SUNRISE
ENGINEERING

DIVISION OF WILDLIFE RESOURCES
SPRINGVILLE FISH HATCHERY PROJECT

2009

CONTRACT DOCUMENTS, STANDARD SPECIFICATIONS, AND SPECIAL PROVISIONS

for the

DIVISION OF WILDLIFE RESOURCES
SPRINGVILLE FISH HATCHERY
PROJECT – 2009
DFCM PROJECT NO. 07146520

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BID SCHEDULE

NOTE: The plans depict to portions of the overall job to be completed, which are denoted by Schedule A and Schedule B. This Bid Schedule shall only include those items denoted as schedule B on the plans, Items which fall under Schedule A shall be by others.

CONTRACT FOR: SPRINGVILLE FISH HATCHERY - 2009

The undersigned Bidder, having examined and determined the scope of the Contract Documents, hereby proposes to perform the work described herein for the following unit prices or lump sum amounts.

Note: ***1. Bids shall include sales tax and all other applicable taxes and fees***
2. All bids shall be checked for errors. If errors are made, unit prices shall govern and corrections will be made according to the unit priceand totals will be revised to reflect the corrections.

No.	Meas. & Pmt. Reference	Item	Quantity	Unit	Unit Price	Amount
EXTERIOR TREATMENT PLANT BUILDING CONSTRUCTION WORK						
1	02000	Mobilization	1	L.S.	$ -	$ -
2	02015	Clear and Grub	1	L.S.	$ -	$ -
3	02201 SP	Earthwork for Treatment Plant Area	1	L.S.	$ -	$ -
4	02201 SP	UBC & Gravel for Treatment Plant Area	1	L.S.	$ -	$ -
5	02222	30" PVC C905 DR 35 and Fittings	340	Ln. Ft.	$ -	$ -
6	02511	3.5" Hot Plant Mix Bituminous Surfacing	695	Sqaure Yards	$ -	$ -
7	03300 SP	Concrete (4000 psi) (Ext. Slabs & Stairs)	1	L.S.	$ -	$ -
8	11388 SP	Recirculation Pump System	1	L.S.	$ -	$ -
9	11389 SP	Diversion Structure	1	Each	$ -	$ -
INTERIOR TREATMENT PLANT BUILDING CONSTRUCTION WORK						
10	03305 SP	Treatment Area Concrete	1	L.S.	$ -	$ -
11	13150 SP	Steel Building	1	L.S.	$ -	$ -
12	15120 SP	Treatment Plant Piping/Equipment	1	L.S.	$ -	$ -
13	11250 SP	Ultraviolet Disinfection System	1	L.S.	$ -	$ -
14	11260 SP	Drum Filter System	1	L.S.	$ -	$ -
15	13320 SP	Gantry Crane and Hoist	1	Each	$ -	$ -
16	09205 SP	Building Interior Finishes	1	L.S.	$ -	$ -

DIVISION 1

GENERAL REQUIREMENTS

SUNRISE
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01019.1 DESCRIPTION

This Section covers measurement and payment practices utilized by Sunrise Engineering in performing its contract management services according to the requirements of these Specifications and other parts of the Contract Documents.

01019.2 MEASUREMENT

01019.2.1 METHODS

The method of measurement and computations to be used in determination of quantities of material furnished, and of work performed under the Contract, will be those methods generally recognized as conforming to good engineering practice.

When items of improvement, equipment, or service referred to herein as "work" are shown on the plans and/or called for in the specifications for the Contractor to furnish, install, or provide, the items of work shall be measured and paid for in one of two ways. First, if the item of work is considered incidental to other items in the Bid Schedule, no separate measurement and payment shall be made and no separate bid item in the bid schedule will appear. In this case measurement and payment for this work shall be included by the Contractor in other bid items on the bid schedule. Second, when shown separately on the bid schedule, the item of work shall be measured as called for in the specifications and paid for at the contract unit price for that work.

01019.2.2 ACCURATE PRICING

The Bidder shall include a price for all bid items in the Bid Schedule and the Schedule of Values if required. Failure to do so may render the Bid non-responsive and may cause its rejection. All bids will be checked for errors. In the event the total "amount" indicated on the Bid schedule for a bid item does not equal the product of the unit price times the estimated quantity, the unit price shall govern, and the amount will be corrected accordingly. In the event the Bid Total does not agree with the sum of the prices bid on the individual bid items, the individual item prices shall govern and the total for the Bid schedule will be corrected accordingly. The Contractor shall be bound by any such corrections. For "Lump Sum" bid items, where applicable, the total shown on the Schedule of Values shall equal the amount entered for the corresponding bid item on the Bid schedule.

01019.2.3 U.S. STANDARD MEASURE

All work completed under this Contract will be measured by U.S. standard measure for the units described herein. Work performed by the Contractor will be measured in those units in accordance with the procedure described herein.

01019.2.4 MEASUREMENT BY ENGINEER

Since the quantities appearing on the Bid Schedules are approximate only and are prepared for the comparison of bids, all work and materials are subject to measurement by the Engineer. Measurement of work performed by the Contractor on Bid items with unit prices other than "lump sum" will be for the actual quantities of work performed and accepted, or material furnished in accordance with the Contract. In the case of lump sum bid items, the Engineer will verify that all of the work represented by the bid item has been completed.

01019.2.5 VARIATIONS IN QUANTITIES OF WORK

The scheduled quantities of work to be done and materials to be furnished may each be increased, decreased, or omitted at the Owner's discretion.

01019.2.6 MEASUREMENT BY LUMP SUM

The term "Lump Sum" when used as a unit of measurement for a specific improvement or separate component of a unit shall include all work necessary to complete that entire unit, including all necessary fittings and accessories delineated by the pay limits as shown on the Drawings. If no pay limits are shown on the Drawings, then the improvement shall include all fittings and accessories within 5-feet of the item.

01019.2.7 MEASUREMENT BY LINEAL FOOT

All work measured by the lineal foot shall be measured parallel to the centerline. For water and gas piping, no deduction will be made for valve, fittings or carrier pipe. For sewer collection piping, measurement shall be to the inside surface of connecting manholes. Piping connected to structures, except headwalls, shall be measured to a point five (5) feet outside of that structure, unless indicated otherwise on the Drawings.

