfill, excavations shall be kept free of water. The static water level shall be drawn down below the bottom of the excavation so as to maintain the undisturbed state of the natural soils and allow the placement of any fill or backfill to the required density. The dewatering system shall be installed and operated so that the

groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent structures or property.

Release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted fill or backfill, and prevent flotation or movement of all structures, pipelines, and sewers.

B. Removal of Obstructions. Contractor shall remove brush, trees, logs, stumps, roots, heavy sods, heavy growth of grass, decayed vegetable matter, fences, and structures where the proper construction and completion of the work require their removal. Contractor shall also remove rock, stones, broken concrete and pavement, debris and obstructions of whatsoever kind of character, whether natural or artificial, encountered in the work.

Material that is removed as specified above, and is not to be incorporated in the work, shall be disposed of off the site.

3.02 EXCAVATION AND BACKFILL FOR STRUCTURES

A. Excavation. Unless otherwise specified, methods of excavation within the work limits shown may be employed which, in the opinion of the contractor, is considered best. At those locations where the excavation extends below the static groundwater level, Contractor shall take whatever precautions are necessary to maintain the undisturbed state of the natural soils at and below the bottom of the excavation.

Where the undisturbed condition of the natural soils is inadequate for the support of the planned structure, the Engineer shall direct the Contractor to overexcavate to adequate supporting soils and refill the excavated space to the proper elevation in accordance with the procedure specified for backfill, or if underfootings, the space shall be filled with concrete. Quantity and placement of such material shall be as ordered by the Owner and shall be paid for as additional work.

Should the excavation be carried below the lines and grades indicated on the Drawings because of the Contractor's operations, the Contractor shall refill such excavated space, at its expense, to the proper elevation in accordance with the procedure specified for backfill, or, if underfootings, the space shall be filled with concrete as directed by the Engineer. Should the natural foundation soils be disturbed or loosened because of Contractor's operations, they shall be recompacted or removed and the space refilled as directed.

Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services, and for inspection, except where concrete is authorized to be deposited directly against excavated surfaces.

Where pipelines and sewers enter a structure, the requirement for trench excavation shall be complied with up to the excavation line of the structure, unless otherwise specified.

B. Backfill. After completion of foundation footings and walls, and of other construction below the elevation of final grade, and prior to

backfilling, forms shall be removed, and the excavation shall be cleaned of debris.

No backfill shall be placed against or on structures until they have attained sufficient strength to support the loads, including construction loads, to which they will be subjected, without distortion, cracking, or other damage. As soon as practicable after structures are structurally adequate and other necessary work has been done, leakage tests, if specified, shall be performed. Promptly after completion of such tests, backfilling shall be started and shall proceed until completion. The best of the excavated materials shall be used in backfilling within 2 feet of the structures.

Unless otherwise specified, material for backfilling around structures shall be Class III. Backfill shall be placed and compacted as specified in paragraph 3.03 E for subsequent trench backfill.

Where backfill is to replace overexcavation beneath the structure, material for backfilling shall be Class I compacted to a minimum of 95 percent relative compaction as determined by Standard Test Method ASTM D1557.

Backfill around pipelines and sewers within the excavation line of structures shall be the same as that specified for such pipelines or sewers up to the top of the initial backfill to a width of the allowable trench section. Unless otherwise specified, the backfill above the initial backfill shall be the same as that specified for subsequent trench backfill.

3.03 EXCAVATION AND BACKFILL FOR PIPELINES

A. **Excavation.** Unless otherwise specified, excavation for pipelines and sewers shall be open cut. Trenching machines may be used, except where their use will result in damage to existing facilities. Unless otherwise specified, Contractor may use any method of excavation which will not damage or endanger adjacent structure or property or disturb the natural soils at or below the bottom of the excavation.

When additional gravel or crushed rock is required to stabilize a soft, wet, or spongy foundation caused by the operations of the Contractor, such gravel or crushed rock shall be selected by the Engineer and shall be provided by the Contractor.

For pipes 12 inches in diameter and larger, trenches shall be excavated at least 6 inches below the barrel of the pipe.

B. **Trench Width.** The maximum allowable width of the trench measured at the top of the pipe shall be the outside diameter of the pipe exclusive of bells and collars, plus 24 inches, and such maximum width shall be inclusive of trench timbers. A minimum of 6 inches shall be maintained between pipe and trench wall or sheetings. Where pipes are placed in a common trench, a clear distance between pipes shall be maintained to allow backfill to be properly compacted with a minimum distance of 12 inches unless otherwise directed by the Engineer or shown on the Drawings. Whenever the maximum allowable trench width is exceeded for any reason, the Contractor shall, at his expense, embed or cradle the pipe in concrete in a manner acceptable to the Engineer or

provide evidence that the pipe can safely carry the additional loading imposed by the increased trench width.

C. Bedding. Pipes 12 inches in diameter and larger shall have a minimum of 6 inches bedding material below the barrel of the pipe. Bedding material shall be Class I Backfill. Bedding shall be placed and compacted as specified for initial trench backfill and shall be shaped around the barrel of the pipe.

Where stabilization of the undisturbed foundation below the 6 inch bedding or overexcavation from the depth shown is required because of soft, spongy, or unstable condition, backfill selected by the Engineer shall be placed in the trench bottom. Quantity and placement of such material shall be as ordered by the Engineer and will be paid for as additional work.

D. Initial Backfill. After the pipe has been properly laid and inspected, Class III backfill shall be placed around the pipe to a depth of 6 inches over the pipe. Backfill material shall be placed in horizontal layers not exceeding 8 inches in loose depth and compacted by power-operated tampers, rollers, or vibratory equipment to a dry density equal to 95 percent of the maximum dry density as determined by the Compaction Test.

Each layer shall be compacted to the specified density prior to placing subsequent layers. The thickness of the loose layer may be increased when in-place density tests acceptable to the Engineer show that the specified density can be obtained. Compaction may be by water jetting. No further backfilling will be permitted until the initial backfill has been accepted by the Engineer.

E. Subsequent Backfill. Above the level of the initial backfill, the trench shall be filled with Class III material unless otherwise indicated on the Drawings. The backfill material shall be placed in horizontal layers not exceeding 8 inches in loose depth, and shall have a moisture content such that the required degree of compaction may be obtained. Each layer shall be compacted by power-operated tampers, rollers, or other suitable equipment to a dry density equal to 90 percent of maximum as determined by the Compaction Test. Compaction under structures and pavements shall be a minimum of 95 percent relative compaction as determined by ASTM D1557. Each layer shall be compacted to the specified density prior to placing subsequent layers. The thickness of the loose layer may be increased when in-place density tests acceptable to the Engineer show that the specified density can be obtained.

3.04 GRADING

A. Scope. Grading includes stripping roadways, and other grading at the site.

B. Stripping. Vegetation, such as roots, brush, heavy growths of grass, and decayed vegetable matter, rubbish, and other unsuitable material within the area of the work shall be stripped or otherwise removed by the Contractor before fill is started. Surfaces under engineered fill and elsewhere as directed by the Engineer shall be scarified to a depth of at least 5 inches and compacted at a moisture content that will permit compaction to the degree specified for the overlying fill. Topsoil shall be stockpiled separately as directed by the Engineer.

C. Excavation. After stripping has been done, excavation of every description and of whatever substances encountered within the grading limits of the work shall be performed to the lines and grades indicated on the Drawings. Suitable excavated material shall be transported to and placed in the fill areas within the limits of the work.

Excavated materials which are considered unsuitable by the Engineer, and the surplus of the excavated material which is not required for fill shall be known as waste and shall be disposed of at Contractor's expense, as directed in paragraph 3.01. During construction, excavation and filling shall be performed in a manner and sequence that will provide proper drainage.

D. Finish. Areas covered by the work, including excavated and filled sections and transition areas, shall be graded uniformly to meet existing grades. The finished surface shall be reasonable smooth, compacted, and free from irregular surface change. The degree of finish shall be that ordinarily obtainable from either bladegrader or scraper operations. The finish surface shall be not more than 0.2 foot above or below finished grade. Surfaces shall be finished to drain readily. The surface of area on which gravel or pavement surfacing is to be placed shall not vary more than 0.05 foot from established grade and approved cross-section.

3.05 EMBANKMENTS

Embankments shall be constructed with Class II material at the locations and to the lines and grade indicated on the Drawings. Material shall be placed in horizontal layers of 8 inches in loose depth for the full width of the cross-section and compacted as specified in paragraph 3.03 E. for subsequent trench backfill.

3.06 FILL UNDER SLABS AND PAVEMENTS

Where fill is required under slabs or paved areas, Class III fill shall be provided. The material shall be compacted as specified in paragraph 3.03 D. for initial backfill.

3.07 AREA FILL

Area fill shall be Class III material and shall be placed in maximum 12-inch thick horizontal lifts. The Contractor shall route his hauling equipment over each lift as placed and distribute the travel evenly over the entire width of fill so as to obtain the maximum uniform compaction possible.

The fill surface shall be maintained to provide adequate drainage.

** END OF SECTION **

SECTION 02440

FENCING

PART 1 - GENERAL

1.01 SCOPE

Fencing includes a chain-link fence in areas around the main plant site where indicated on the drawings. Fencing shall include gates and all necessary appurtenances.

1.02 SUBMITTALS

Shop drawings and product information shall be submitted to the Engineer in accordance with the provisions of SECTION 01300. Material to be included in the submittals shall include manufacturer's shop drawings with dimensions, weights, and clearances sufficient to indicate the suitability of the equipment for the intended application.

PART 2 - PRODUCTS

Materials for the chain-link fence and gates shall conform to MAG Specifications, except as provided herein. Posts, rails, and braces shall be MAG Standard Type A. Wire fabric shall be 72 inches in width. Bottom selvage shall be open. Posts shall be provided with extension arms with 3 strands of barbed wire made up of three strands No. 12-1/2 gage galvanized steel wire with four point steel barbs spaced at a maximum distance of 6 inches. Concrete for post footings shall conform to the provisions of Division 3 of these specifications.

Concrete footings shall be at least 12-inch diameter by 3-foot deep for fence posts and 18-inch diameter by 4-foot deep for gate posts. All posts shall be set in concrete a minimum of 6" from the bottom of the footing. Concrete bases shall have their tops sloped for drainage. Posts shall be accurately aligned and shall have their tops at constant slope between changes of grade.

Gates shall be chain-link and shall be equipped with suitable hinges to permit a 90-degree swing and a drop bar locking device. A heavy duty padlock with stainless steel core keyed to the plant master system and two keys shall be provided for each gate. Stops to hold the gates open and a center rest with catch shall be provided.

Gates shall be equipped with extension arms and barbed wire to provide protection equal to that of the adjoining fence.

PART 3 - EXECUTION

3.01 INSTALLATION

The equipment specified in this section shall be manufacturer and installed as shown and specified. Nothing herein shall be construed as relieving the Contractor of his responsibility for this portion of the work.

** END OF SECTION **

SECTION 02600

MANHOLES AND CLEANOUTS

PART 1 - GENERAL

1.01 SCOPE

A. This section includes furnishing materials and equipment and installing all manholes and cleanouts as indicated on the drawings and specified herein, and as required for a complete and accessible system.

1.02 APPLICABLE STANDARDS

Standards shall be the latest edition, including addenda, supplements, and revisions. Applicable standards shall include pertinent provisions of the following:

ASTM.

PART 2 - PRODUCTS

2.01 GENERAL

Manholes shall conform in shape, size, dimensions, materials, and other respects to details indicated on the drawings. Inverts shall conform accurately to the size of adjoining pipes. Side inverts shall be curved and main inverts at direction changes shall be laid out in smooth curves of the longest possible radius which is tangent, within the manhole, to the centerlines of the adjoining pipelines. Invert channels shall be formed in the concrete of the base. Outer ends of all openings shall be sealed with a precast concrete plug made watertight with mastic compound or rubber gasket. All pipe shall be connected to manholes with a flexible joint. Neoprene rubber seal waterstops shall be used on all inlet/outlet from manholes for plastic pipe as specified in SECTION 15060, except where otherwise shown.

2.02 DESIGN REQUIREMENTS

A. Manholes shall have precast or cast-in-place concrete bases, as indicated. Walls, barrels, and cones shall be precast concrete sections, not less than 5 inches thick conforming to the requirements of ASTM C478 or C 139. Top of the cone, not to exceed 11 inches, shall be built of reinforced concrete rings to permit adjustment of the frame to meet the finished surface. All cast-in-place concrete shall be Class A and shall conform to the requirements specified under Section 03300, Case-In-Place Concrete.

B. Cast-iron frames and covers shall be standard frame and cover, minimum Class 25, ASTM A48-74 with factory-applied coat of coal tar pitch varnish marked with the word "SEWER". Cleanout frame shall be 8-inch cast iron as indicated on the drawings, marked to indicate service.

C. Joints between precast manhole sections shall be made with round 'O-ring' rubber gaskets with suitable groove on spigot ends, and conforming to the current edition of ASTM C443 or tongue and groove sealed with an approved gasket sealing compound preformed plastic for pipe joints Type I Rope Form such as RAM-NEK as manufactured by K.T. Snyder, or equal.

D. Manhole steps shall be aluminum, having a protective coating of bituminous material. Steps shall be grooved to prevent slipping. Aluminum

shall be 6062-T6 alloy conforming to Federal Specification QQ-4-200/8. Plastic manhole steps which conform to OSHA and ASTM C-48.7 requirements may be used, if cast into manhole sections during manufacture.

E. Mortar for plugging lift holes shall be one part Type II Portland cement to 1-1/2 parts sand, mixed slightly damp.

F. Exterior surfaces of manholes shall be waterproofed. Waterproofing material for exterior surfaces of manholes, shall be as specified in SECTION 09900, for exterior, below grade concrete. Brush or spray applied in accordance with the manufacturer's recommendations. Sufficient time shall be allowed between coats to permit the first to dry.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Precast-reinforced concrete manhole sections shall be set vertically with sections and steps in true alignment. Rubber gaskets shall be installed at all joints in accordance with manufacturer's recommendations. All holes used for handling shall be completely plugged with rubber plugs or mortar. Mortar shall be hammered into holes until it is dense, and excess paste appears on the surface. Mortar shall be finished smooth and flush with adjoining surfaces. If shown on the drawings, exterior surfaces of all manholes shall be given two coats of waterproofing material as specified above.

B. Manhole frames and covers. Frames shall be set with tops conforming accurately to grade of pavement or finished ground surface, or as otherwise indicated on the drawings. Covers shall be left in place in frames on completion of other work at manholes. Cleanout frames shall be set in Class B concrete, 6-inches thick.

C. Infiltration/exfiltration testing. Manholes shall be filled with clean water, after plugging inlet/outlet pipes and allowed to stand 24 hours. Manholes shall then be filled within 2-feet of the top and leakage measured. Leakage shall not exceed 0.1 gal./hr./vert. foot of manhole depth. Manholes shall be tested with fill in place, at the Contractor's option, and tests witnessed by the Owner or his representative.

** END OF SECTION **

SECTION 03150

FORMWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This section includes formwork, including quality of material and workmanship.

B. Related work specified elsewhere includes, but is not necessarily limited to:

Cast-in-Place Concrete

SECTION 03300

1.02 QUALITY ASSURANCE

When so instructed, the Contractor shall submit the design and details of formwork for the Engineer's approval. No concreting shall be commenced until the Engineer has inspected and approved the executed formwork.