A station, when used as a unit of measurement, will be 100 lineal feet.

Items measured by the lineal foot; such as pipe culverts, guardrail, under-drains, etc., will be measured parallel to the base or foundations upon which structures are placed.

The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fractions of inches.

01019.2.8 MEASUREMENT BY AREA

Area computations will be made from actual horizontal and transverse measurements made on the site of the work.

Structures will be measured to the neat lines shown on the plans or as altered to fit site conditions.

Lumber will be measured by the thousand feet board measure (M.F.B.M.) actually incorporated in the structure. Measurement will be based on nominal widths and thickness and the extreme length of each piece.

01019.2.9 MEASUREMENT BY VOLUME

In computing volumes of excavation, the average end area method will be used unless the Engineer and Contractor agree, in writing, to an alternate method.

Materials to be measured by volume or by load count shall be hauled in approved vehicles and measured at the point of delivery. Vehicles for this purpose may be of any size or type, provided the body is shaped so the actual volume may be readily and accurately determined.

When liquid bituminous materials are measured by the gallon or ton, volumes will be measured at 60° F, or will be corrected to the volume of 60 degrees F, using ASTM D 1250 for asphalt or ASTM D 633 for tars. When bituminous materials are shipped by truck or transport, net certified weights or volume subject to correction for loss or foaming, may be used for computing quantities.

01019.2.10 MEASUREMENT BY WEIGHT

The term "ton" will mean the short ton of 2,000 pounds avoirdupois.

When measurement units require weighing materials for payment, the Contractor shall be responsible for providing weight measurement from commercial certified scales or from scales provided at the job site which are certified in the state wherein the work is located.

Cement will be measured by the ton or hundredweight.

01019.2.11 CONVERSION OF WEIGHT TO VOLUME

When requested by the Contractor and approved by the Engineer in writing, materials specified to be measured by the cubic yard may first be weighed and the weight converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and agreed to by the Contractor before this method of measurement of quantities is used.

01019.2.12 SPECIFIC MANUFACTURED ITEMS

When standard manufactured items are specified; such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit, weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerance in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

01019.2.13 RENTAL EQUIPMENT

Rental of equipment will be measured in hours of actual working time and necessary traveling time of the equipment within the limits of the project. If equipment is ordered held on the project on a standby basis by the Engineer, the agreed rental rate, minus the labor and fuel costs, will be paid.

01019.2.14 MEASUREMENT BY EACH

All work measured by each shall be an an individual or single unit.

01019.3 PAYMENT

01019.3.1 SCOPE OF PAYMENT

The Contractor shall receive and accept compensation provided in the Contract as full payment for:

- Furnishing all materials, labor, equipment, tools, transportation and incidentals required for completion of work.
- All loss or damage due to the nature of the work, action of the elements and unforeseen difficulties until final acceptance by the Engineer, subject to the provisions of the General Conditions.
- All costs arising from any infringement of a patent, trademark or copyright.
- Bids shall include all sales tax and all other applicable fees.

01019.3.2 NON-PAYMENT

No payment will be made for:

- Work which is in excess of that described in the Contract Documents.

- Removal and replacement of defective work.
- Loss of anticipated profits.

01019.3.3 LUMP SUM

The term "lump sum", when used as a unit for payment, shall include all work required to complete the item, including all necessary fittings and accessories, as described in the Bid Schedule.

01019.3.4 FULL PAYMENT

The Contractor shall receive and accept compensation provided for in the Contract as full payment for furnishing all materials and for performing all work under the Contract in a complete and acceptable manner and for all risk, loss, damage or expense of whatever character arising out of the nature of the work or the execution thereof.

01019.3.5 VARIATION IN QUANTITY OF WORK

The Owner reserves the right to make variations in quantities by adding to, or deleting from, quantities listed in the bid schedule in order to match the total bid with the money available in the budget.

01030.1 DESCRIPTION

This section covers project meetings including the pre-construction meeting and other progress and/or work coordination meetings conducted to provide communication and awareness to all parties associated with the Contract.

01030.2 PRE-CONSTRUCTION CONFERENCE

Prior to the commencement of work at the site, a pre-construction conference will be held at a mutually agreed time and place to be arranged by the Engineer. The Engineer shall also provide notification to all parties expected to attend the meeting. Attendees will include the following:

- Engineer
- Project Inspector
- Owner/Owner's Representative
- Contractor/Contractor's Representative/ Subcontractors as appropriate
- Governmental Representatives as appropriate (State, County, Municipal, etc.)
- Manufacturer/Supplier Representatives/Adjoining Contractors, as appropriate.
- Utility Service Representatives as appropriate.

01030.2.1 Unless previously submitted to the Engineer, the Contractor shall bring to the conference one copy each of the following:

- Contract construction schedule in accordance with the General Conditions.
- Procurement schedule of major equipment and materials and items requiring long lead-time.
- Shop Drawings, samples or substitution proposals for items proposed as substitutions or "or equal" items.
- Schedule of work that includes the anticipated monthly payment amounts during the contract.
- A Schedule of Values of work to be paid for as lump sum items where partial payment is anticipated.

01030.2.2 The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda may include but not be limited to the following items:

- Contractor's Work Schedule.
- Transmittal, review, distribution and approval of Contractor's submittals.
- Processing of applications for payment.
- Maintaining records and documents.
- Critical work sequencing.
- Field decisions and Change Orders.
- Use of project site, office and storage areas, security, housekeeping, and Owner's needs.
- Major equipment deliveries and priorities.
- Interpretation of Drawings and Specifications.
- Contractor's responsibilities for safety, first-aid and sanitation.

01030.2.3 The Engineer will preside at the pre-construction conference and will arrange for keeping minutes and distributing them to all attendees to the meeting.

01030.3 PROGRESS/COORDINATION MEETINGS

01030.3.1 The Contractor shall conduct regular on-site progress and coordination meetings at least weekly and at other times as requested by Engineer or as required by progress of the work. The

Contractor, Engineer, and all Subcontractors active on the site shall be represented at each meeting. The Contractor may, at its discretion, request attendance by representatives of its suppliers, manufacturers, and other Subcontractors. The Contractor shall be responsible for providing written notification to those deemed necessary for attendance at least 36 hours prior to the time set for the meeting.