Unless otherwise specified, all formwork shall conform with ACI 347.

1.03 SUBMITTALS

Comply with pertinent provisions of SECTION 01300. Within 60 calendar days after date of Notice to Proceed, submit manufacturers' data and installation instructions for proprietary materials including form coatings, ties, and accessories and manufactured form systems, if used.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

A. FORMS. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without excessive and objectionable bow or deflection.

1. Construct formwork for exposed (painted or unpainted) concrete surfaced with smooth faced undamaged plywood or other panel type materials acceptable to the engineer to provide continuous, straight, smooth as-cast surfaces. Furnish in largest practicable sizes to minimize number of joints.

2. Construct formwork for concrete concealed from view or covered with cement plaster with rough sawn boards of sound grade, as approved by the Engineer, to provide a mechanical bond for subsequent application of plaster.

B. FORM TIES. Provide factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection and to prevent spalling concrete surfaces upon removal.

Provide ties so that portion remaining within concrete after removal of exterior parts is at least 3.8 cm (1-1/2") from the outer concrete surface. Provide form ties which will not leave a hole larger than 2.5 cm (1") diameter in the concrete surface.

C. FORM COATINGS. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces

requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

2.02 DESIGN OF FORMWORK

A. GENERAL. Design, erect, support, brace, and maintain formwork so that it will safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation, and position.

1. Carry vertical and lateral loads to the ground by formwork system and in-place construction that has attained adequate strength for that purpose. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.

2. Provide shoring and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured. Support form facing materials by structural members spaced sufficiently close to prevent objectionable deflection. Provide camber in formwork as required for anticipated deflections due to weight and pressures of fresh concrete and construction loads.

3. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities, and within allowable tolerances.

4. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

B. Earth forms, side forms of footings may be omitted and concrete placed directly against excavation only when requested by the Contractor and accepted by the Engineer. When omission of forms is accepted, provide additional concrete 2.5 cm (1") on each side of the minimum design profiles and dimensions shown.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

Examine the substrate and conditions under which work of this Section is to be performed, and correct unsatisfactory conditions which would prevent proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 FORM CONSTRUCTION

A. GENERAL. Construct forms complying with ACI 347, to the exact sizes, shapes, lines, and dimensions shown, and as required to obtain accurate alignment, location, grade, level, and plumb work in finished structures.

Provide for openings, offsets, sinkages, keyways, recesses, moldings, reglets, chamfers, blocking, screeds, bullheads, anchorages, inserts, and other features required. Use selected materials to obtain required finishes.

Forms for openings and construction which accommodates installation by other trades whose materials and products must be fabricated before the opportunity exists to verify the measurements of adjacent construction which affects such installations, shall be accurately sized and located as dimensioned on the Drawings. In the event that deviation from the Drawing dimensions results in problems in the field, the Contractor shall be responsible for resolution of the conditions as approved by the Engineer without additional expense to the Owner.

B. FABRICATION. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to temporary openings on forms in as inconspicuous locations as possible, consistent with design requirements. Form intersecting planes to provide true, clean cut corners.

C. FALSEWORK. Erect falsework and support, brace and maintain it to safely support vertical, lateral, and asymmetrical loads applied until such loads can be supported by in-place construction. Construct falsework so that adjustments can be made for take-up and settlement. Provide wedges, jacks, or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure, make necessary adjustments to produce work of require dimensions.

D. FORMS FOR EXPOSED CONCRETE.

1. Drill forms to suit ties sued and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes.

2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.

3. Use extra studs, walers, and bracing to prevent objectionable bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material which will produce bow.

4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.

E. CORNER TREATMENT. Unless shown otherwise, form chamfers with 2 cm x 2 cm (3/4" x 3/4") strips, accurately formed and surfaced to produce uniformly

straight lines and tight edge joints on exposed concrete. Extend terminal edges to required limit and miter chamfer strips at changes in direction.

F. CONTROL JOINTS. Locate as indicated.

G. PROVISION FOR OTHER TRADES. Provide openings in concrete formwork to accommodate work of other trades. Verify size and location of openings, recesses, and chases with the trade requiring such items. Accurately place and securely support items to be built into forms.

H. CLEANING AND TIGHTENING. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is placed. Retighten forms immediately after concrete placement as required to eliminate mortar leaks.

3.03 FORM COATINGS

Coat form contact surfaces with form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

3.04 INSTALLATION OF EMBEDDED ITEMS

A. GENERAL. Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of the items to be attached thereto.

B. Edge forms and screed strips for slabs. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support types of screeds required.

3.05 SHORES AND SUPPORT

Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified. Submit a shore removal and reshoring schedule and drawings for the Engineer's review before proceeding with this work. Do not proceed until schedule and drawings have been reviewed.

3.06 REMOVAL OF FORMS

A. GENERAL. Formwork not supporting concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 10 degrees C (50 degrees F) for 7 days after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operation, and provided that curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements may not be removed in less than 14 days, and not until concrete has attained design minimum 28 day compressive strength. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of the concrete location or members, as specified in other Sections.

C. Form facing material may be removed four days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

D. If concrete is placed in hot, dry weather, the forms shall be loosened after the time specified herein so that the concrete surfaces can be kept moist or coated with a curing membrane.

3.07 RE-USE OF FORMS

Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated, or otherwise damaged formfacing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork. When forms are re-used for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets.

** END OF SECTION **

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This section includes furnishing and installation concrete reinforcing where shown and indicated on the drawings and described herein.

B. Related work specified elsewhere includes, but is not necessarily limited to:

Hot Weather Concreting	SECTION 03052
Concrete Formwork	SECTION 03150
Cast-in-Place Concrete	SECTION 03300

1.02 QUALITY ASSURANCE

Reference Standards. Standards shall be the latest edition, including addenda, supplements, and revisions.

ASTM A615-S1, Grade 60
ACI 318-83

1.03 SUBMITTALS

The following information shall be provided in accordance with SECTION 03300:

1. Bar placement drawings,
2. Bar lists and bending details,
3. Certified mill test analyses, tensile and bend test results,
4. Bar tags, and
5. Welder qualification certificate in accordance with ASTM D12.a-75.

1.04 PRODUCT HANDLING

A. DELIVERY. Deliver reinforcement to the job site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

B. STORAGE. Store reinforcement at the job site in a manner to prevent damage and accumulation of dirt and rust.

C. STEEL WIRE. Comply with ASTM A 82.

D. SUPPORTS FOR REINFORCEMENT. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place.

1. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, and other unacceptable materials.

2. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

3. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with either hot-dip galvanized or plastic protected legs.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise shown or specified, all reinforcing steel shall be fabricated in the shop and placed in the field in accordance with the drawings and ACI 315.

B. Reinforcing bars shall be clean and free from loose mill scales, loose rust, oil, grease, tar, paint, concrete droppings, salt contamination, or other deleterious materials, and shall be maintained so up to the time of concreting. If any cleaning of reinforcement is required, the Contractor shall submit his proposal for such cleaning to the Engineer and obtain his approval.

2.02 MATERIALS

A. **REINFORCING BARS.** All reinforcing shall, as a minimum, meet the requirements of ASTM for grade 60 deformed bars.

B. **WELDED WIRE FABRIC.** Welded wire fabric shall be electrically-welded fabric of cold drawn wire of gage and mesh indicated and shall conform to ASTM A185.

2.03 FABRICATION

A. **GENERAL.** Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI Manual. In case of fabricating errors, do not rebend or straighten reinforcement in a manner that will injure or weaken the material.

B. **UNACCEPTABLE MATERIALS.** Reinforcement with any of the following defects will not be permitted in the Work:

1. Bar lengths, depths, and bends exceeding specified fabrication tolerances.

2. Bends or kinks not indicated on Drawings or final Shop Drawings.

3. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 - EXECUTION

3.01 STORAGE AND PROTECTION

All reinforcing stored on-site shall be stored in an area where minimum traffic occurs and shall be raised off the ground on pallets or other suitable support. In no case shall reinforcing that has been deformed by rusting or heavy traffic loads be used.

3.02 INSTALLATION

A. GENERAL

1. Comply with specified standards for details and methods of reinforcement placement and supports and as herein specified.

2. Place reinforcement to obtain the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.

3. Provide sufficient numbers of supports and of strength to carry reinforcement. Do not place reinforcing bars more than 5 cm (2") beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

4. The reinforcement shall be placed accurately in accordance with the drawings and be supported and maintained in position by wire ties or suitable clips at bar intersection and by a minimum number of spacers to maintain the reinforcement in its correct position. The spacers shall be securely fastened to the reinforcement at the time of placing.

B. If the Contractor proposes to use waterstops or other waterproofing membrane, the reinforcement shall be placed in such a manner that no damage is done to the waterproofing membrane.

C. In slabs provided with two or more layers of reinforcement, the parallel layers of steel shall be supported by steel chairs. Spacers shall be provided at each chair to support layers of reinforcement from the concrete carpet or formwork.

D. **SPLICING.** Where splicing of reinforcement is required, the length of the lap joints shall not be less than forty times the diameter of the larger bar.

Fabric reinforcement, when laid continuously with other sections of reinforcement or when spliced, shall have a minimum lap of 12 inches for the main wires and 8 inches for the transverse wires. The use of off cuts will not be permitted.

E. Heating or welding of bars will be permitted only with prior approval of the Engineer. Reinforcing rods to be welded shall be preheated to a minimum of 200 degrees F at a distance of 3 inches each side of the weld, and then welded using a low-hydrogen type welding rod.

F. Reinforcing shall not be bent or re-straightened in a manner that might injure the material.

G. No concreting shall be commenced until the Engineer has inspected and approved the placement of reinforcement.

** END OF SECTION **

SECTION 03250

CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This section includes all labor, material, and services required to install anchors, inserts, waterstops, sealants, and admixtures in cast-in-place concrete.

B. RELATED WORK. Related work described elsewhere includes, but is not necessarily limited to:

Cast-in-Place concrete	SECTION 03300
Waterproofing and Sealants	SECTION 07100

1.02 SUBMITTALS

A. GENERAL. Submittal and review procedures shall be as specified in SECTION 01300 of these specifications.

B. PRODUCT DATA. Manufacturer's literature and the Contractor's proposed usage details shall be submitted for the following items:

1. Joint fillers,
2. Waterstops,
3. Sealants, and
4. Admixtures.

PART 2 - PRODUCTS

2.01 MATERIALS

A. WATERSTOPS. Waterstops shall be installed at the Contractor's option as qualified by the Drawings. Waterstops shall be as specified in SECTION 07100.

B. JOINT FILLER. Joint fillers such as cork (resin-bonded), rubber, and other materials conforming to ASTM D1752 may be used.

C. SEALANTS. Sealants shall be as specified in SECTION 07100.

D. ADMIXTURES. Admixtures shall not be used without the written approval of the Engineer. Proposal shall be submitted according to requirements of SECTION 01300, at least 30 days prior to start of any concreting operation. Admixtures shall be introduced into the concrete mixture only at the time and dosage recommended by the manufacturer and approved by the Engineer. Calcium chloride or any admixture containing calcium chloride shall not be used.

E. INSERTS AND EMBEDMENTS. Anchor bolts shall be located where shown on the Drawings and shall be as specified by the equipment manufacturer and, unless otherwise indicated, shall be hot-dip galvanized or stainless steel. Expansion anchors shall not be used without approval by the Engineer. Expansion type anchors shall be Phillips Red Head or approved equal and tested and accepted by the International Conference of Building Officials (ICBO). Unless noted otherwise, anchor bolts shall conform to ASTM 307.

Stainless steel bolts, nuts, and washers shall conform to ASTM A320, Type 316, unless noted otherwise on the Drawings or in these specifications.

PART 3 - EXECUTION

3.01 GENERAL

All expansion and construction joints in water containing structures shall include either a waterstop or a joint filler sealant.

3.02 INSTALLATION

A. WATERSTOPS.

1. For Expansion and Contraction Joints: End joints in waterstops shall be held to a minimum. When unavoidable, joints may be used. However, joints shall be shop fabricated so that only straight joints will be field spliced. After splicing, the joint shall develop the effective watertightness of a continuous waterstop and permanently retain flexibility. Waterstops shall be securely held in position during the concrete placing operation so that they are not jarred from position during the concrete placing operations. If waterstops are deflected during concrete placement the Contractor shall remove the surrounding concrete, re-set the waterstop, and replace the concrete, all at his own expense. The Contractor may choose to construct a watertight joint without the use of waterstops upon approval by the Engineer.

2. Waterstops for Cold Joints and Control Joints: Installation shall be as per manufacturer's recommendations. Waterstop shall be installed using both a primer/adhesive and concrete nails at one foot on center. Waterstop shall be located on positive-pressure side of reinforcing steel, outside of keyways, no closer than 1/2 inch to the edge of the concrete slab.

B. JOINT FILLERS AND SEALANTS. Joint fillers and sealants shall be used on all expansion and contraction joints on all structures and where shown on the drawings for control joints. Depending on the application, fillers and sealants may be used together or with waterstops. Prior to being sealed, all joints shall be dry and completely free of grease, dust, scale, dirt, and form oil. To insure this, the Contractor shall wire brush or lightly sandblast joints, blow out with compressed air and apply primer before applying sealants. Preformed joint filler shall be placed before concrete is poured. The Contractor shall be careful to protect cork fillers from moisture-before placement, to prevent their expansion or deterioration.

C. INSERTS AND EMBEDDING. Where pipes, castings, or conduits pass through walls, the Contractor shall place such pipes or castings in the forms before pouring the concrete, or in special cases, with the express consent of the Engineer or as specified, he shall build approved boxes in the forms to make cored openings for subsequent insertion of such pipes, castings, or conduits as directed by the Engineer.

Additional reinforcement shall be provided around large openings as shown on the drawings. The pipes, castings, or conduits as specified shall be grouted in place by pouring in grout under a head of at least 4 inches. The grout shall be poured, rammed, or vibrated into place to fill completely the space between pipes, castings, or conduits and the sides of the openings so as to obtain the same watertightness as the wall itself. The grouting material so placed shall be surfaced when the forms are removed to give a uniform appearance to the wall if exposed to view.

** END OF SECTION **

SECTION 04200

UNIT MASONRY

PART 1 - GENERAL

1.01 DESCRIPTION

This section includes all masonry work required for a complete structure.

1.02 QUALITY ASSURANCE

All work shall be performed by skilled craftsmen experienced in the type of work required.

1.03 SUBMITTALS

Submit complete information on masonry units, mortar, steel reinforcement, and grout in accordance with SECTION 01300.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete masonry units shall conform to ASTM C-90-64T, grade NI, f'm - 1,350 psi, hollow load bearing units. Block shall be as follows:

12" x 8" x 16" and 8" x 8" x 16" plain CMU, plain color, where concealed or where shown on the Drawings.

8" x 4" x 16" plain split face CMU, plain color, where shown on the Drawings.

Other sizes as shown and as required.

B. Mortar shall conform to ASTM C-270, Type "S", f'm - 1,800 psi at 28 days, natural color.

C. Horizontal reinforcement shall be 9 gauge Dur-O-Wal.

PART 3 - EXECUTION

3.01 CMU

All walls shall be laid in common running bond, except as shown otherwise. All coursing shall be laid out with a story pole and courses shall be maintained level.