01030.3.2 The Contractor shall preside at the meetings and maintain a file of minutes of the proceedings. The purpose of the meetings will be to review the progress of the work, maintain coordination of effort, discuss changes in scheduling, and resolve other problems which may develop.

01090.1 DESCRIPTION

Wherever in these Specifications references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronyms or abbreviations only. As a guide to the user of these Specifications, the following acronyms or abbreviations, which may appear herein, shall have the meanings indicated below.

01090.1.1 DEFINITIONS OF ABBREVIATIONS AND ACRONYMS

AAR	Association of American Railroads
AASHTO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institute
ADC	Air Diffusion Council
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute, Inc.
APWA	American Public Works Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASQC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BLM	Bureau of Land Management (U.S. Department of Interior)
CDA	Copper Development Association
CEMA	Conveyor Equipment Manufacturer's Association
CGA	Compressed Gas Association
CFR	Code of Federal Regulations
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CS	Commercial Standard of NBS (U.S. Dept. of Commerce)
CTI	Cooling Tower Institute
DIP	Ductile Iron Pipe
EIA	Electronic Industries Association
EPA	U. S. Environmental Protection Agency
ETL	Electrical Test Laboratories
FEMA	Federal Emergency Management Administration
FERC	Federal Energy Regulatory Commission
FS	Forest Service (U.S. Department of Agriculture)
FWS	Fish and Wildlife Service
GI	Galvanized Iron
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
ID	Inside Diameter

IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code
ISA	Instrument Society of America
ISO	International Organization for Standardization
MBMA	Metal Building Manufacturer's Association
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFGC	National Fuel Gas Code
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NRCS	Natural Resources Conservation Service (U.S. Department of Agriculture) (formerly SCS)
NSF	National Sanitation Foundation
OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PDI	Plumbing and Drainage Institute
PE	Polyethylene
PVC	Polyvinyl Chloride
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SMACNA	Sheet Metal and Air Conditioning Contractor’s National Association
SSPWC	Standard Specification for Public Works Construction
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
UPRR	Union Pacific Railroad
USDARD	Rural Development (U.S. Department of Agriculture) (formerly Farmers Home Administration)
WCRSI	Western Concrete Reinforcing Steel Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

01090.2 REFERENCED WORKS, CODES AND STANDARDS

Whenever references to specifications, codes, standards and other publications are made to these Specifications, the following rules shall apply:

01090.2.1 TITLES OF SECTIONS AND PARAGRAPHS

Titles of sections and/or paragraphs shown in these Specifications are for convenience of reference only, and do not form a part of the Specification.

01090.2.2 APPLICABLE PUBLICATIONS

Whenever references in these specifications are made to published specifications, codes, standards, or other requirements, it shall be understood that unless a date is specified, only the latest edition of these specifications, codes, and/or standards which have been published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or

requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

01090.2.3 SPECIALISTS AND SPECIAL ASSIGNMENTS

In certain instances, specification text requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such direction shall be recognized as special requirements and is not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" and qualified for the assignment of the work. Nevertheless, the final responsibility for fulfilling this assignment remains with the Contractor.

01090.2.4 BUILDING CODES

Reference herein to "Building Code" shall mean the Uniform Building Code issued by the International Conference of Building Officials (ICBO). The latest edition of the code as approved and used by the local agency as of the date of award, as adopted by the agency having jurisdiction, shall apply to the work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

01090.2.5 OSHA

01090.2.5.1 OSHA REGULATIONS - References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

01090.2.5.2 OSHA STANDARDS - References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards of the U.S. Code of Federal Regulations, including all changes and amendments thereto.

01090.2.6 DOT STANDARDS/SPECIFICATIONS

References to "State DOT Specifications" or "State DOT Requirements" shall mean the Specifications for Excavation on State Highway Right-of-Way and/or Standard Specifications for Road and Bridge Construction, including all amendments thereto, issued by the State agency responsible for highways wherein the Contract is located and any other written requirements or provisions issued by that agency which are contained in these Contract Documents.

01090.2.7 FEDERAL PIPELINE SAFETY STANDARDS

Reference to "Federal Pipeline Safety Standards" shall mean Title 29, Parts 191 and 192, Federal Pipeline Safety Minimum Standards, U.S. Code of Federal Regulations including all changes and amendments thereto.

01090.2.8 STATE GAS PIPELINE SAFETY STANDARDS

References to "State Gas Pipeline Safety Standards" shall mean the appropriate section/s of the legal code or regulations adopted in the State wherein the work is located, including all changes and amendments thereto.

01090.3 STANDARDS IMPOSED BY OTHER AGENCIES OR ORGANIZATIONS

01090.3.1 PROPERTY BELONGING TO OTHER AGENCIES OR ORGANIZATIONS

Construction may occur on property owned or administered by agencies or organizations other than the Owner, such as federal and/or state departments of transportation, the U. S. Forest Service, the U. S. Bureau of Land Management, the U.S. Fish and Wildlife, counties, canal companies, irrigation companies, utility companies, other federal and state agencies, municipal governments, etc. Work which is to take place on such property may be required to be in accordance with special construction requirements of that agency or organization as well as these specifications.

01090.3.2 ADDITIONAL INFORMATION AND SPECIFICATIONS

Information will be provided on the plans to indicate areas of the Work which fall on property owned or administered by agencies and organizations other than the Owner. Specifications from agencies which are affected by the work will be provided in the Appendix to the Contract Documents. Those specifications provided in the Appendix shall be considered part of the Contract Documents and the Contractor shall include sufficient compensation in its bid to cover the work required for compliance thereto.

01090.4 CONFLICTS

In case of conflict between codes, reference standards, Drawings and the other Contract Document, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to ordering or providing any materials or labor required therefrom. The Contractor shall assume the most stringent requirements apply when preparing bids for this Contract.

01200.1 DESCRIPTION

The purpose of this section is to clarify certain aspects of the Project and the Contract that must be taken into consideration and completed before final acceptance of the Work can be given. These items include cleanup, demonstration of acceptable performance of equipment and facilities furnished and installed, submittals, payment for all work completed, issuance of final acceptance documentation, accepted repair and restoration of work and materials found defective during the warranty period. Specific instructions are provided herein for completion of the Work in such a manner that it will be fully acceptable and that the Contractor will be eligible for receipt of final payment.