Columns, beams, joists, and similar structural members shall be anchored to the walls with anchor bolts or their equivalent. Anchors shall be fully and solidly grouted in place. Embedment shall not be less than two-thirds of the wall thickness.

Masonry units shall be neatly cut with a water-cooled carborundum or diamond saw or by other approved methods when necessary to obtain bonding or joining as detailed on the Drawings. Rough, jagged, broken, or otherwise defective units shall not be accepted.

Vertical head joints shall be buttered well for thickness equal to the face shell of the unit, and these joints shall be shoved tightly so that the mortar bonds well to both units. Joints shall be solidly filled from the

face of the block to at least the depth of the face shell. Lintels, capping units, all bearing plates, etc., shall be set in a full bed or mortar.

The starting joint on foundation shall be laid with full coverage on the bed. Mortar joints shall be straight, clean, and uniform in thickness. Unless specified otherwise, the horizontal and vertical mortar joints shall be 3/8" thick with full mortar coverage on the face shells and on the webs surrounding cells to be filled with grout.

3.02 REINFORCEMENT

All concrete masonry units shall be reinforced as shown on the Drawings and as follows: Install vertical steel at all corners, intersections, and ends of walls, at each jamb or all openings, and as shown and detailed on the Drawings.

All vertical steel shall be continuous (or lapped 30 bar diameters) from foundation to top of wall.

Vertical steel shall be positioned in center of grouted masonry void in all concrete block walls.

All masonry shall be reinforced with standard 9 gauge Dur-O-Wal wire reinforcing at 16" vertical intervals. All splices in Dur-O-Wal shall lap a minimum of 6 inches. Dur-O-Wal shall be No. 8's at 8" walls, No. 12's at 12" walls.

3.03 GROUT

Grout all cells and bond beams containing reinforcement with concrete grout, 2,000 psi at 28 days. Maximum aggregate size shall be 3/8 inch. Grout shall be tested by an independent testing laboratory. Contractor shall pay all costs.

Provide cleanouts at bottom of each grouted cell if grout lift exceeds 4'-0". Maximum height of any grout lift shall not exceed 8'0"-.

3.04 FINISH

At completion of job, point and fill all holes and cracks in exposed mortar joints. --

All concealed joints shall be struck flush, including surfaces to receive waterproofing and cement plaster. All exposed joints, including all joints at interior masonry surfaces, shall be tooled concave.

** END OF SECTION **

SECTION 07100

WATERPROOFING AND SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This Section includes all materials required to provide waterproofing at expansion, construction, and control joints in concrete, joints around metal items built into concrete, and pipe penetrations at walls, floors, and manholes.

1.02 SUBMITTALS

Submittals and manufacturers' descriptive literature shall be provided in accordance with the provisions of SECTION 01300.

PART 2 - PRODUCTS

2.01 WATERSTOPS

Waterstops for cold joints and control joints shall be of the self-pressuring type, containing at least 75% sodium bentonite. Waterstops shall be as supplied by American Colloid. Waterstops for expansion and contraction joints shall be polyvinyl chloride (PVC), conforming to Corps of Engineers Spec. No. CRD-C 572. Reclaimed PVC will not be permitted. Minimum width is 6 inches.

2.02 SEALANTS

Sealants shall be premium grade, high-performance, moisture cured, 1-component, polyurethane base elastomeric sealant meeting FED Spec. TT-S0230C, Class A. Sealants shall be non-sagging for vertical or sloping joints and self-leveling or pourable for horizontal joints. Sealants shall be suitable for continuously submerged conditions. For joints subject to traffic, Type I (self-leveling), Sikoflex 12 SL or approved equal; for joints not subject to traffic, Type II (non-sag), 35 psi stress at 50% tensile strain (ASTM D-412), plus and minus 50% movement capability, Sikoflex 15 LM or approved equal shall be used.

PART 3 - EXECUTION

3.01 WATERSTOPS

Waterstops shall be installed in accordance with manufacturer's recommendations, and as specified in SECTION 03250 for joints in concrete, and in SECTION 15060 for manhole entrances.

3.02 SEALANTS AND CAULKING

A. Sealants shall be installed in accordance with the manufacturer's recommendations and as specified in SECTION 03250. All applications shall be made to completely clean and dry surfaces, having no surface laitance or loose materials. Free of any traces of curing compound, form oil, or other chemicals. Where joint will be immersed in water, use a primer as recommended by the manufacturer.

B. Sealant shall be forced into place with sufficient pressure to completely fill joint grooves and expel all air. Exposed sealant shall be uniform and smooth.

C. All adjoining surfaces shall be cleaned of all smears or other defects resulting from sealing or caulking operations. Cleaning shall be done as the work progresses, using solvent or other cleaning agent recommended by the manufacturer.

** END OF SECTION **

SECTION 07110

MASONRY WATERPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION

Work in this Section includes all items necessary to waterproof masonry units.

1.02 QUALITY ASSURANCE

Work shall be performed by skilled labor experienced in the type of work required.

1.03 SUBMITTALS

Submit complete information in accordance with SECTION 01300 along with Contractor's guarantee.

PART 2 - PRODUCTS

2.01 WATERPROOFING

Waterproofing shall be Bithutene, manufactured by W.R. Grace & Co., a 0.60" self-adhering membrane.

2.02 PRIMER

Bithutene Primer P-1300.

2.03 CORNER FILLETS

Daraweld - C mixed with cement mortar or liquid membrane LM-3000. Do not use wood of fiber cant strips.

2.04 JOINT SEALER

Bithuthene EM-3000.

PART 3 - EXECUTION

3.01 WATERPROOFING

Waterproofing shall be applied at all areas where earth backfill is placed against walls, as detailed on the Drawings, and as required to waterproof the blower building where it comes into contact with earth below finish grade.

The waterproofing membrane coating system shall be installed by an approved applicator of the manufacturer. The manufacturer shall also provide on-the-job inspection, technical assistance, and membrane-application guidance as necessary to complete the waterproofing membrane application.

Before installation, the Contractor shall inspect the surface to receive waterproofing and assure that the surface is clean, dry, sound, smooth, and free of dirt and debris. All areas that are not satisfactory shall be reported to the General Contractor and necessary repairs shall be made before waterproofing commences.

All surfaces to receive waterproofing shall be smooth, dry, clean, and firm. Concrete shall be cured and in place a minimum of 7 days prior to application of the membrane. Remove all sharp protrusions. Masonry joints shall be struck flush.

Prime the masonry surface with Bithutene Prime P-1300 with a lambswool roller. Prime only those areas which will be covered with membrane in a working day. Areas not covered with membrane in 24 hours shall be reprimed. Cover primed surfaces immediately where contaminants accumulate on the surface.

Cover all inside and outside corners with an initial strip a minimum of 11-inches wide centered on the axis of the corner, followed by the full width of Bithutene Membrane application. Outside corners shall be free of sharp edges. Inspect surfaces adjacent to all corners and repair, if necessary, to provide a smooth, dense surface. Inside corners should receive a fillet formed with epoxy mortar or latex-modified cement mortar (such as Daraweld-C mixed in with cement mortar) and a double coverage of membrane as described above. Do not use fiber or wood cants. An alternate method is to use Liquid Membrane LM-3000 for the fillet. Apply LM-3000 6-inches in each direction from the corner and form a fillet with a minimum 3/4" face.

Apply Bithutene Membrane vertically in strips of 8-feet in length or less. Edge seams must be overlapped at least 2-1/2". Press edges with a metal or hardwood tool such as a hammer or knife handle. Failure to use heavy pressure at terminations can result in a poor seal. Nailing of the membrane is usually not required. However, if nailing is required, use large-headed nails on 12-inch centers. Cover nails with an 8-inch wide strip of Bithutene Membrane.

At the base of the foundation wall, Bithutene Membrane must be drawn down over the edge of the footing, and rolled or pressed firmly.

Apply a troweled bead of Bithutene EM-3000 to all vertical and horizontal terminations.

Seal all daily terminations with a thin troweled bead of EM-3000. Bithutene must not be applied in any areas permanently exposed to sunlight.

Patch tears and inadequately lapped seams with Bithutene Membrane. Slit fishmouths and repair with a patch extending 6-inches in all directions from the slit and seal edges of the patch with EM-3000. Inspect membrane thoroughly before covering and make any corrections immediately.

Install protection board to avoid damage. Board shall be Bithutene Protection Board BP-3000 adhered with Bithutene Protection Board Adhesive PBA-3000, applied at a rate of 250-350 square feet per gallon.

Apply entire waterproofing membrane system in strict accordance with manufacturer's instructions.

3.02 GUARANTEE

The waterproofing system shall be guaranteed for a period of two years after the date of substantial completion. Any required repairs shall be accomplished by the Contractor at no additional cost to the Owner, including removal and replacement of backfill, patching, and any other work necessary for repair.

** END OF SECTION **

SECTION 09900

PAINTING AND FINISHING

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. Painting and finishing shall include all materials, labor, tools, equipment, and services required for the furnishing and application of all painting and finishing as specified herein or as indicated on the Drawings. Work shall include, but not be limited to, cleaning and preparation of surfaces, paint materials, miscellaneous materials and the application of all paint and other coating materials.

B. RELATED WORK. Pipe marking system shall be as specified in SECTION 15060. Galvanized, anodized and shop-finished item as specified under the appropriate Section, including SECTIONS 05510, 05520, and 05530, as applicable.

1.02 QUALITY ASSURANCE

A. CODES AND STANDARDS. In addition to the requirements of these specifications, the work to be performed under this Section shall comply with the following codes and regulations:

1. Steel Structural Painting Council Specifications (SSPC).
2. National Association of Corrosion Engineers Standards (NACE).
3. Applicable Standards of American National Standards Institute, Inc. (ANSI).
4. Occupational Safety and Health Act Regulations (OSHA).

B. SAFETY. In addition to any safety precautions called for in the codes and standards listed herein, further safety precautions shall include lockout of moving equipment and de-energizing of electrical equipment.

C. PAINTER'S QUALIFICATIONS. The Contractor shall cause the work specified under this Section to be performed by or under the supervision of a qualified painter. The Contractor shall be prepared to document the painter's experience, competence, and ability to comply with the requirements of these specifications and to complete the work in a timely manner. All documents shall be submitted to the Engineer for review before the work specified herein is started. However, nothing herein shall be construed as relieving the Contractor of his general responsibility for the work.

D. STANDARD PRODUCTS. All materials, supplies, and articles provided shall be the standard products of recognized, reputable manufacturers. All paints in a paint system shall be the products of one manufacturer. The number of paint suppliers shall be as few as practicable.

The standard products of manufacturers other than those specified will be accepted when it is demonstrated to the satisfaction of the Engineer that they are equal in composition, durability, usefulness, and convenience for

the purpose intended. Substitutions will be considered, provided the following minimum conditions are met:

1. The proposed paint system shall employ an equal or greater number of separate coats to achieve the required dry film thickness.
2. The proposed paint system shall employ coatings of the same generic type.
3. All requests for substitution shall carry full descriptive literature and directions for application, along with complete information on generic type, nonvolatile content by volume and a list of at least 10 similar projects, all at least three years old, where the coatings have been applied to similar exposures.
4. If the above mentioned data appears to be in order, the Contractor shall provide certified laboratory data sheets showing the results of complete spectrographic and durability tests performed on the proposed substitute. Tests shall be performed by an independent testing laboratory selected by the Engineer, and all costs incurred in the testing program shall be charged to the Contractor.

In any case, the Engineer shall be sole and final judge of the equality of any proposed substitution to the specified item.

E. PRE-JOB CONFERENCE. Before the work specified herein is started, a conference among the Engineer and the Contractor, the painter and the paint supplier shall be held to establish a schedule of work to be accomplished. This schedule shall, at a minimum, define the order of work items to be performed, the necessary time lapse between performance of work items and the manner of performing these work items. The schedule shall be subject to the Engineer's review. Once reviewed, and when the Engineer has not taken any exceptions, the schedule shall be strictly observed. However, establishment of this schedule shall not be construed as relieving the Contractor of his general responsibility.

1.03 SUBMITTALS

Before any paint materials are delivered to the job site, the Contractor shall submit a complete list of all materials proposed to be furnished and applied under this Section.

- A. Two identical sets of samples of actual paint colors shall be submitted for acceptance at least 60 days prior to painting. Samples of each color and system used shall be painted on 8-1/2-inch by 11-inch material. The material for the samples, where possible, shall be the same material as that on which the coating will be applied in the work.
- B. For each paint, the Contractor shall furnish the paint manufacturer's specific application instructions which shall include the following:
 1. Surface preparation recommendations.
 2. Type of primer, if required.

3. Maximum dry and wet mil thickness per coat.
4. Minimum and maximum curing time between coats, including atmospheric conditions for each.
5. Curing time before submergence in water.
6. Thinner to be used with each paint.
7. General ventilation requirements.
8. Atmospheric conditions during which the paint shall not be applied.
9. Allowable methods of application.
10. Maximum allowable moisture content and minimum age of plaster, concrete, and wood surfaces at time of paint application.

1.05 DELIVERY AND STORAGE

All materials shall be delivered to the job site in their original, unopened containers bearing the manufacturer's name, brand, batch number, date of manufacture, and any special directions.

Only the approved material shall be stored at the job site, and only in designated areas restricted to the storage of paint materials and related equipment. All paints shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Storage of flammable materials shall conform with State and local safety codes. Emulsion type paints shall be protected from freezing. Materials exceeding storage life recommended by the manufacturer will be subject to rejection and, if so rejected, removed from the site.

The Contractor shall provide one unbroken gallon container of each color and type of coating and each type of solvent and thinner required by these specifications for future maintenance. Spare paint supplies shall be stored as directed by the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

Paint materials shall be as specified for each paint system. Materials used in a paint system shall be the product of a single manufacturer. No paint materials shall be used until the Engineer has inspected the materials and obtained the information data on the container labels.

2.02 PAINTING SCHEDULE

This Section describes the various paint systems to be used on this project and specifies the dry film thickness range in mils. Systems shall be Tnemec (specified), Koppers, Porter, or equal.

2.02.01 Steel Structural, Miscellaneous, Pipes, and Equipment
Including Hollow Metal Frames and Doors.

A. Exterior, Non-Immersion
System No. 70-1, Aliphatic Polyurethane
Surface Preparation: SSPC-SP6, Commercial Blast Cleaning

First Coat:	66-(color), Hi-Build Epoxoline	Min.	Max.
		4.0	-- 6.0
Second Coat:	70-(color) Endura Shield	<u>1.5</u>	-- <u>2.5</u>
		5.5	-- 8.5

B. Interior Non-Immersible - Severe Exposure
System No. 66-2, Epoxy-Polyamide
Surface Preparation: SSPC-SP6, Commercial Blast Cleaning

First Coat:	66-1211, Epoxoline Primer	Min.	Max.
		3.0	-- 5.0
Second Coat:	66-(color) Hi-Build Epoxoline	<u>4.0</u>	-- <u>6.0</u>
		7.0	--11.0

C. Immersion-Potable or Non-Potable Water
System No. 66-2, Epoxy-Polyamide
Surface Preparation: SSPC-SP10, Near White Blast Cleaning

First Coat:	66-1211, Epoxoline Primer	Min.	Max.
		3.0	-- 5.0
Second Coat:	66-(color) Hi-Build Epoxoline	<u>4.0</u>	-- <u>6.0</u>
		7.0	--11.0

D. High Temperature Surfaces 250 degrees to 1,200 degrees F.
System No. 39-2, Heat Resistant Aluminum
Surface Preparation: SSPC-SP10, Near White Blast Cleaning

First Coat:	39-1261, Silicone Aluminum	Min.	Max.
		0.7	-- 1.5
Second Coat:	39-1261, Silicone Aluminum	<u>0.7</u>	-- <u>1.5</u>
		1.4	-- 3.0

2.02.02 Mill Coated Steel Pipe

A. Exterior or Interior - Non Immersion
System No. 66-2, Epoxy Polyamiderethane
Surface Preparation: Surface shall be clean and dry.

First Coat:	66-1211, Epoxoline Primer	Min.	Max.
		3.0	-- 5.0
Second Coat:	66-(color) Hi-Build Epoxoline	<u>4.0</u>	-- <u>6.0</u>
		7.0	--11.0

B. Immersion - Potable or Non-Potable Water
System No. 66-2, Epoxy Polyamide
Surface Preparation: SSPC-SP10, Near White Blast Cleaning

First Coat: 66-1211, Epoxoline Primer	Min.	Max.
	3.0	-- 5.0

Second Coat: 66-(color) Hi-Build Epoxoline	<u>4.0</u>	-- <u>6.0</u>
	7.0	--11.0

2.02.03 Galvanized Steel - Pipe and Miscellaneous Fabrications.

A. Exterior, Severe Exposure or Mild Exposure
System No. 70-1, Aliphatic Polyurethane
Surface Preparation: SSPC-SP1, Solvent Cleaning

First Coat: 66-(color), Hi-Build Epoxoline	Min.	Max.
	4.0	-- 6.0

Second Coat: 70-(color) Endura Shield	<u>1.5</u>	-- <u>2.5</u>
	5.5	-- 8.5

B. Interior
System No. 66-9, Epoxy Polyamide
Surface Preparation: SSPC-SP1, Solvent Cleaning

First Coat: 66-(color), Hi-Build Epoxoline	Min.	Max.
	4.0	-- 6.0

C. Exterior, Above Grade
System No. 66-2, Epoxy Polyamide
Surface Preparation: SSPC-SP1, Solvent Cleaning

First Coat: 66-1211, Epoxoline Primer	Min.	Max.
	3.0	-- 5.0

Second Coat: 66-(color) Hi-Build Epoxoline	<u>4.0</u>	-- <u>6.0</u>
	7.0	--11.0

2.02.04 Concrete

A. Exterior - Above Grade
System No. 52-1, Modified Epoxy - Sand Texture
Surface Preparation: Surface shall be clean and dry.

First Coat: 52-(color), Tneme-Crete	Min.	Max.
	6.0	--10.0

Second Coat: 52-(color), Tneme-Crete	<u>6.0</u>	-- <u>10.0</u>
	12.0	--21.0

Application of the first coat of paint shall follow immediately after surface preparation. Any surface not receiving first coat of paint within eight hours after preparation shall be recleaned prior to application of any paint.

B. Preparation of metallic surfaces shall be conducted in accordance with applicable portions of surface preparation specifications of the Steel Structures Painting Council (SSPC) and National Association of Corrosion Engineers (NACE). Specific applicable standards are included in each paint system. Solvent, in solvent cleaning operations, shall be as recommended by the manufacturer.

Preparation of metallic surfaces shall be based upon comparison with "Pictorial Surface Preparation Standards for Painting Steel Surfaces", SSPC-Vix 1, ASTM Designation D220; "Standard Methods of Evaluating Degree of Rusting on Visual Standard for Surfaces of New Steel Airblast Cleaned with Sand Abrasive", NACE Standard TM-01-70; and as described herein. To facilitate inspections, the Contractor shall on the first day of sandblasting operations, sandblast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. After mutually agreeing that a specific panel meets the requirements of the specifications it shall be initialed by the Contractor and the Engineer and coated with a clear non-yellowing finish. One such panel shall be prepared for each type of sandblasting and it shall be utilized as a comparison standard throughout the project.

Surface preparation for galvanized metal and aluminum shall be in accordance with SSPC-SP-1 (solvent cleaning) and passivated per manufacturer's written instruction.

C. PREPARATION OF CONCRETE SURFACES. Unless otherwise specified, concrete surfaces which are to receive any paint coating shall be allowed to age for at least 28 days and to dry to a moisture content of not more than 4 percent. Moisture content shall be tested with a Delmhorst Instrument Company moisture detector, or equal. In addition, the surfaces shall be brushed, treated with a 10 percent muriatic acid solution and thoroughly flushed with water after 10 minutes. Where necessary, loose concrete and laitance shall be removed by sandblasting or chipping, and all voids and cracks shall be repaired in accordance with the paint manufacturer's instructions.

As directed by the Engineer, all surfaces shall be cleaned with clear water by washing and scrubbing to remove all foreign and deleterious substances.

Steam cleaning shall be used to clean wall surfaces of existing process channels and tanks to be painted. All surfaces to be painted, or repainted, shall be repaired, cleaned, and finished to the standards as specified herein and in SECTION 03300 for new concrete.

3.02 APPLICATION

A. WORKMANSHIP. All work shall be done in a workmanlike manner so that the finished surfaces will be free from runs, drops, ridges, waves, laps, and unnecessary brush marks. All coats shall be applied in such a manner as to produce a even film of uniform thickness completely coating all corners and

crevices. All painting shall be done in accordance with the requirements of SSPC-PA1 for "Shop, Field, and Maintenance Painting", and NACE recommended practices.

The Contractor's coating and painting equipment shall be designed for application of materials specified and shall be maintained in a first-class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators and spray nozzles shall be of the proper sizes.

Each coat of paint shall be applied evenly and sharply cut to line. Care shall be exercised to avoid over spraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drops cloths, or other suitable measures.

B. PAINT PROPERTIES, MIXING AND THINNING. All paint, when applied, shall provide a satisfactory film and smooth even surface, and glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Paints shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more components shall be mixed in accordance with manufacturer's instructions. Where necessary to suit conditions of the surface, temperature, weather, and method of application and with the engineer's approval, the paint may be thinned immediately prior to use by the addition of not more than one pint per gallon of the proper thinner; provided that in no case shall the paint be reduced more than necessary to obtain the proper application characteristics. Where specifically allowed by the specifications, certain paints may be thinned more than the maximum indicated above. Paint thinner shall be as recommended by the paint manufacturer.

C. ATMOSPHERIC CONDITIONS. Except as specified or required for certain water-thinned paints, paints shall be applied only to surfaces that are thoroughly dry and only under such combination of humidity and temperatures of the atmosphere and surfaces to be painted as will cause evaporation rather than condensation. In no case shall any paint be applied during rainy, misty weather-or to surfaces upon which there is frost or moisture condensation, without suitable protection as accepted by the Engineer. Where painting is permitted during damp weather, or when the temperature is at or below 40 degrees F, the surfaces, except those which may be warped by heat, may be dehydrated by flame-heating devices immediately prior to paint application. While any painting is being done and for a period of at least eight hours after the paint has been applied, the temperature of the surfaces to be painted, the painted surfaces and the atmosphere in contact therewith shall be maintained at or above 40 degrees F and 5 degrees above the dewpoint. All paint when applied shall be approximately the same temperature as that of the surface on which it is applied. The use of fans or heaters shall be required inside enclosed areas where conditions causing condensation are severe.

D. PROTECTION OF PAINT SURFACES. Where protection is provided for painted surfaces, such protection shall be preserved in place until the paint film has properly dried and the removal of the protection is authorized. Items which have been painted shall not be handled, worked on or otherwise

disturbed until the paint coat is completely dry and hard. After delivery at the site of permanent erection of installation, all shop-coated metalwork shall be repainted or retouched from time to time with specified paint whenever, in the opinion of the Engineer, it becomes necessary to maintain the integrity of the film.

E. METHOD OF PAINT APPLICATION. Where two or more coats are required, alternate coats shall contain sufficient approved color additive to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Color additives shall not contain lead or any lead compound which may be destroyed or affected by hydrogen sulfide or any gas likely to be found in wastewater treatment plants.

Electrical and mechanical equipment, on which the manufacturer's coating is sound, shall be touch-up primed and painted with 2 coats of the specified paint system to match the color scheduled. This does not apply to electrical and instrumentation equipment otherwise specified in Division 16.

No paint shall be applied to any surface until it has been prepared as specified and approved by the Engineer. Unless otherwise specified, the primer or first coat of paint shall be applied by brush to ferrous surfaces. All subsequent coats for all ferrous surfaces may be either brush or spray applied. Unless stated otherwise, prime and finish coats shall be applied at the rate recommended by the manufacturer for the service involved. After primer coat is dry, all suction spots shall be touched up before succeeding coats are applied. All coats for blast cleaned ferrous metal surfaces may be brushed or sprayed. All coats for concrete and masonry shall be brushed or rolled unless otherwise specified. Before painting or repainting existing surfaces, the Contractor shall test-paint a small area on the actual surface to show that the new color matches the old one.

Unless otherwise specified, finish coats shall not be applied until all other work in the area is done and until the prime and intermediate coats have been approved by the Engineer.

F. FILM THICKNESS AND CONTINUITY. The actual surface area covered per gallon of oil or varnish vehicle paint for various types of surfaces shall not exceed those recommended by the manufacturer. The first coat on metal surfaces refers to the first full paint coat and not to conditioning or other pretreatment applications. All coatings shall be applied to the thickness and in accordance with these specifications. Except as otherwise specified, the average exposed metal surfaces shall not be less than 1.25 mils per coat. The minimum thickness at any point shall not deviate more than 25 percent from the required average. Except as specified, no less than two coats shall be applied.

In testing for continuity about welds, projections such as bolts and nuts and crevices, the Engineer will determine the minimum conductivity for smooth areas of like coating where the dry mil thickness has been found adequate. This conductivity shall then be taken as the minimum required for these rough irregular areas. All pinholes and holidays shall be repainted to the required coat coverage. All ferrous metal surfaces shall meet minimum continuity requirements.

It is intended that the dry film thickness and the continuity of painted ferrous metal surfaces be subject to continual field check by the Engineer. Dry film thickness will be measured by an Elcometer or Mikrotest film thickness gage. Continuity will be tested by a low voltage wet sponge transistorized device as manufactured by the K-D Company, Tinker-Rason, or equal. The Contractor shall furnish, until final acceptance of coating and painting, inspection devices in good working condition for detection of holidays and measurement of dry film thickness. The Contractor shall also furnish U.S. Department of Commerce, National Bureau of Standards certified thickness calibration plates to test accuracy of dry film thickness gauge and certified instrumentation to test accuracy of holiday detectors. These inspection devices shall be available for the Engineer's use at all times. Safe and suitable ladders or temporary scaffolding and adequate illumination shall be provided at the Engineer's direction to facilitate inspection.

G. SPECIAL REQUIREMENTS. Hangers shall be painted except for the final coat, prior to installation. Bolts and bolt holes in flanges, such as those used with couplings or wafer type valves, where hole and bolt as finally installed will be exposed to weather or moisture shall be painted prior to assembly to prevent rusting of the unprotected metal.

3.03 CLEANUP

Upon completion of the painting, the Contractor shall remove all surplus materials, protective coverings and accumulated rubbish and thoroughly clean all surfaces and repair any overspray or other paint-related damage.

3.04 FINISH SCHEDULE

New and existing surfaces to be painted and systems to be used are described below. Additionally, the Contractor shall repaint areas damaged by him either in connection with the construction of the new work or as a result of his activities. Do not paint aluminum or stainless steel.

** END OF SECTION **

SECTION 11311

VERTICAL PROPELLER PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This section includes furnishing and installing the vertical propeller pumps as indicated on the drawings and as described herein.

B. MASS ELASTIC SYSTEMS. Each complete system, including pump, electric motor driver and all appurtenances shall have no dangerous critical or resonant frequencies or multiples of resonant frequencies within 20 percent above and 30 percent below the speed required by the pump to meet the specified operating conditions. In addition, the system shall be free of objectionable vibration at the operating speed.

1.02 QUALITY ASSURANCE

A. MANUFACTURER'S QUALIFICATIONS. The equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. All equipment shall be furnished by one manufacturer to ensure uniformity and interchangeability of parts. Manufacturer shall assume responsibility for, and guarantee performance of, all equipment furnished; however, this shall not be construed as relieving the Contractor from his responsibility for the proper installation and functioning of the work.

B. REFERENCE STANDARDS. Standards shall be the latest edition, including addenda, supplements, and revisions. Applicable reference publications include the following:

NAMA
ASTM
ANSI.

1.03 SUBMITTALS

The following material shall be submitted to the Engineer in accordance with the provisions of section 01300. All material submitted hereunder shall be included in one complete submittal. The submittal shall consist of the following data and descriptive material:

A. Pump performance, brake horsepower, and efficiency curves at all specified operating conditions.

B. Propeller vane design.

C. Manufacturer's shop drawings and dimensional data, along with seal manufacturer's drawings and dimensions. Submittals shall include details for seal or stuffing box.

D. O & M manuals as specified in Section 01730.

E. Spare parts list.

1.04 FACTORY TESTING

Each new pump shall be fully tested on water at the manufacturer's plant before shipment. Units shall be tested at rated speed, head, and capacity, and shall be checked for efficiency and brake horsepower, and at such other conditions of head and capacity as needed to properly establish the performance curve. Certified copies of tests curves shall be submitted to the Contractor. Standards of the Hydraulic Institute shall govern the procedures and calculations for tests.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

The pumps shall be rated for 3,600 GPM, and shall produce ¹³~~25~~ total pump head including velocity head losses at the pump discharge. Pumps are to be mounted at 1021' elevation with a sump floor at 1001' elevation and the minimum sump water level occurring at 1007.5' elevation. Pump discharge centerline shall be at 1022.8' elevation. Maximum pump speed shall not exceed 880 RPM with the driver size limited to ²⁰~~50~~ HP.

2.02 CONSTRUCTION AND FABRICATION (NEW PUMPS ONLY)

A. **PUMP BOWLS.** Pump bowls shall be of flanged, and free from sand and blow holes. The Suction Bell shall be of the flared inlet type with a grease packed lower bearing. It shall be provided with three guide vanes designed to minimize entrance losses and reduce vortexing. A Sand Cap shall be provided to prevent entrance of sand into the Suction Bell Bearing.

The units shall be supplied with galvanized clip-on type Basket Strainers.

The Discharge Bowl shall be provided with a bearing immediately above the Propeller and a Connector Bearing above the diffuser vanes. A Discharge Bowl Bearing by-pass shall be provided in the bearing cavity for drainage and pressure relief. The Connector Bearing shall be externally threaded along its entire length. The first stage propeller seal surface shall be in the Suction Bell.

Propellers of the mixed flow three vane design, capable of passing a 2.25" solid, shall be supplied. Vane leading edges shall be rounded to prevent accumulation of fibrous material. Propeller(s) shall be statically and dynamically balanced to limit vibration and supported on both sides by bearings for stability.