01200.1.1 RELATED WORK AND REFERENCED SECTIONS

Not used.

01200.1.2 SUBMITTALS

Section 01300 - Submittals
See paragraph 01200.3.5 below.

01200.1.3 DEFINITIONS

Not used.

01200.2 MATERIALS

Not used.

01200.3 CONSTRUCTION REQUIREMENTS

01200.3.1 CLEANUP

The Owner will not give final acceptance of the Work until the Contractor has satisfactorily complied with the finishing and cleanup requirements contained in these Contract Documents and with any applicable local regulations. The Contractor shall accomplish the cleanup operations so as to leave the work site in an orderly, acceptable, and presentable condition.

01200.3.2 REPAIR AND RESTORATION

All major and minor damage to improvements and finished surfaces resulting from the Contractor's performance of the Work, whether to materials and equipment located on the project site or to those constructed under this Contract, shall be repaired to an original, or like-new, condition before final acceptance will be provided by the Engineer and Owner. Where damage to surfaces or materials can not be sufficiently repaired or restored, in the opinion of the Engineer, the Contractor may be required to replace the entire surface covering or structural member to achieve an original or like-new condition of the surface or material.

01200.3.3 TESTING

All performance and operational testing of facilities and equipment required by the Contract Documents, together with any required supportive documentation, shall be completed by the Contractor and approved by the Engineer prior to final acceptance of the Work.

01200.3.4 ACCEPTANCE FROM PROPERTY OWNER

The Contractor shall obtain a written release from each property owner on whose property work has been required by these Contract Documents. Such release shall indicate the property Owner's approval of the restoration and/or replacement of all disturbed improvements, surfaces and structures. Any request made to the Contractor by a private property owner, and determined to be unreasonable in the opinion of the Engineer, may be waived by the Owner.

01200.3.5 SUBMITTAL OF MANUFACTURER'S DOCUMENTATION

All guarantees and warranties, operation and maintenance manuals or brochures, or other materials furnished to the Contractor by the manufacturer for any equipment or material used for the Work shall be delivered to the Owner in protective 3-ring binders. Retainage held to the Contractor in accordance with the General Conditions of the Contract Documents will not be released until such documentation is submitted. See Section 01300 for more detail regarding O&M manuals.

01200.3.6 FINAL ACCEPTANCE

01200.3.6.1 CONTRACTOR'S STATEMENT OF COMPLETION - When the Contractor has completed the Work under this contract, including all of the Contractor's testing and clean-up, the Contractor shall inform the Engineer in writing that the Work has been completed and request a final inspection by the Engineer. The Engineer will then conduct a final inspection with the Owner and representatives of the pertinent funding and regulatory agencies. If items are found by the Engineer to be incomplete or not in compliance with the contract requirements, the Engineer will inform the Contractor of such items. After the Contractor has completed these items, the procedure shall then be the same as described above for the Contractor's statement of completion and request a final inspection.

01200.3.6.2 NOTICE OF FINAL ACCEPTANCE - After the Engineer has determined that all work required under the Contract Documents has been completed and that all of the considerations specified herein above are satisfactorily concluded, the Engineer will recommend to the Owner, in writing, that final acceptance of the entire Work under this contract be made as of the date of the Engineer's final inspection. The Owner and Engineer will then indicate formal approval and acceptance of the Work by issuing the "Notice of Final Acceptance" form.

01200.3.6.3 NO PARTIAL ACCEPTANCE - Unless otherwise required by Special Provisions, partial acceptance of any portion of the Work will not be made. While Substantial Completion notice can be issued in accordance with the General Conditions to allow use of completed work for its intended purpose, no acceptance other than the final acceptance of all completed work will be made. No inspection or approval or Notice of Substantial Completion pertaining to specific parts of the work shall be construed as final acceptance of any part until written final acceptance of all work is issued.

01200.4 METHOD OF MEASUREMENT

Not used.

01200.5 BASIS OF PAYMENT

Not used.

01300.1 DESCRIPTION

This section covers procedures to be followed by the Contractor when providing information to the Owner and/or Engineer to obtain approval of materials, equipment, procedures, etc. described in the Specifications and Drawings.

01300.2 SHOP DRAWINGS AND MATERIALS SUBMITTALS

01300.2.1 NUMBER OF COPIES OF SUBMITTALS

The Contractor shall furnish six (6) copies of each shop drawing and pertinent materials information sheet to the Engineer for review. A full set of submittals shall be provided to the Engineer seven (7) days prior to commencement of construction activity. Following review and approval, two copies shall be returned to the Contractor for his records, two shall be retained by the Engineer for inspection and verification purposes, and two shall go to the Owner as working and archival records.

01300.2.2 SHOP DRAWINGS

01300.2.2.1 CONTRACTOR REVIEW - The Contractor's shop drawing submittals shall be reviewed by a qualified representative of the Contractor, prior to submission to the Engineer. Such review shall be made to ensure the accuracy and compliance with the technical requirements and performance described and illustrated in the Drawings and Specifications.

01300.2.2.2 CONTENT - Shop drawings shall include drawings, pictures and sketches with sufficient details and explanations to reflect the Contractor's interpretations of components and required configurations not shown on the drawings, so that a documented record of such can be approved for incorporation in the Work. These drawings shall be accurate, distinct, and complete and shall contain all required information, including satisfactory identification of items and unit assemblies in relation to the Drawings and/or Specifications.

01300.2.2.3 TIMELY SUBMITTAL - Shop drawings shall be submitted sufficiently in advance to allow the Engineer not less than ten regular working days prior to manufacturing for examining the drawings.

01300.2.2.4 ENGINEER APPROVAL - When the shop drawings are approved by the Engineer, two sets of copies will be returned to the Contractor marked "Approved", "Revise as Noted", "Rejected", "Approved Except as Noted", or similar notification. If changes or corrections are necessary, one set will be returned to the Contractor with such changes or corrections indicated by a brief statement, and the Contractor shall correct and resubmit the drawings, in triplicate, to the Engineer.