B. **COLUMN AND BEARING RETAINER.** Column shall be flanged, size 16", with rabbet fits to assure proper alignment and weighing a minimum of 42.20 lbs./ft. Maximum flange O.D. shall not exceed 20". Bearing Retainer shall be fabricated steel, welded inside the column pipe and machined to accept Non-Revolvable Rubber Bearings.

C. **OPEN LINESHAFT.** The Lineshaft shall be of open design, 1-11/16", minimum diameter, size per ANSI-B 58.1 to provide satisfactory operation without undue vibration or distortion, and furnished in sections of uniform length not exceeding 10 feet. Bearings shall be lubricated by the pumped fluid. The Lineshaft shall be coupled with threaded steel Shaft Coupling(s) machined from solid bar stock. A replaceable Lineshaft Sleeve having a maximum O.D. of 1-7/8" shall be supplied at each lineshaft bearing journal.

C. **DISCHARGE HEAD.** The discharge head shall be of the above ground configuration designed to provide a mounting surface for the driver and shall

have adequate space provided to allow for (a two-piece topshaft arrangement) (the installation and adjustment of a flanged adjustable coupling) and the maintenance of a shaft sealing arrangement. The discharge shall terminate in a plain end with cross bolt lugs to accept a compression type coupling. The pump mounting plate shall be 36" x 36" to permit the withdrawal of the complete pump unit. It shall be a minimum of 1" thick and designed to adequately support the entire pump unit.

An Open Lineshaft Packing Box rated for a minimum working pressure of 125 PSI and suitable for a 1-11/16" diameter shaft and a 1-7/8" O.D. Sleeve shall be supplied. Packing Box depth shall be 1-5/8" minimum and shall be provided with 4 rings of 3/8" square packing. A Packing Box Bushing, arranged for grease lubrication of the Packing, shall be supplied. A Shaft Slinger shall be furnished to prevent pumped fluid from traveling up the shaft into the driver.

PART 3 - EXECUTION

3.01 INSTALLATION

Pumping unit shall be aligned, connected, installed, and tested as shown on the drawings and in strict accordance with the manufacturer's recommendations. Nothing herein shall be construed as relieving the Contract of his responsibility for this portion of the work.

3.02 TESTING

After completion of installation, pumping unit shall be completely field tested over the entire range of operating conditions, to demonstrate compliance with the specified performance requirements.

3.30 ACCEPTANCE

As a condition precedent to final acceptance of the work, Contractor shall certify the proper installation, testing, and start-up of equipment included under this section. Certification shall warrant that the equipment and its installation are free of defects and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's equipment guarantee.

3.04 SPARE PARTS

Manufacturer shall provide the following spare parts:

- 1 - Bowl shaft, each size and type of pump
- 1 - Bottom bearing, each size and type of pump
- 1 - Set, bowl bearings, each size and type of pump
- 1 - Upper bearing, each type and size of pump
- 2 - Sets, packing and gaskets each type and size of pump
- 1 - Packing box bearing, each type and size of pump
- 1 - Set, lineshaft bearings, each size and type of pump

** END OF SECTION **

SECTION 15060

PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This section includes all piping, fittings, and all necessary appurtenances as shown and specified, and required to make the work complete and operable.

Piping sizes, unless otherwise required by applicable codes or regulations, shall be as shown on the contract drawings.

1.02 QUALITY ASSURANCE

A. MANUFACTURER'S QUALIFICATIONS. The Contractor shall cause the material and equipment to be furnished under this Section to be the product of firms regularly engaged in the design and manufacture of this type of item.

B. REFERENCE STANDARDS. Reference standards referred to shall be the latest edition, including addenda, supplements and revisions. Attention is drawn to the following ASTM standards for materials testing: C443, C497, D395, D412, D471, D573, D1149 and D2240.

1.03 SUBMITTALS

The following material shall be submitted to the Engineer in accordance with the provisions of Section 01300. The submittal shall consist of the following data and descriptive material:

- a. Manufacturer and manufacturer's type designation.
- b. Any exceptions to these specifications along with justification for each exception.
- c. Catalog data, including cutaway views, construction features, dimensional data, and technical information, which define exactly all materials, gauges, details of construction, etc.

PART 2 - PRODUCTS

2.01 GENERAL

With the exception of sewers and flexible joint piping, all piping is designated on the Drawings by size and service. Pipe, fittings, valves and appurtenances shall be as specified herein or as shown on the drawings.

2.02 PIPE

A. REINFORCED CONCRETE PIPE AND FITTINGS.

1. Reinforced concrete drain pipe. Reinforced concrete drain pipe shall be tongue and groove type, manufactured of Portland cement, mineral aggregates and steel, and shall be in accordance with ASTM C76. The Portland cement shall be Type V high sulfate resistant cement in accordance with ASTM C150. The strength requirement shall be Class III unless otherwise indicated or specified. Yard testing shall be completed in conformance with ASTM C76. Three certified copies of all test reports shall be filed with the Engineer.

2. Fittings for Reinforced Concrete Pipe. Unless otherwise shown, fittings for reinforced concrete pipe shall be fabricated from steel plate or sheets and shall be cement mortar lined and coated. All fittings shall conform to the dimensional requirements of AWWA C208. Fabrication shall conform to the dimensional requirements of Part 22.01B.6.

Bell adapters shall be fabricated from steel plate and shall be accurately dimensioned for a rubber gasket joint. Shop drawings showing details and dimensions of all fabricated fittings shall be submitted for acceptance before fabrication.

D. POLYVINYL CHLORIDE PIPE.

1. PVC pressure pipe. PVC pressure pipe shall conform to AWWA Standard C-900 except where specified otherwise. Pipe fittings shall conform to ASTM D2466 and ASTM D2467, or ASTM D3311 for DWV fittings. Pressure pipe joints shall conform to ASTM D3139. Gravity pipe fittings shall conform to ASTM D3212. Seals shall conform to ASTM F477. Any plastic pipe stored outdoors shall be protected from prolonged exposure to sunlight with suitable opaque materials.

2. Alternate pressure pipe. Alternates where indicated shall be PVC SDR rated pipe. SDR26, Class 160 shall be rated at 110 psi working pressure, SDR21, Class 200 at 140 psi, and SDR17.5, Class 250 at 165 psi. Fitting shall be O-ring push-on joint.

Where shown on the plans, Schedule 80 PVC solvent weld pipe.

2.03 FITTINGS

A. FLANGES, BOLTS, AND THREADS. All 125 lb extra heavy cast iron flanges shall be raised face conforming to ANSI B16.1. All 250 lb extra heavy cast iron flanges shall be raised face conforming to ANSI B16.1. Companion flanges shall be threaded conforming to ANSI B2.1. The ends of the pipe shall be refaced to be flush with the face of the companion flange.

All--150 lb and 300 lb forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class D and ANSI B16.5. Unless otherwise specified, all steel flanges shall be ANSI Class 150 lb. or AWWA Class D.

Flange assembly bolts shall be standard square or hexagon head carbon steel machine bolts with standard hog pressed hexagon nuts conforming to ANSI B18.2. Threads shall conform to ANSI B1.1, coarse thread series, Class 2 fit. Bolt length shall conform to ANSI B16.5. Flange assembly bolts and nuts for submerged service shall be alloyed with approximately 1.2 percent copper, 0.5 percent nickel and 1 percent chromium.

When plain faced flanges and raised face flanges are bolted together the raised face shall be removed.

Unless otherwise noted, all pipe threads shall conform in dimension and limits of size to ANSI B2.1, taper pipe thread.

B. MECHANICAL PIPE COUPLINGS.

1. General. Mechanical pipe couplings shall be sleeve type or grooved or plain end pipe couplings.

2. Sleeve-type. Unless otherwise indicated, flexible type mechanical pipe couplings not intended to take tension shall be Smith-Blair Type 411 or Dresser Style 38, or equal, with the stop removed from the middle ring. Couplings for connecting steel pipe to cast iron pipe shall be Smith-Blair Type 913 or Dresser Style 128, or equal. Gaskets shall be suitable for exposure to petroleum products, solvents and temperatures of 230 degrees F.

3. Plain end or grooved end couplings. Plain end pipe couplings shall be Gustin-Bacon 154 or Victaulic Style 90 or equal. Grooved end pipe couplings employed for jointing purposes shall be either Gustin-Bacon 110 or Victaulic HP70, or Gustin-Bacon 154 Victaulic style 741, or equal. Grooved end couplings for pipe jointing where flexibility is desired (indicated as PC-T on the drawings) shall be Gustin-Bacon 100, Victaulic 77, or equal. Unless specifically stated or indicated otherwise, grooved end pipe couplings shown on the drawings shall be the flexible type. Coupling gaskets for all services except heat reservoir and jacket water systems shall be Gustin-Bacon Type VI or Victaulic Grade E or equal.

2.04 CONSTRUCTION AND FABRICATION

The types and sizes of pipes to be used shall be as specified and shown. Where sizes of small pipe are omitted from the drawings and not mentioned in the specification, the sizes to be used shall correspond to the latest edition of the Uniform Plumbing Code requirements. In any event, undesignated pipe shall be proper for the functions to be performed, and as accepted by the Engineer. Steam and boiler piping shall be installed to meet the requirements of the latest editions of the boiler and the pressure piping codes.

In erecting the pipe a sufficient number of screw unions, flanged or grooved end type joints, shall be used to allow any section or run of pipe to be disconnected without taking down adjacent runs. Flanged and grooved end joints shall be employed on pipelines 3-inches in diameter and larger. The provision of an adequate number of appropriate take-down fittings shall be employed near the wall.

The location and spacing of expansion joints, anchors, guides, hangers, and supports shall be as required by good piping practice and as recommended by the Expansion Joint Manufacturers Association to accommodate pipe movement due to temperature changes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL. All pipe shall be carefully placed and supported at the proper lines and grades, and where possible shall be sloped to permit complete drainage. Piping runs shown on the drawings shall be followed as closely as possible, except for minor adjustments to avoid architectural and structural features. If major relocations are required, they shall be acceptable to the

Engineer. Flexible joint pipe shall be laid with a maximum of 12 degrees open joint.

Wherever a ductile iron or PVC drainage pipe passes from concrete to earth, two bell and spigot joints or two flexible couplings shall be installed. Wherever a steel or ductile iron two inches in diameter and larger passes from concrete to earth, two flexible pipe couplings or joints shall be installed with the first joint not less than two feet nor more than three feet from the face of the structure. The spacing between the two couplings shall be a minimum of two feet and a maximum of three feet. Flexible pipe couplings shall be as specified herein. Particular care shall be taken to insure a full support of the pipe in the earth between and beyond the joints.

Wherever a copper pipe is connected to a steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be installed. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions of an acceptable type may be used in lieu of the specified insulating sections. Wherever copper pipe is supported from hangers, it shall be suitably insulated from the hangers.

The interior of all piping shall be cleaned after assembly and before connecting to equipment.

B. PRESSURE PIPING.

1. Pipe supports. Piping shall be properly supported by anchor brackets, saddles or hangers. Unless otherwise shown, hangers for all horizontal runs of all sizes of pipe shall be spaced in accordance with the standard details shown on the drawings. Hangers or supports shall be provided at each change of direction.

2. Thrust blocks. Concrete blocks shall be placed at fittings of bends and tees of buried pressure pipes in accordance with the standard details shown on the drawings.

3. Pipe welding. All pipe welding shall be done by shield metal arc, gas shield arc, or submerged arc welding methods by welders certified by the ASME. Welds shall be made as shown on the drawings, and the weld and material shall meet the requirements of ASME Boiler Code (Class I).

4. Pipe cutting. The Contractor shall perform all work of cutting pipe and fittings or special castings necessary to the proper and accurate assembly, erection and completion of the work. All pipe shall be cut to fit accurately with smooth edges and faces. PVC pipe shall be cut square, and a factory-furnished beveled end used as a guide for obtaining the proper level angle and depth. Sharp edges shall be removed.

5. Pipe threads. Pipe ends shall be reamed to the full bore of the pipe. Threads shall conform in dimension and limits of size to ANSI B2.1, taper jointing thread. In making up threaded joints, an accepted thread lubricant shall be applied to the make threads only.

6. Flanged joints. Flanged joints shall be made up square with even pressure upon the gaskets and shall be perfectly watertight.

7. Laying and jointing of buried piping.

a. Pipe laying. Laying of cast iron and steel pressure pipelines shall conform to applicable portions of Section 6, 7, and 10 of AWWA C-600.

1. Horizontal. When water lines and sewer are laid parallel to each other, the horizontal distance between them shall not be less than six (6) feet. Each line shall be laid on undisturbed or bedded material in a separate trench. Where conditions prevent the minimum horizontal separation set for above, or where both lines are in the same trench, both the water line and sewer shall be constructed of mechanical joint cast iron pipe, or other approved pipe, which is pressure tested to assure water tightness before backfilling. In such instances, a complete description of the circumstances and details of the proposed construction shall be submitted to the Engineer.

2. Vertical. When a sewer crosses two feet or more below a water line, no extra protection is required. When a sewer crosses less than two (2) feet below a water line, the sewer shall be constructed of cast iron pipe with leaded or mechanical joints, or other approved pipe, for at least six (6) feet in both directions from the crossing, or the sewer shall be encased in concrete of 6-inch minimum thickness for the same distance. When a water line must cross under a sewer, a vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line shall be maintained with support provided for the sewer to prevent settling. The sewer shall be constructed of cast iron pipe with leaded or mechanical joints, or other approved pipe at least six (6) feet in both directions from the crossing, or the sewer shall be encased in concrete of 6-inch minimum thickness for the same distance.

3. No water pipe shall pass through or come into contact with any part of the sewer or manholes.

Anchorage shall be provided for fittings where there is a possibility of pulling the joint under pressure. Anchors shall be in accordance with applicable portions of Section 12, AWWA C-600, except as otherwise shown.

Cement mortar lined and coated steel pipe shall be handled with canvas slings or similar devices to prevent damage to the pipe exterior. Each piece of pipe shall be laid in such a manner as to prevent any sudden offsets in the flow line. As the work progresses, the interior of the pipe shall be cleared of all dirt and debris of every description. Pipe shall not be laid when the condition of the trench or the weather is unsuitable. At times when work is not in progress, open ends of pipe and fittings shall be closed.

Unless otherwise indicated, pipe 12 inches in diameter and larger shall be placed on a prepared subgrade of select material at least 6 inches deep below the barrel of the pipe. The bedding material shall be as specified in Section 02220.

Anchorage for cement mortar lined and coated steel pipe shall be provided for all joints from pipe to fittings and from fittings to structures by providing bolts at spring line or by intermittent welding of the steel joint rings. Details shall be submitted to the Engineer for approval.

b. Pipe jointing.

1. Mechanical joints or push-on joints. Mechanical joints or push-on O-ring gasket joints shall be installed in strict accordance with the manufacturer's recommendations.

2. Cement mortar lined and coated steel. Rubber gasket joints for cement mortar lined and coated steel pipe shall be made in accordance with the manufacturer's instructions. The rubber gasket shall be carefully positioned in the spigot ring groove and shall be lubricated with an approved lubricant. After the joint has been made, the position of the rubber gasket shall be checked with a specially made feeler gauge. Joints found to be improperly made shall be fully separated, rejointed and checked.

The inside joint space shall be pointed with mortar containing an approved shrinkage inhibitor. For pipe less than 24 inches in diameter, the inside joint space shall be filled with grout by pulling an approved swab or inflated ball through the pipe. For pipe 24 inches in diameter and larger the inside joint space shall be manually filled. The outside joint space shall be field coated in an approved manner using the cement mortar of a consistency which will insure that the entire joint space is filled.

When welded joints or partially welded joints are used, all pipe welding shall be done by the shielded electric arc method by welders certified by the ASME. Welds shall be made as shown or required and the weld and material shall meet the requirements of ASME Boiler Code (Class I) and API Standard 1104 "Standard for Field Welding of Pipelines".

8. Protection of buried steel pipe, valves and appurtenances. All steel pipe installed underground shall be protected as specified for the particular system. All buried valves, flanges, mechanical joints and mechanical pipe couplings shall be protected with a built-up asphalt mastic coating covered with a protective tape wrap. Surfaces shall be cleaned by wire brushing immediately prior to application of the mastic. The mastic shall be molded firmly to encase all bolts, nuts and flanges, and built-up to a uniform surface over entire fitting. The built-up surface shall be covered with a protective tape wrap. Materials shall be applied in full accordance with manufacturer's recommendations. Coating shall be Type-M-1 (LT) Denso Plast with Denso (LT) tape as supplied by Unico Engineering, Inc., Tapecoat CT with TC mastic, or equal.

c. SEWERS AND DRAINS, GRAVITY LINES.

1. General. The types and sizes of pipe to be used shall be as specified and shown. Pipe laying shall proceed upgrade with the spigot ends of bell and spigot pipe pointing in the direction of flow. Each piece shall

be laid true to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets in the flow line. As the work progresses, the pipe interior shall be cleared of all dirt and debris of every description. Where clearing after laying is difficult because of small pipe size, a suitable swab or squeegee shall be kept in the pipe and pulled forward past each joint immediately after jointing has been completed. Pipe shall not be laid when the condition of the trench or the weather is unsuitable. At times when work is not in progress, open ends of pipe and fittings shall be closed.

When additional gravel or crushed rock is required to stabilize a soft, wet or spongy foundation caused by the operations of the Contractor, such gravel or crushed rock shall be provided at the Contractor's expense.

2. Pipe jointing.

a. Reinforced concrete pipe. Rubber gasket joints in reinforced concrete pipe will not normally require mortar, except when the interior joint space is over 1/2-in. wide. Interior joint space of tongue and groove pipe shall be mortared.

D. STEEL CASING AND PIPE INSTALLATION.

1. General. Augering for the installation of steel casing conduit will be required at the locations shown on the plans. This method of installation shall be accomplished by a combination augering-jacking operation with equipment specifically designed for this purpose. Equipment operators shall be experienced, qualified, personnel. The casing shall be installed true to line and grade with little or no positive camber (a full circle of light should be directly visible through the casing from the opposite end). If for any reason whatsoever that a boring once started may not be completed, that portion of casing installed shall be plugged and abandoned in place. A new boring shall be started at a location designated by the Engineer.

a. Pipe shall be jacked or bored beneath all paved areas where shown on the drawings at a minimum depth of 36". boring shall begin no closer than 8 feet from edge of pavement. All bore pits and receiving pits shall be adequately protected by the use of fencing or barricades.

b. All backfill shall be compacted to 95% maximum density of the same material. Each lift shall be implemented as described in Arizona State Standards and Specifications. Each lift shall be no greater than 8" loose. The maximum densities shall be determined by a laboratory on the same material in accordance with ASSHO T-99. Proof of compaction will be furnished by the Permittee from a qualified independent laboratory.

c. All bore pits shall be backfilled in layers not to exceed 8" (loose). The excavated material may be utilized as backfill. If the in-place moisture is low, water may have to be uniformly added. The density requirements will be 95% of the maximum density.

d. All trenches shall be at a depth to accommodate a minimum of 36" cover material.

e. Vertical drops running adjacent to roadway shall not be left overnight without proper barricades.

f. All surplus material shall be removed from the Right-of-Way.

g. All pavement cuts shall be saw cuts. The pavement cuts shall be replaced in accordance with Arizona Highway Department Standard C-7.03. New pavement shall be sealed to match the existing in color and texture, in kind.

h. Traffic shall be protected in accordance with the Arizona Highway Department Traffic Control Manuals. All signs, placement of signs and necessity of using flagmen is the responsibility of the Permittee. Manual on UNIFORM TRAFFIC CONTROL DEVICES may be substituted if A.D.O.T. Manual is not available.

i. Under not circumstances shall the Contractor detour traffic without permission from the District Engineer or his agent.

j. The Contractor shall assume full responsibility in attaining clearances from utility companies and will be responsible for damage to any utility line.

k. When completed, the Permittee shall be responsible to see that the work area has been neatly graded, and that no berms nor depressions remain.

l. The stopping of traffic will not be done by personnel.

m. A minimum of two advanced warning signs shall be installed along with normal barricading.

n. Upon completion of an underground installation, the Contractor shall furnish as-built plans showing the elevations of their facilities tied to a bench mark furnished by the Department, or when approved by the District Engineer, other adequate elevation reference.

3.02 PIPELINE TESTING

A. GENERAL. All piping, both gravity and pressure pipelines, shall be tested. The Contractor shall provide all necessary utilities, labor and facilities for testing and shall dispose of all waste, including water.

B. GRAVITY LINES.

1. Obstructions. After backfilling and restoration of surfaces, all gravity lines shall be inspected for obstructions and shall be cleaned. Pipes less than 24-in. in diameter shall be cleaned using the sewer ball method.

2. Leakage. Sewers shall be tested for leakage. The program of testing shall fit the conditions as mutually determined by the Engineer and the Contractor. The Contractor shall take all necessary precautions to prevent any joints from drawing while the sewers or their appurtenances are being tested. He shall correct any excess leakage and repair any damage to the

pipe and their appurtenances, or to any structures resulting from or caused by these tests. Either air testing or exfiltration testing will be allowed.

Gravity sewers shall be air tested in accordance with MAG Standard 615.10.

If hydrottested, each section of sewer shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers and filling the pipe and manhole, or, if ground water is present, 6-ft. above the section's average adjacent ground water level. The line shall be filled at least one hour prior to testing and shall be tested at least 6 hours maintaining the head specified above by measured additions of water. The sum of these additions shall be the leakage for the test period.

If ground water is present to a height of at least 4-ft. above the crown of the sewer, the leakage test may be made by measuring the rate of infiltration. Whether the test is made by infiltration or exfiltration, the allowable leakage shall not exceed 20 gal. per inch diameter per mile per day.

Where the actual leakage exceeds the allowable, the Contractor shall determine the cause and retest. For the purpose of this section, a section of sewer is defined as that length of sewer between successive manholes or special structures.

3. Deflection. A minimum of 20 percent of the PVC gravity sewer lines shall be short term deflection tested for vertical deflection after complete backfill and compaction, but prior to installation of finish surface material. The pipe section to be tested shall be as designated by the Engineer using a mandrel approved by the Engineer. A short-term vertical deflection in excess of 5% of the average I.D. shall be cause for rejection of the pipe and all related work for that section.

** END OF SECTION **

SECTION 15080

PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This Section includes all miscellaneous piping specialties not specified in other sections, but required for the installation of a complete and satisfactorily performing piping system as specified on the Drawings.

1.02 QUALITY ASSURANCE

A. MANUFACTURER'S QUALIFICATIONS. The equipment to be furnished under this Section shall be the product of firms regularly engaged in the design and manufacture of such equipment. All like items shall be furnished by one manufacturer to ensure uniformity and interchangeability of parts. Manufacturer shall guarantee all equipment furnished; however, this shall not be construed as relieving the Contractor from his responsibility for the proper installation and functioning of the work.

B. REFERENCE STANDARDS. Standards shall be the latest edition, including addenda, supplements, and revisions. Applicable publications include the following:

AWWA

ANSI.

1.03 SUBMITTALS

The following material shall be submitted to the Engineer in accordance with the provisions of SECTION 01300. All material stipulated herein shall be submitted in one complete submittal. The submittal shall include the following:

A. Manufacturer and manufacturer's type designation.

B. Any exceptions to these specifications, along with justification for each exception.

C. Catalog data including cut-away views, construction features, dimensional data, and technical information defining all material gauges, construction details, etc.

PART 2 - PRODUCTS

2.01 MISCELLANEOUS EQUIPMENT

A. YARD HYDRANTS.

1. Unless otherwise noted, hose valves shall be brass, composition disc. Three-quarter inch valves shall have hose thread outlet and 1-inch valves and larger shall have iron pipe hose thread outlet. Hose valves mounted on walls shall be provided with escutcheon plates.

2. Hydrants shall have galvanized steel casing and be fitted with 3/4-inch male hole thread brass nozzle. Hydrants shall be Model 20 for wall faucets, Model Y34 and Y1 for yard hydrants, as manufactured by Woodford Manufacturing Co., or equal.

B. Flushing cocks shall consist of DeZurik 159 101S, Homestead 1212, or equal, and a Viton-faced eccentric plug valve with a hose nipple adapter, if required. Unless otherwise noted, flushing cocks shall be 1-inch diameter and installed as shown.

C. Air line strainers shall be Y-pattern, iron body, with 40 mesh Monel screen packed with Everdur wool for sizes up through 2-inch. Monel perforated screens shall be furnished for pipe sizes 2-1/2" and larger. Strainer shall be fitted with brass blowoff cock with suitable pressure rating.

D. Water service strainers shall conform in rating and end connections to SECTION 15060, screwed or flanged, and shall be 'Y' type unless indicated otherwise. Body shall be bronze or carbon steel with 316 stainless steel or Monel screens and tapped blowoff connections. Screen perforations shall be 0.020-inch for steam service and 0.045-inch for water service.

E. Quick disconnects for water service shall be Ever-Tite Part B, Gate Part B, or equal, and shall be 1-inch size, unless otherwise shown.

2.02 MANUAL AIR VENTS

Manual air vents shall be installed at the high points of all pipelines. Air vents for water of any service class which cannot be vented through service connections or vent cocks furnished with equipment shall be 1/4-inch size, consisting of an acceptable bronze cock and short copper tubing return. Vents for sludge lines shall be 1-inch flushing cocks.

2.03 HANGERS AND SUPPORTS

Pipework shall be suspended and supported in such a manner to prevent sagging or overstressing pipe or connection, and to prevent transfer of any load or stress to any equipment. Many hangers and supports are indicated on the Drawings, but additional hangers and supports shall be installed as necessary to support or suspend all piping to conform to the above requirements. Hangers and supports shall be types and materials as shown on the Drawings, and conform to applicable Federal Specifications, Manufacturers Standardization Societies Requirements, and be listed if available for the particular type of support.

2.04 GRATED IRON TRENCH DRAINS

Prefabricated ferrous floor trenching shall be fabricated from ductile iron conforming to ASTM A536-77. Floor trenching shall be specially designed for installation in poured-in-place concrete floors, and shall be fitted with a single outlet pipe as shown on the plans. If fabrication in sections is necessary, individual trench sections shall be designed to form watertight joints with adjoining sections and end sections shall be closed except for the aforementioned single outlet pipe. Cover grating on individual sections shall be removable and designed to form a smooth transition with grating on adjoining section, thus preventing gaps between sections of grating.

PART 3 - EXECUTION

3.01 INSTALLATION

All equipment specified herein shall be installed, connected, tested, and finished as shown and specified in strict accordance with the manufacturer's

recommendations. Nothing herein shall be construed as relieving the Contractor of his responsibility for this portion of the work.

3.02 ACCEPTANCE

As a condition precedent to final acceptance of the work, Contractor shall certify the proper installation and testing of equipment included under this Section.

3.03 SPARE PARTS

Suppliers providing backflow preventers, yard hydrants, flushing cocks, and/or manual air vents shall provide a minimum of one complete set of replacement gaskets, packing, seats, and/or diaphragms as are required for every five (5) or less devices of a given type and size supplies.

Pressure gauge manufacturers shall provide a minimum of one replacement gauge for every ten(10) or less of a given type and size of gauge supplied.

** END OF SECTION **

SECTION 15081

GASKETS AND CAULKING

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This section includes all material for gaskets required in piping and other systems.

1.02 QUALITY ASSURANCE

All material specified hereunder shall be furnished by a single manufacturer who shall assume responsibility for the performance of the material. The manufacturer shall be regularly engaged in the design and manufacture of this type of material.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. JOINT GASKET MATERIAL. Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene, exclusively. Said compound shall contain not less than 50 percent by volume of neoprene, and shall contain no factice, reclaimed rubber or any deleterious substances. The stock shall be extruded or molded and cured in such a manner that cross section will be dense, homogeneous, and free from porosity, blisters, pitting and other imperfections. The stock shall be extruded or molded with smooth surfaces to the required diameter within a tolerance of plus or minus 1/32-inch at any cross section. The compound shall meet the following physical requirements when tested in accordance with the appropriate ASTM standards. Tests shall be run on samples taken from the gaskets furnished for the job.

2.02 PIPE TO PIPE SEAL

A. DESCRIPTION. The pipe to pipe closures shall be "Link-Seal" as manufactured by Thunderline Corporation - Belleville, Michigan 48111. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipes. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipes. The seal shall be constructed so as to provide electrical insulation between the pipes, thus reducing chances of cathodic reaction between these two members.

B. INSTALLATION. Contractor shall familiarize his installing personnel with Line-Seal instruction bulletin (packed with each carton) which illustrates the proper procedure for installing and tightening the seal to provide a water-tight pipe penetration.

** END OF SECTION **

SECTION 15110

CHECK VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This section includes all check valves, with all necessary appurtenances as shown and specified, and required to make the work complete and operable.

B. EQUIPMENT NUMBERS. Specific valves, sizes and locations are listed in Section 15100, Valve Schedule.

1.02 QUALITY ASSURANCE

A. The equipment to be furnished under this section to be the product of firms regularly engaged in the design and manufacture of this type of item. All like items shall be furnished by one manufacturer to ensure uniformity and interchangeability of parts. Manufacturer shall guarantee all equipment furnished; however, this shall not be construed as relieving the Contractor from his responsibility for the proper installation and functioning of the work.

B. REFERENCE STANDARDS. Standards shall be the latest edition, including addenda, supplements and revisions. Applicable publications include the following:

ASTM
ANSI
AWWA.

1.03 SUBMITTALS

The following material shall be submitted to the Engineer in accordance with the provisions of Section 01300. All material stipulated herein shall be submitted in one complete submittal. The submittal shall include the following:

A. Manufacturer and manufacturer's type designation.

B. Any exceptions to these specifications, along with justification for each exception.

C. Catalog data including cut-away views, construction features, dimensional data and technical information defining all material gauges, construction details, etc.

PART 2 - PRODUCTS

2.01 VALVES, LIQUID SERVICE

Check valves shall be Series TF-2 Tideflex Check Valves, all rubber and of the flow operated check type with a slip-on end connection. Inlet port areas shall be 100% of the mating pipe port size. The port area shall contour down to a duckbill which shall allow passage of flow in one direction while preventing reverse flow. The check valve is designed to slip over the specified pipe outside diameter. The flexible duckbill sleeve shall be one

piece rubber construction with fabric reinforcement. The check valve shall also have a protective EPDM exterior wrapping for protection against sunlight attack. Check valves shall be attached to the pipe outside diameter by means of vendor furnished clamps. Company name, plant location, and valve size and serial number shall be bonded to the check valve.