Fabrication work shall not commence until the Engineer has reviewed the pertinent shop drawing/s and returned copies to the Contractor marked either "Approved" or "Approved - Except as Noted". Corrections indicated on such submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

Approval of shop drawings will not be required for reinforcing steel that is detailed by the Contractor in accordance with the Plans and Specifications. Any change from the Plans and Specifications made by the Contractor in any aspect of the Work shall be approved by the Engineer in a written Change Order prior to any work being altered from that already approved for construction.

001300.2.3 MATERIALS INFORMATION SUBMITTALS

In keeping with 01300.2.1 above, the Contractor shall assemble and submit six (6) original copies of each manufacturer's catalog cuts and materials information sheets pertaining to materials and equipment to be furnished and installed in the Work. These submittals shall be enclosed in 3-ring binders. Failure to submit all materials information may result in the Contractor's partial payments to be withheld until submittals are complete. Photocopies of the catalog cuts and information sheets will not be acceptable as submittals without prior authorization from Engineer.

01300.2.4 CONTRACTOR LIABILITY

The Contractor shall assume all responsibility and risk for any re-work or other costs resulting from errors in Contractor submittals. The Contractor shall be responsible for showing accurate dimensions and details of connections required to ensure the function of the equipment and/or component of the Work being illustrated.

01300.3 SAMPLES

01300.3.1 NUMBER OF SUBMITTALS

Whenever requested by the Engineer, the Contractor shall submit at least one sample of each item or material indicated in the Specifications to the Engineer for inspection and acceptance and do so at no additional cost to the owner.

01300.3.2 TIMELY AND ORDERLY SUBMITTAL

Samples shall be submitted sufficiently in advance of placement of orders that the Engineer shall have not less than ten regular working days for examining and testing the material for acceptance prior to delivery to the job site. Samples shall be submitted in an orderly sequence and appropriately identified so that dependent materials or equipment can be assembled and reviewed without causing delays in the work or mistakes in their identity.

01300.3.3 SELECTION OF COLORS AND TEXTURES

Unless otherwise specified, the Owner and the Engineer will select all colors and textures of specified items from the manufacturer's standard colors and standard materials, products, or equipment lines.

01300.4 OPERATIONS AND MAINTENANCE MANUALS

01300.4.1 STRUCTURE OF OPERATIONS AND MAINTENANCE MANUALS

The Contractor shall furnish to the owner four (4) identical sets of Operations and Maintenance manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl plastic, hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A table of contents shall be provided which indicates all equipment in the Operations and Maintenance manuals.

01300.4.2 CONTENTS

The Contractor shall include in the Operations and Maintenance Manuals the following information for each item of mechanical, electrical, and instrumentation equipment:

- Care and maintenance of all finished exposed surfaces.
- Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.
- Preventive maintenance procedures and schedules.
- Complete parts lists, by generic title, identification number, and catalog number, complete, with exploded views of each assembly.
- Disassembly and reassembly instructions.
- Name and location of nearest supplier and spare parts warehouse.
- Name and location of manufacturer.
- Recommended start-up, testing and troubleshooting procedures.
- Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

01300.4.3 SCHEDULE OF DELIVERY

Operations and Maintenance manuals shall be submitted in final form to the owner before seventy-five (75) percent of the Work is completed. Any discrepancies found by the owner and Engineer in the Operations and Maintenance manuals shall be corrected by the Contractor prior to final acceptance of the project.

01300.5 SCHEDULE OF VALUES

At the time of the pre-construction conference, the Contractor shall submit a Schedule of Values of the Work measured as lump sum bid items. On the Schedule, those items shall be subdivided into component parts in sufficient detail as to form a basis for determining progress payments during construction. Quantities, and/or prices, shown on the Schedule shall equal the total contract price for each lump sum item. Information provided on the Schedule will be reviewed and approved by the Engineer when found acceptable. That information will then be incorporated into the data used for preparing the Application for Payment by the Engineer.

01300.6 CONTRACT CONSTRUCTION SCHEDULE

A construction schedule, prepared in accordance with requirements of the General Conditions, shall be submitted to the Engineer at the pre-construction conference. Unless required otherwise in Special Provisions, such schedule shall show the anticipated time of completion, approximate start dates of identifiable segments of the Work, and anticipated value of the work expected to be completed in monthly time periods within the contract period.

01300.7 PROCUREMENT SCHEDULE

At the time of the pre-construction meeting (see Section 01030), the Contractor shall submit a procurement schedule to the Engineer. This plan shall include all equipment and materials required for the Work included in the Contract that are not readily available and will require off-site manufacture and lead time which can affect the progress of the Work. The plan shall show at least the following information:

- Equipment/Material Name
- Anticipated amount of time for ordering, manufacturing, and shipping to Work site.
- Anticipated dates for ordering, receiving and installing.

01300.8 CONSTRUCTION PHOTOGRAPHY RECORDS

When required in the Contract Documents and prior to commencement of any of the Work, the Contractor shall prepare colored CD photography records of all areas of the Contract work site and provide copies of such records to the Engineer. Such records shall become the property of the owner and may be used for determining the condition of work site/s and degree of restoration required for completion of the Work (see also Section 2000).

01400.1 DESCRIPTION

This section covers quality control of all work and activities on the part of the Owner, the Engineer, and the Contractor, to ensure compliance with these Specifications and the requirements of the Contract.

01400.2 ASSIGNMENT OF RESPONSIBILITY

01400.2.1 THE CONTRACTOR

The Contractor has primary responsibility for ensurance of quality control of the Work provided under the Contract. Therefore, any omission or failure on the part of the Engineer to notify the Contractor of, or to condemn defective work and/or materials at the time of construction shall not be taken as acceptance of the work or materials, and the Contractor will be required to correct any defective work or materials prior to final acceptance.

01400.2.2 THE OWNER AND ENGINEER

The Engineer will endeavor to locate any errors or defective materials or workmanship, and call them to the attention of the Contractor prior to subsequent work being performed. However, the Engineer is under no obligation to do so, and neither the Owner, nor the Engineer shall be held liable for errors, or defective material, or defective workmanship performed by the Contractor and not discovered by the Engineer prior to subsequent work being performed.

01400.2.3 CORRECTIONS

Prior to execution of the Agreement, the Engineer may correct errors and omissions to these Contract Documents by issuing Addenda. After execution of the Agreement, correction of errors, omissions or other changes necessitated shall be made in accordance with the General Conditions (Section 00700).

01400.3 QUALITY OF MATERIALS

01400.3.1 COMPLIANCE WITH SPECIFICATIONS

All materials and equipment incorporated in the Work shall be of new manufacture and shall be of the grade and quality described by these Specifications and the Special Provisions.

01400.3.2 SPECIFIED MATERIALS

Where a specific brand or manufacturer's equipment, model, system, or etc. is specified in these Specifications, no intention is made to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance.

01400.3.3 SUBSTITUTION OF MATERIALS

The Engineer, in accordance with the General Conditions (Section 00700.8), may allow substitution of equipment or materials. The Owner reserves the right to reject substitutions if, in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

01400.4 QUALITY OF WORK

All workmanship incorporated in the Work covered by the Contract is to be of the grade and quality described by these Specifications and the Special Provisions.

01400.5 INSPECTION

01400.5.1 AUTHORITY AND DUTIES OF INSPECTOR

01400.5.1.1 AUTHORITY - Inspectors representing the Engineer are authorized to inspect all work performed and all materials furnished and to reject defective material and any work that is improperly performed, subject to the final decision of the Engineer. This authority extends to all or any part of the Work, including the preparation, fabrication, or manufacture of any materials or equipment to be used for completion of the Work. The Inspector is not authorized to alter or waive the provisions of these Specifications or other provisions of the Contract Documents. The Engineer may delegate additional authority to the Inspector when such action is determined to be necessary.

01400.5.1.2 DUTIES - Inspectors keep the Engineer informed as to the progress of the Work and the manner in which it is performed. Inspectors are also assigned to call the Contractor's attention to any observed nonconformance with the Contract Documents. The Inspector will not act as foreman for the Contractor.

01400.5.2 INSPECTION OF MATERIALS

01400.5.2.1 TESTING - In accordance with the Contract Documents and at the option of the Engineer, materials to be supplied under this contract will be tested and/or inspected either at their place of origin or at the site of the Work. The Contractor shall give the Engineer written notification well in advance of actual readiness of materials to be tested and/or inspected at the point of origin. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the material nor shall it preclude re-testing or re-inspection at the site of the Work.

01400.5.2.2 SAMPLES - The Contractor shall furnish such samples of materials as are requested by the Engineer, without charge. No material shall be incorporated into the Work until the Engineer has approved it (see Section 01300).

01400.5.3 CONTRACTOR LIABILITY

The inspection of the Work shall not relieve the Contractor of any of its obligations to fulfill its contract as herein provided, and unsuitable materials may be rejected notwithstanding that such unsatisfactory performance may have been overlooked and accepted or estimated for payment.

CHARACTER OF WORKERS, METHODS AND EQUIPMENT — SECTION 01500

01500.1 DESCRIPTION

Covers requirements for aptness, competency, quality, and quantity in the labor, equipment, tools, and materials supplied by the Contractor for execution of the Work.

01500.2 REQUIREMENTS

In order to bring the Work to completion in the manner and on the time schedule required by the Contract Documents, the Contractor shall provide sufficient labor and equipment with adequate training and capability as follows:

- The Contractor shall employ sufficient labor and equipment with adequate training and capability for executing the Work to full completion in the manner and time required by these Specifications.

- All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have appropriate training and sufficient experience in such work, in the opinion of the Engineer, to perform all work properly and satisfactorily.

- Any person employed by the Contractor or by any Subcontractor who, in the opinion of the Engineer, does not perform their work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed forthwith by the Contractor or Subcontractor employing such person. Such person(s) shall not be employed again in any portion of the Work without the approval of the Engineer. When such action is considered, and if requested by that employee, a hearing attended by the employee, Engineer, and Contractor shall be conducted before final dismissal action is taken.

- Should the Contractor fail to remove such person or persons as required above or fail to furnish suitable and sufficient personnel for the proper execution of the Work, the Engineer may suspend the Work by written notice until such order is complied with.

- All equipment, which is proposed to be used on the Work, shall be of sufficient size and in such mechanical condition, in the opinion of the Engineer, as to produce a satisfactory quality of Work. Equipment used on any portion of the Work shall be fitted with appropriate protective devices in accordance with OSHA and other applicable safety regulations such that no injury to employees, the Work, or to adjacent property will result from its use.

- When the specific methods and equipment to be used by the Contractor in accomplishing the Work are not described in the Contract Documents, the Contractor is free to use any methods or equipment that will accomplish the Work in conformity with the requirements of this Contract.

CHARACTER OF WORKERS, METHODS AND EQUIPMENT — SECTION 01500

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- The Contractor shall employ sufficient labor and equipment with adequate training and capability for executing the Work to full completion in the manner and time required by these Specifications.

- All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have appropriate training and sufficient experience in such work, in the opinion of the Engineer, to perform all work properly and satisfactorily.

- Any person employed by the Contractor or by any Subcontractor who, in the opinion of the Engineer, does not perform their work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed forthwith by the Contractor or Subcontractor employing such person. Such person(s) shall not be employed again in any portion of the Work without the approval of the Engineer. When such action is considered, and if requested by that employee, a hearing attended by the employee, Engineer, and Contractor shall be conducted before final dismissal action is taken.

- Should the Contractor fail to remove such person or persons as required above or fail to furnish suitable and sufficient personnel for the proper execution of the Work, the Engineer may suspend the Work by written notice until such order is complied with.

- All equipment, which is proposed to be used on the Work, shall be of sufficient size and in such mechanical condition, in the opinion of the Engineer, as to produce a satisfactory quality of Work. Equipment used on any portion of the Work shall be fitted with appropriate protective devices in accordance with OSHA and other applicable safety regulations such that no injury to employees, the Work, or to adjacent property will result from its use.

- When the specific methods and equipment to be used by the Contractor in accomplishing the Work are not described in the Contract Documents, the Contractor is free to use any methods or equipment that will accomplish the Work in conformity with the requirements of this Contract.