PART 3 - EXECUTION

3.01 INSTALLATION

All equipment specified herein shall be installed, connected, and tested, finished as shown and specified and in accordance with the manufacturers recommendation. Nothing herein shall be construed as relieving the Contractor of his responsibility for this portion of the work.

3.02 ACCEPTANCE

As a condition precedent to final acceptance of the work, Contractor shall certify the proper installation and testing of equipment included under this section. Certification shall warrant that equipment and installation are free of defects and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's equipment guarantee.

** END OF SECTION **

SECTION 15145

SUBMERSIBLE SUMP PUMP

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This section specifies sump pumps for pumping drainage which may contain small concentrations of small diameter solids.

B. TYPE. The pump shall be of the submersible electric motor driven, centrifugal type.

C. EQUIPMENT LIST. Equipment numbers are:

<u>ITEM</u>	<u>EQUIPMENT NO.</u>
ABS TRASH HANDLING PORTABLE SUBMERSIBLE PUMP	AFPT 2 HP

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS. Pump shall be designed for normal intermittent operation and for periods (up to 48 hours) of continuous duty. Pumps shall be ABS Pumps Model AFPT.

B. OPERATING REQUIREMENTS. The pump shall be designed for the following operating conditions:

1. Rated total head, feet	25
2. Rated capacity, gpm	200
3. Rated speed, rpm	1750

1.03 SUBMITTALS

Submit in accordance with Section 01300.

1.04 INFORMATION TO BE PROVIDED

Submit operation and maintenance data in accordance with Section 01730.

PART 2 - PRODUCTS

2.01 MATERIALS

Materials shall be:

<u>COMPONENT</u>	<u>MATERIAL</u>
Motor Housing	Gray Iron
Impeller	Gray Iron
Shaft	Stainless Steel
Volute Casing	Gray Iron
Hardware	Stainless Steel
Seal	Brass and Ni-Resist

2.02 CONSTRUCTION

A. SEAL. Seal shall be mechanical, self-lubricated operating in an oil filled cavity.

2.03 EQUIPMENT

A. ELECTRIC MOTOR. Motor shall be submersible type, designed for operation on 240V AC, one phase, 60 HZ.

B. BUILT-IN LIQUID LEVEL CONTROL. Pump shall be supplied with all independent on-off liquid level control equipment required for automatic operation.

PART 3 - EXECUTION

3.01 INSTALLATION

Pump shall be installed as shown on the Drawings and in accordance with manufacturers recommendations.

** END OF SECTION **

SECTION 15161

PIPING EXPANSION JOINTS AND FLEXIBLE CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE. This Section includes all materials and requirements for vibration isolation and expansion equipment for all systems, as shown and specified. The work includes expansion joints to accommodate pipe movement and absorb vibration for all piping systems as specified and shown on the Drawings.

B. RELATED WORK. Related work specified elsewhere includes, but is not limited to, the following:

Pipe and Fittings	SECTION 15060
Blowers	SECTION 11373
Centrifugal Pumps	SECTIONS 11211 AND 11312.

1.02 QUALITY ASSURANCE

A. STANDARDS. All material and work provided under this Section shall comply with the requirements of the following standards:

ASTM
ANSI
USAS (B16.1) FLANGES.

B. UNIFORMITY. All expansion joints and vibration isolation equipment shall be of one manufacture in order to provide interchangeability of parts. Manufacturer shall assume responsibility for and guarantee performance of the materials. Manufacturer shall be regularly engaged in the design and manufacture of this type of equipment.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. FLEXIBLE COUPLINGS. Flexible couplings for blowers and pumps shall be synthetic rubber and asbestos spool type, single arch, General Rubber Corp. Style 1025, Class II or LD Belmont Style 5404, or equal, unless otherwise shown on the Drawings, depending on pressure, suitable for operation at temperatures of 250 degrees F.

Couplings on pump suction shall be filled arch type. Other couplings shall have integral liners. The tube shall be natural or rubber Buna N, and shall present a smooth surface to the flow, extending completely through the bore of each coupling in one single unbroken piece to fully face both flanges. The carcass of each coupling shall be constructed of high strength polyester fiber, bonded to both sides of a core consisting of copper coated steel reinforcing rings separated by a hard rubber filler and designed to prohibit migration. Each coupling shall be covered with a heavy duty neoprene-hypalon jacket designed to be resistant to abrasion, heat, petroleum products, ozone, and weathering. Flanges shall be fitted with split steel retaining rings. Drilling and bolting shall comply with ANSI B16.1, Class 125. Flexible couplings for pump inlets shall be General Rubber Corp. Style

1025 filled arch, or equal. All discharge couplings shall be rated for a working pressure of 140 psi and, where required, shall be equipped with suitable expansion control units designed for an internal pressure of 150 psig. Discharge couplings shall be General Rubber Corp. Style 1025, Belmont Style 5404, or equal.

B. EXPANSION JOINTS. Expansion joints and anchors shall be provided as recommended by the expansion joint manufacturer to accommodate pipe movement due to temperature changes. Details shall be submitted to the Engineer for acceptance before installation. All expansion joints shall be suitable for pressure and temperature as set forth in SECTION 15060 without crimping or corrugations. Corrugated type shall be suitable for a minimum of 100,000 pressure, temperature, and deflection cycles. Packed type joints shall have packing suitable for the service involved and shall be Certain-Teed Fluid Tite PVC, Johns-Manville PVC double bell expansion joints, or equal, suitable for buried installation where shown.

1. Unless otherwise shown or specified, expansion joints for low pressure air and sludge piping shall consist of Dresser Style 38 or Smith-Blair Type 411 couplings, or equal. Restraint and gap between pipe ends shall be as recommended by the coupling manufacturer for the service intended.

2. Expansion joints for polyvinyl chloride piping shall be CPS "hemtrol", CPVC slip type with flow impregnated seal rims; Certain-Teed Fluid Tite PVC, Johns-Manville PVC double bell expansion joint, or equal.

3. Expansion joints for sludge shall be of the double packed slip type with limited movement feature, Dresser Style 63, Type 4, Smith-Blair Type 612, or equal. Packing shall be suitable for use with wastewater sludge. Provisions shall be made for pressure lubrication of the packing.

4. Where shown on the Drawings or where space limitation is a factor, ball joints shall be used to accommodate pipe expansion and movement. These shall be as manufactured by Aeroquip Corp., Barco Division; Chiksan Co., a subsidiary of Food Machinery & Chemical Co., or equal.

5. Expansion joints for air and gas compressor discharges shall be Type BMH as manufactured by the US Flexible Metallic Tubing Company, similar type as manufactured by Anaconda, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

All materials specified herein shall be installed and tested as shown and specified, and in strict accordance with the manufacturer's recommendations.

3.01 ACCEPTANCE

As a condition precedent to final acceptance of the work, Contractor shall certify the proper installation of materials included under this Section.

** END OF SECTION **

DIVISION 16 - ELECTRICAL

SECTION 16 A - ELECTRICAL

1. Scope of Work

- a. Provide all conduit, conductor, panelboards, motor control center, controls, wiring devices, lighting fixtures and miscellaneous materials and equipment required for complete electrical installation as indicated on the Drawings and specified herein.
- b. The Drawings indicate the general extent and general arrangement of the electrical work. If any departures from the Drawings are deemed necessary by the Contractor, details of such departures shall be submitted to the Engineer for review and approval. Departures shall not be made without prior written approval.

2. Compliance Submittals

- a. Within fifteen (15) days after award of Contract, submit six (6) copies of the following information.

Shop Drawings: See General Conditions for requirements. Submit for review before placing final order for following equipment and materials:

- a. panelboards
 - b. lighting fixtures
 - c. motor control center
 - d. pressure and level switches
 - e. transformers
 - f. alarm system components
 - g. service entrance equipment
- b. Material list including manufacturer, type, and model number of the following equipment that will be used:
 - a. conduit
 - b. conductor
 - c. wiring devices, including boxes for all waterproof devices
 - d. Other information: Provide as required by the Engineer

3. Codes, Permits, Licenses and Standards

- a. The Contractor shall comply with all applicable laws, building and construction codes and requirements of governmental agencies under whose jurisdiction work is being performed. Unless specifically noted to contrary, conform with and test in accordance with applicable Sections of latest revisions of the following codes and standards.

American Society for Testing and Materials (ASTM)
National Fire Protection Association, National
Electrical Code (NEC) 1981
Insulated Power Cable Engineers Associations (IPCEA)
Underwriters Laboratories, Inc. (UL)
American Steel and Iron Institute, "Design Manual
on Steel Electrical Raceways"

National Electrical Manufacturer's Association
American National Standards Institute (ANSI)

- b. Should any conflicts arise between above Codes and Standards, the Code or Standard establishing the more stringent requirements shall be followed.
- c. Any conflicts between above Codes/Standards and Specifications and/or Drawings shall be resolved by following the more stringent requirements.

4. Material and Workmanship

- a. All equipment and materials shall be new, of the best quality and free from defects. Each type of equipment or material shall be the same make and quality. Workmanship shall be in accordance with the best present day construction methods and shall be neat and orderly throughout the project.

5. Defective Equipment

- a. If equipment fails to conform to detailed Specifications or to operate satisfactorily, the Owner shall have the right to operate equipment until defects are corrected. The Owner shall have the right to operate rejected equipment until it is replaced, without cost for depreciation, use, or wear.
- b. Removal of defective equipment from operation for examination, adjustment, alteration or change shall be undertaken only at times approved by Owner.

6. As-Built Drawings

- a. Blue-line white prints of the Drawings will be furnished by the Engineer on which the Contractor shall accurately and neatly mark in colored pencil all changes or deviations from the Drawings as they are made in the work. These Drawings shall be reviewed with the Engineer at least once a month. Failure to keep As-Built Drawings up-to-date shall be cause for withholding monthly or final payments.

7. Manufacturers

- a. Acceptable manufacturers for electrical equipment used in this project shall be Allen-Bradley, Cutler Hammer, General Electric, ITE, Square D, Republic Steel, Triangle, National, Carlon, Allied, Westinghouse, or approved equal, or as otherwise specified.

SECTION 16 B - MATERIAL AND METHODS

1. Raceway and Fittings

- a. All wires and cables shall be installed in metal raceways as specified herein and as indicated. Provide all couplings, fittings and hangers for complete installation.

2. Materials

- a. Rigid Metallic Conduit: Per USAS C80.1, zinc-coated by hot-dip galvanizing or sheradizing with additional enamel or lacquer coating. Fittings shall be threaded type of same material as

conduit.

- b. Flexible Liquid Tight Conduit: Galvanized steel liquid-tight, compression type.
- c. Non-Metallic Conduit: Unplasticized polyvinyl-chloride heavy wall Type 40 suitable for direct burial. Fittings shall be threaded or solvent welded type of same material as conduit. Non-metallic conduit shall not be embedded in concrete.

3. Location

- a. Rigid Metallic Conduit: Shall be PVC coated or half-lapped with 20 mil tape approved for use where used for underground and underslab runs and where runs are placed in concrete and runs where conduit is exposed to moisture, weather or mechanical injury.
- b. Flexible Liquid-Tight Conduit: Use between motor terminal boxes or vibration producing devices and rigid conduit or other devices.
- c. Non-Metallic Conduit: May be used for all underground runs and runs under concrete slabs. Runs under concrete slabs shall be imbedded in earth a minimum of 4 inches. Shall not be used where exposed. Shall not be concealed in walls or floors. Ground conductors shall be furnished and installed as required by NEC. Risers through concrete slabs shall be taped or PVC coated rigid steel conduit. Provide steel adapters as required.

4. Sizes

- a. As indicated but not less than 3/4".

5. Electrical Conduit Installation

- a. Electrical Continuity: All metallic conduit systems shall be electrically continuous throughout.
- b. Moisture: All conduit systems shall be moisture-tight. Conduits shall slope to manholes or boxes. Where pockets cannot be avoided in exposed conduit, provide drainage fittings.
- c. Alignment of Exposed Conduit: Parallel with or at right angles to lines of structure.
- d. Field Cuts and Threads: Cuts shall be square, threads clean and sharp. Remove by reaming butts, sharp or rough edges. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of rigid steel conduit. Apply coat of red lead, zinc chromate or special compound recommended by manufacturer to conduit where conduit protective coating is damaged.
- e. Bends
 - 1. General: Uniform, whether job-fabricated or made with standard fittings or boxes. Do not dent or flatten conduit. Bends larger than 1-1/4" shall be factory made.
 - 2. Exposed Conduit: Symmetrical insofar as practicable.
- f. Location

1. Routing: Generally shown in schematic fashion, unless dimensioned or noted to contrary. Contractor shall determine actual routing as approved.
2. Conduit Not Shown: Contractor shall route as required to connect equipment as specified.
3. Vertical Risers, Equipment, and Device Locations: Approximately as shown. Contractor shall coordinate installation of conduit, in locations indicated, with structure and equipment.

- g. Buried Conduit: Depth of burial shall be a minimum of 24" below finished grade. Metal conduit shall be coated with an approved asphaltic compound or wrap with two layers of approved corrosion protection tape. PVC conduit shall be encase with 3 inches of red concrete where not under floor slab.
- h. Conduit Ends: Install a nylon 200# test drag line in all spare conduits and cap ends. Insulating bushings shall be installed in open conduit ends terminating in control centers, consoles or similar locations where exposed to entrance of foreign material. Space around cables shall be plugged with oakum and/or sealing compound. Conduit ends shall be capped or plugged during construction to prevent entrance of foreign material.
- i. Conduit Connections: Connections to panels and boxes shall be made with double locknuts and insulating bushings for rigid conduits. Metallic conduit terminating in non-metallic manholes or pullboxes shall have grounding bushings.
- j. Cleaning: The Contractor shall clean and swab inside of conduits by mechanical means to remove foreign materials and moisture before conductors are installed.

6. Conductors

- a. Size, Type, Location: See Drawings.
- b. Standard: IPCEA S-19-81.
- c. Material: Soft annealed coated copper per ASTM B33 or B189.
- d. Stranding: No. 10 and smaller - Solid
No. 8 and larger - Class B
- e. Insulation and Covering:
 1. General: As indicated on the plans and specified herein.
 2. Thickness: Per IPCEA
 3. Material:
 - a. No. 8 and smaller: Type XHHW or THHW single conductor power cable, moisture resistant, flame retardant thermoplastic insulation, 480 volt, 75 degrees C., copper temperature.
 - b. No. 6 and larger: Type THHW single conductor power cable, heat and moisture resistant, flame retardant, thermoplastic

insulation, 75 degees C. copper temperature.

- c. Multi-Conductor Control Cable: Color coded cross-linked polyethylene insulation on each conductor, necessary fillers and polyester-film tape over conductor group with an overall PVC jacket, 480 volt, number of conductors shown. General Electric S1-58742 or approved equal.