PROTECTION OF EXISTING IMPROVEMENTS — SECTION 01510

01510.1 DESCRIPTION

This section covers measures and instructions for prevention of damage to existing structures and utilities, whether above ground or underground, during execution of the Work of the Contract.

01510.2 PROTECTION OF EXISTING UTILITIES

01510.2.1 INTEGRITY OF UTILITIES

The Contractor shall be responsible for safeguarding and maintaining the integrity of all conflicting utilities. This responsibility includes securing the assistance of available utility location services in the area in which the Work is being performed. The Engineer has attempted to show the location of all utilities anticipated to conflict with the Work. However, when a conflicting utility line is discovered that was not shown on the plans, the Contractor shall contact the utility's owner and notify the Engineer immediately for resolution of the conflict. When realignment or relocation of the Work, or relocation of the conflicting utility is deemed necessary, the Engineer shall give direction in writing for the Contractor to proceed. Work resulting from such direction may be treated as a changed condition, and appropriate authorization and payment will be made in accordance with the General Conditions.

01510.2.2 LOCATING UTILITIES

It shall be the responsibility of the Contractor to locate and expose or identify all existing utilities, both underground and overhead, for the purpose of preventing damage to them. The Contractor shall notify all concerned utility offices at least 48 hours in advance of construction operations in which a utility agency's facilities may be involved. This shall include, but not be limited to, irrigation water, culinary water, telephone, gas, and electric.

01510.2.3 CHANGES TO UTILITIES

The Contractor shall be responsible for any and all changes to, or re-connections to, public utility facilities encountered or interrupted during execution of the Work, and all costs related thereto shall be borne by the Contractor. The Contractor shall negotiate with, and pay, the respective utility agency for work it must do in connection with moving, repairing, or restoring its utility(s). The Contractor shall further make all necessary notifications, scheduling, coordination, and management of details related to any such interference. The potential or projected cost of any public utility interference shall be included in the Contractor's price covering the major Contract Item to which the interference or changes are attributable.

01510.2.4 MAINTENANCE OF SERVICE

01510.2.4.1 CONTINUOUS SERVICE - Unless otherwise required in the Contract Documents, all utilities, both underground and overhead, shall be maintained in continuous service throughout the entire contract period. The Contractor shall be responsible and liable for any damages to or interruption of service caused by the construction.

01510.2.4.2 ACCIDENTAL INTERRUPTION OF SERVICE - In the event of interruption of other utility services as a result of accidental breakage, the Contractor shall promptly notify the appropriate responsible authority. The Contractor shall then cooperate with that authority in restoration of service as soon as possible, and shall bear all cost of repair. In no case shall interruption of any water or other utility service be allowed outside working hours unless the Engineer has issued prior authorization. When changeover of service connections to new utility lines becomes necessary, interruptions of individual services for periods of up to 8 hours will be allowed providing 24 hour advance notice has been given to affected users.

01510.2.4.3 TEMPORARY INTERRUPTION AND RELOCATION - If the Contractor desires to temporarily or permanently relocate or shut down any utility or appurtenance, the Contractor shall make the necessary arrangements and agreements with the owner or operator of the respective utility and shall be completely responsible for all costs concerned with the relocation or shutdown and reconstruction. Shutdown and relocation and/or reconstruction shall be subject to inspection and approval by the Engineer and the owner of the utility.

01510.3 PROTECTION OF PROPERTY AND EXISTING STRUCTURES

01510.3.1 REMOVAL OR RELOCATION OF PROPERTY - All property removed or relocated by the Work shall be reconstructed in its original or new location as soon as possible. Restoration of existing property or facilities shall be to a condition as good or better than its original condition.

01510.3.2 DAMAGE TO PROPERTY - All property damaged by the Contractor, whether inside or outside the limits of easements provided by the Owner, shall be the responsibility of the Contractor. All such damages shall be repaired with like material and restored to its original condition, or better. Such repair or restoration shall be accomplished at the Contractor's expense without additional compensation from the Owner.

01510.4 PROTECTION OF PAVED SURFACES

To avoid unnecessary damage to paved surfaces, tracked equipment shall use rubber cleats or paving pads when operating on or crossing all existing paved surfaces unless authorized otherwise in writing by the Engineer.

01510.5 RIGHTS-OF-WAY AND EASEMENTS

01510.5.1 MINIMAL DISTURBANCE OF RIGHTS-OF-WAY - When construction easements have been obtained by the Owner, the Contractor shall take appropriate measures to minimize disturbances to surface improvements within the easements. The Contractor shall obtain a signed release from each property owner, approving restoration work in the construction easements across its respective property/s.

01510.5.2 CONSTRUCTION AREAS - The Contractor shall confine construction operations to the area within the dedicated rights-of-way for public thoroughfares, or within areas for which construction easements have been obtained, unless the Contractor has made separate special agreements with the affected property owners in advance.

01510.5.3 PROPERTY OWNER NOTIFICATION - The Contractor shall give at least 48 hours advance notification of commencement of construction to property owners having land on which construction will take place. During all construction operations, the Contractor shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No one shall be cut off from access to their property for a period exceeding eight (8) hours unless the Contractor has made special arrangements with the affected persons. The Contractor shall grade all disturbed surfaces required for motor vehicle traffic at least daily unless directed otherwise in the Contract Documents or in writing by the Engineer.

01520.1 DESCRIPTION

This Section includes requirements that shall be followed by the Contractor, to protect the environment, while performing work under this contract. The Contractor shall also comply with any applicable additional requirements made by federal, state, or local government agencies.

01520.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 00700 – General Conditions, paragraph 32 (for RDA funded projects)

01520.1.2 SUBMITTALS

Section 01300 – Submittals.

01520.1.3 DEFINITIONS

Not used.

01520.2 MATERIALS

Not used.

01520.3 CONSTRUCTION REQUIREMENTS

01520.3.1 EXPLOSIVES AND BLASTING

The use of explosives on the work will not be permitted unless approved otherwise in the Contract Documents or in writing by the Engineer.