7. Conductor Installation

- a. Bending Radii: Not less than permitted by IPCEA.
- b. Supports in Vertical Runs: As prescribed by NEC.
- c. Splicing: Permitted only in junction boxes or similar accessible locations. Number of splices held to absolute minimum.
- d. Connectors: Solderless compression type.
- e. All Power Cables: In strict accordance with manufacturer's instructions.
- f. Instrument and Control Wiring: No splicing allowed without specific approval.
- g. Connections
 - 1. Apparatus Lugs: Solderless compression of approved manufacturer. Thoroughly clean lug and conductor and coat with suitable oxidation inhibiting compound prior to connection.
 - 2. Terminal Blocks: Use retaining cup washers where solid wire is used. Use compression type connectors where stranded wire is used.
 - 3. Twist on Type Connectors: Restricted to the connection of lighting fixture wires only. Connectors shall be "Scotchlok" or approved equal.
- h. Phasing
 - 1. Where common neutral is run for two or three circuits, phase conductors shall be connected to breakers in panel which are connected to different phase legs.
 - 2. Homeruns: May be combined at option of Contractor providing not more than three circuits are installed in one conduit unless shown otherwise.
- i. Conductor Pulling: Use powdered soapstone or approved commercial pulling compound. Use of soap or other solutions not permitted.

SECTION 16 C - SERVICE SYSTEMS

1. Grounding

- a. Ground Cable: Bare copper, sizes as required by NEC.
- b. Grounding Lugs: Clamp type, high conductivity copper alloy.

Provide lugs for all equipment to be grounded.

- c. Incoming Service: Grounded as shown on the Drawings.
- e. Neutral Conductor Connection to Ground Conductor: At main service enclosure only.

2. Site Service

- a. Provide main service as shown. Verify types of equipment and details of installation with serving utility. Electrical Contractor shall pay for all utility charges to serve entrance section.

3. Service Entrance Equipment

a. General Construction (NEMA 3R)

1. Furnish and install where indicated a dead front type, completely metal enclosed self-supporting structure independent of wall supports. It shall consist of the required number of vertical sections bolted together to form one rigid switchboard 90-3/8" high incorporating switching and protective devices of the number, ratings and type noted herein or shown on the Drawings with all necessary intercommunications, instrumentation and control wiring. Switchboard construction shall be of the universal frame type using die-formed members bolted and braced through the exclusive use of self-tapping bolts which will not loosen during shipment. The sides, top and rear shall be covered with removable screw-on plates having formed edges all around. Front plates shall be sectionalized and removable. All front plates shall be fabricated from code gauge steel and shall have formed edges all around. Ventilation openings shall be provided where required. All covers shall be secured by self-tapping screws.
2. The buss shall be tin plated aluminum of sufficient size to limit the temperature rise of 60 degrees C. based on UL tests and adequately braced and supported to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having the indicated available short circuit current. All connections shall be tightly bolted.
3. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished when required. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. All hardware used on conductors shall have a high tensile strength and an anti-corrosive zinc plating.
4. A ground bus and lug shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
5. Record Drawings shall be furnished providing the following information: switchboard, voltage/current ratings, overall outline dimensions - including available conduit space, switching and protective device ampere ratings and one line diagram.
6. Adequate conduit space shall be provided to meet NEC requirements.

7. Each switching and protective device shall be provided with visible means of ON-OFF identification. All terminals shall be of the anti-turn solderless type suitable for Cu or Al cable of sizes indicated.
8. Provide space in distribution section for 5 KVA transformer and 6 circuit panelboard as shown on drawings.

4. Reduced Voltage Starter (NEMA 3R):

- a. Reduced Voltage Starter shall be built and tested in accordance with:
 1. NEMA Standards
 2. ANSI
 3. Underwriters Laboratories, Inc.
- b. Service:
 1. Suitable for operation on 480 volts, 3-phase, 4-wire, 60 Hz.
 2. Suitable for connection to an available fault of 42,000 RMS symmetrical amperes.
- c. Incoming Line:
 1. The incoming line shall enter the section at the top and will be cable connected.
- d. Wiring:
 1. The reduced voltage starter shall be wired NEMA Class 1 Type B.
- e. Structure:
 1. Structures shall be totally enclosed, dead-front, free standing assemblies, 90 inches high and not less than 16" deep for front mounted units. Working height shall be 72" to accommodate starter units in multiples of 6" increments with a minimum of 12". Removable lifting angles will be provided.
 2. All structure doors to be mounted on removable pin hinges and secured with quarter-turn indicating-type fasteners.
 3. Structures shall contain a horizontal wireway at the top, isolated from horizontal bus and readily accessible. Each structure shall contain an isolated vertical wireway with cable supports, accessible through hinged doors.
 4. Other units to be included in the reduced voltage starter are cabinet control relays and devices needed for function of operating control panel. See Drawings for details.

SECTION 16 D - DISTRIBUTION SYSTEM

1. Lighting and Power Panels:

- a. Type: Dead front, circuit breaker, indoor mounted in service entrance section.
- b. Breakers: Bolt-in, molded case, thermal magnetic, quick-make, quick-break, trip free, trip indicating. Number and size as indicated.
- c. Panel and Box: Galvanized steel with plain steel front complete with hinged door lock. Panel front shall have concealed mechanism to fasten to box. Provide card holder and typewritten schedule of circuits.
- d. Interrupting Rating: 10,000 AIC. Values shown are symmetrical amperes minimum for breakers and bus.
- e. Standard: UL "Standard for Panelboard", No. 67.
- f. Nameplates: Required on each panel with identification as shown. Engraved white bakelite with black core.

2. Wiring Devices:

- a. Type: Heavy duty, backwires as shown on Drawings.
- b. Location: Approximately where shown. Devices shall coordinate with structure and various equipment. Exact locations to be determined in the field.
- c. Ratings: 20A, 120V

SECTION 16 E - CONTROL PANELS CP1

1. Panel shop drawings shall be submitted for CP1 complete with schematics (wiring drawing not required), panel layout and parts list. All schematics shall have wiring identified with number per construction documents.
2. Furnish shop drawing submittals on full voltage starters to conform to drawings.
3. Commission controls before shipment and notify engineer of functional problems so they can be corrected before delivery.
4. Panels shall not be fabricated prior to shop drawing approval.

1. Summary

- a. Upon completion of the electrical work, the entire installation shall be tested by the Electrical Contractor and demonstrated to be operating satisfactorily. Wiring shall be tested for continuity, short circuits and/or accidental grounds. Motors shall be operating in proper rotation and control devices functioning properly.
- b. Test all feeder and motor circuits with "meggar" tester and furnish list to Owner/Engineer. Check all motor controllers to determine that properly sized overload devices are installed and other electrical equipment for proper operation.
- c. All systems shall be entirely free from "grounds", "short circuits" and any or all defects.

- d. Tests and adjustments shall be made prior to acceptance of the electrical installation by the Engineer and a certificate of inspection and acceptance of the electrical installation by local inspection authorities shall be provided.
- e. All equipment or wiring provided which tests prove to be defective or operating improperly shall be corrected or replaced promptly at no additional cost to the Owner.
- f. Electrical system shall be warranted for one year after date of beneficial use. Any repair or part replacement within the warranty period shall be made with no labor or material cost to the Owner.

ENGINE GENERATOR SET - PLANT

PART I - GENERAL

1. SCOPE OF WORK

The contractor shall furnish and install a new diesel generator set complete with automatic engine starting control, generator control panel, automatic transfer switch, engine mounted radiator, residential type muffler, fuel system, weatherprotective enclosure, etc. in order to provide a complete and operative system as detailed on the drawings and as hereinafter specified.

These specifications are based on the Generac packaged unit which is the standard for quality, testing, heat rejection, air flow, exhaust flow and dimensions.

2. PARTS AND SERVICE

The engine-generator set bidder shall be the authorized dealer of the engine-generator set manufacturer and shall be fully qualified and authorized to provide service and parts for both the engine and generator anytime during the day or night.

3. INFORMATION TO BE FURNISHED BY THE EQUIPMENT SUPPLIER

- 3.1 Detailed Drawings for this Installation.
- 3.2 Drawings and/or Literature Describing All Equipment to be Furnished.
- 3.3 Make of Engine-Generator Set.
- 3.4 Complete Operating Instructions and Maintenance Manual with Parts List.
- 3.5 Published Literature Describing the Engine-Generator Set Combination.

PART II - PRODUCTS

1. RATING

The engine-generator unit shall have a continuous standby rating of 100 KW/125 KVA on the drawings for operation at 2500 feet elevation in an ambient temperature of 110° F. The output voltage shall be 277/480 V, 3-phase, 4-wire.

The above rating shall be based on operation at 1800 RPM when equipped with all necessary operating accessories, such as radiator cooling fan and battery charging alternator. Engine/generator shall successfully start (2) 50HP motors stagger started with 20% voltage dip.

2. ENGINE

The engine shall be four stroke cycle, compression ignition diesel, with mounted radiator and accessories as specified. Manufacturers published literature shall be provided indicating the engine's net horsepower output is acceptable in this application.

Engine speed shall be governed by mechanical governor to maintain frequency within 3 Hz. The engine shall be capable of satisfactory performance on a commercial grade of Number 2 fuel oil. A fuel filtering system approved by the manufacturer shall be supplied.

The engine shall be equipped with the following accessories: battery charging alternator, lube oil filter, air cleaner, radio suppression, jacket water heater, critical area muffler, electric solenoid, oil drain extension. Safety controls shall include low oil pressure shutdown, high water temperature shutdown, low water shutdown, overspeed shutdown, overcrank and wired to indication lights on the control panel. High generator stator temperature shall open the voltage regulator circuit.

A flexible exhaust duct shall connect radiator discharge to exhaust louvre in block wall. Louvre, flexible duct and installation shall be by engine generator supplier. Discharge duct shall be 1 1/2 times the radiator exhaust cross section or 1 1/2" static pressure drop; whichever is less.

3. FUEL SUPPLY TANK

A fuel tank of code gauge steel shall be supplied. The tank shall be supplied with a fuel gauge and low fuel level alarm contacts to close when 8 hours fuel supply remains in the tank.

4. STARTING

Starting shall be accomplished by a single positive engagement, solenoid-shift starting motor. The starting system shall be designed for re-starting in the event of a false engine start, by permitting the engine to completely stop and then re-engage the starter.

A battery, battery rack, cables and 2 amp float-type battery charger with ammeter shall be provided. A 120 volt jacket water heater with thermostat shall be installed on the engine in order to assure quick starting of the diesel engine under the environment as specified elsewhere.

5. PLANT MOUNTING

The engine-generator shall be equipped with factory installed vibration isolators mounted between the plant and fabricated steel skid base to prevent distortion of alignment between alternator on engine when installed.

6. WEATHERPROOF ENCLOSURE

The engine-generator set, control panel, line circuit breakers, etc. shall be installed in a weatherproof enclosure. The enclosure shall have lockable, removable panels or hinged doors, conveniently located for ease in surveillance and servicing of the unit. The critical area silencer shall be mounted horizontally on the enclosure with a stainless steel bellows type flexible connection to the engine exhaust manifold. Sheet metal shall be zinc electro-plated and painted with automotive enamel of manufacturers standard color. All locks shall be stainless steel.

7. ALTERNATOR

The alternator shall be four pole, revolving field, 12 lead, reconnectable of drip-proof construction with amotisseur windings and temperature compensated solid state voltage regulator. The regulator shall be constant voltage type between 58 and 68 HZ. When the frequency drops below 58 HZ, it shall convert to volts/HZ type.

Radio interference suppression meeting commercial standards shall be supplied. Voltage regulation shall be within $\pm 2\%$ of rated voltage from no load to full load.

8. GENERATOR SET CONTROL PANEL

A generator mounted control panel shall be vibration isolated on the alternator frame. It shall include the following factor installed, wired and tested equipment:

- 8.1 Overcrank Protection Designed to Open the Cranking Circuit if Engine does not Starter After Eight (8) Cranking Attempts with Cranking Reset Button.
- 8.2 Emergency Shut-Down Switch for Immediate Stopping.
- 8.3 Line Circuit Breaker, Sized as Shown on the Drawings.
- 8.4 Direct Reading Frequency Meter.
- 8.5 AC Voltmeter
- 8.6 AC Ammeter

- 8.7 Ammeter/Voltmeter Phase Selector Switch
- 8.8 Engine Oil Pressure and Water Temperature Gauges
- 8.9 Engine Hourmeter
- 8.10 Battery Charge Rate Ammeter and Trickle Charge Rate Ammeter
- 8.11 Safety Indicating Lights for Engine Overspeed, Overcrank, Low Oil Pressure, High Water Temperature, Alarm Test and Reset and Complete Auto Start System.

9. AUTOMATIC TRANSFER SWITCH

9.1 Construction: The automatic transfer switch shall be a contactor type with operating mechanism designed to ensure reliable and positive performance under all conditions. The operating mechanism shall have sufficient mechanical and electrical interlocks to prevent simultaneously energizing both normal and standby service.

The design of the main contacts shall include all necessary arc suppression and heat dissipating devices to provide dependable transfer of highly inductive loads. The transfer switch shall have been tested in accordance with Underwriters' Laboratories standard for safety, automatic transfer switches, UL 1008.

9.2 The transfer switch shall contain the following minimum features:

- 9.2.1 Individual adjustments for voltage pickup and drop out on each phase.
- 9.2.2 Adjustable time delay on engine start from 0.1 to 5 seconds.
- 9.2.3 Adjustable time delay on transfer to emergency from 0-3 minutes.
- 9.2.4 Adjustable time delay on transfer to normal from 1-3 minutes.
- 9.2.5 Adjustable time delay on engine shut down from 1-5 minutes.
- 9.2.6 Adjustable minimum run timer to ensure the engine will operate long enough to reach operating temperature before shut down adjustable from 5 - 30 minutes.
- 9.2.7 Automatic exerciser solid state with crystal oscillator.

It shall be supplied with a standby battery pack. It shall have a digital display of time of day or exercise time. LED's indicate what day it is and a switch to select any or all days for exercise. It shall also have a selector switch for no load or load exercise.

9.2.8 Generator running light, AC volt meter, AC ammeter, phase selector switch and frequency meter mounted on the door.

9.2.9 Transfer switch position lights.

9.2.10 NEMA 12 dust tight enclosure.

PART III - EXECUTION

1. TESTING

At the completion of the installation of this emergency power system an acceptance test of at least two hours duration shall be run using available building load. Fuel will be supplied by the Owner. During this test and at 15 minute intervals, the following information shall be recorded: 1) Oil pressure, 2) Water temperature, 3) Battery charge rate, 4) Outside ambient, 5) Generator output voltage (each phase), 6) Generator current (each phase) and 7) Generator frequency.

After this test has been completed to the satisfaction of the engineer and Owner, the complete system shall be tested and start-up time recorded by opening the circuit breaker feeding the normal supply to the automatic transfer switch. Total time from opening the circuit breaker until the machine assumes the emergency load shall not exceed 10 seconds.

2. OWNER'S INSTRUCTIONS

At the Owner's convenience the generator set supplier shall provide a qualified representative to instruct the Owner's operating personnel in the function, operation and maintenance of the complete system. At this time, the generator set supplier shall furnish the Owner with 2 copies of the operation and maintenance manuals.

3. GUARANTEE

The engine-generator set and accessory components furnished under these specifications shall be guaranteed for a period of one year from date of final acceptance against defective design, materials and workmanship on the equipment supplied.