01520.3.2 DUST ABATEMENT

01520.3.2.1 CONTROL MEASURES - The Contractor shall furnish all labor, equipment, water and means required to provide effective dust control and abatement measures. Control measures shall be applied as often as necessary and wherever directed in writing by the Engineer, to prevent construction operations from producing dust in amounts that may be damaging to property, vegetation, or animals, or detrimental to persons within reasonable proximity of the work site.

01520.3.2.2 HAUL ROUTES AND WORK SITES - The Contractor shall identify haul routes or material handling areas, outside of the Work site, whereon dust may be generated, and shall exercise appropriate measures to abate any dust problem caused by its operation. Such dust abatement measures shall be taken immediately when observed or when required in writing by the Engineer.

01520.3.3 STORM AND GROUND WATER

01520.3.3.1 PERMITS REQUIRED - If a storm water NPDES permit is required, the Contractor is responsible to obtain such permit and comply with the conditions thereof.

01520.3.3.2 CONTROL MEASURES - The Contractor shall provide and maintain, at all times during construction, ample means and devices to promptly remove all water entering the Work, whether the water is surface or ground water. Water removed by the Contractor shall be directed into ponds or areas separated from live streams or drainage ways, to keep sediment from entering live water.

01520.3.3.3 DRAINAGE PATTERNS - In excavation, fill, and grading operations, the Contractor shall take care, to disturb the existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water onto private property or into streets or drainage ways inadequate for the increased flow.

01520.3.3.4 FORDING OF WATERWAYS - Fording of live streams or any body of live water to accomplish the Work shall not be permitted. Mechanized equipment also shall not be operated in live water to accomplish the Work unless authorized in writing by the Engineer, or in the Contract Documents.

01520.3.3.5 FILLING OF WATERWAYS - The Engineer will not approve the filling of any ditches, washes, drainage ways, streams, wetlands, or other surface waters by the Contractor to accomplish the Work unless specific instructions are included in the Contract Documents which will provide for how the affected drainages or surface waters are to be treated.

01520.3.4 NOISE ABATEMENT

In or near inhabited areas, particularly residential areas, the Contractor's operations shall be performed in a manner to prevent noise from becoming a nuisance or problem. Particular consideration shall be given to noise generated by repair and service activities during the night hours.

01520.3.5 CHEMICALS

All chemicals and/or petroleum based products used during project construction or furnished for project shall be handled, applied and disposed of in strict accordance with the printed instructions of the manufacturer and regulations enforced by Federal, State and Local health authorities.

01520.3.6 WASTE AND SURPLUS MATERIALS DISPOSAL

01520.3.6.1 CLEAN WORK SITE - The Contractor shall keep the work site, haul roads and other areas of use in a neat, clean condition, free from any accumulation of surplus materials. It shall be the responsibility of the Contractor, at its own expense, to remove and legally dispose of all surplus materials resulting from all Work activities performed in accordance with the Contract Documents.

01520.3.6.2 SURPLUS MATERIAL - Surplus material includes, but is not limited to, salvaged materials and equipment that otherwise would have been abandoned in place, rocks too large to be used as backfill, wood and other organic or unsuitable materials, trash, rubbish, and waste products of any nature, and any other debris generated by the Work.

01520.3.6.3 REGULATORY COMPLIANCE - Disposal of surplus materials shall be accomplished in accordance with all local codes, laws, ordinances, and all applicable safety laws (particularly to the requirements of Part 1926 of the OSHA Safety and Health Standards for Construction) in affect at the approved disposal site. In no case shall it be acceptable for any surplus material to be disposed of in streams, marshes or wetlands.

01520.3.6.4 APPROVAL OF DISPOSAL - The Engineer will not approve any disposal operation, which creates an unsightly and/or unsanitary nuisance. The Contractor shall maintain disposal sites in a reasonable condition of appearance during construction. When designated and/or public disposal sites are unavailable, written approval must be obtained from the Engineer to dispose of any surplus materials on any other site. All disposal sites are subject to approval by the Engineer. The Contractor shall secure permission and all permits required for use of any dumpsite not

previously arranged and designated by the Owner. The Contractor shall retain copies, and provide copies upon request, of all disposal permits and/or agreements obtained for the Contract Work.

01520.3.6.5 SCHEDULED REMOVAL - The Contractor shall establish regular intervals of collection and disposal of surplus materials during construction. Stockpiling of surplus materials for later disposal will not be approved or allowed.

01520.3.7 OPEN BURNING

Open burning of materials may be allowed only in strict accordance with all regulations in effect for the area at which the burning would be performed, and the Contractor shall obtain any necessary permits from the appropriate governing entity prior to the start of burning. The Contractor shall not allow fire to spread beyond the material intended for burning. No accumulation of residue from burning shall remain on or adjacent to the construction site, without written approval of the Engineer.

01520.3.8 SANITATION

01520.3.8.1 TOILETS - The Contractor shall provide fixed or portable chemical toilets for employee use in conformance with the requirements of Part 1926 of the OSHA Standards for Construction and when public toilets are not available or within fifteen (15) minutes walking distance of the Work site.

01520.3.8.2 COLLECTION OF WASTES - The Contractor shall be responsible for daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor shall be disposed of away from the site in accordance with all laws and regulations pertaining thereto.

01520.3.9 HAZARDOUS MATERIAL

01520.3.9.1 REGULATORY COMPLIANCE - Disposition of any hazardous material or toxic or hazardous waste shall be made in accordance with the requirements and regulations administered by the State agency wherein the Work site is located.

01520.3.9.2 ABNORMAL CONDITONS - Abnormal conditions include, but are not limited to, the following: buried barrels with liquid or solid contents; buried or above ground tanks with liquid contents; obnoxious odors; excessively hot earth; stained and discolored soils; smoke; unidentifiable powders, sludge, pellets; or any other similar condition.

01520.3.9.3 DISCOVERY AND NOTIFICATION - If any abnormal conditions are encountered during construction, which indicate the presence of a hazardous material, toxic, or hazardous waste, the Contractor shall immediately suspend work in the area of the discovery and notify the Engineer and treat the situation with extreme caution. The Contractor's operation in the area of discovery shall not resume until so directed by the Engineer; however, the Contractor shall continue working in other areas of the project, unless otherwise directed by the Engineer.

01520.3.9.4 DISPOSAL - When it becomes necessary for the Contractor to dispose of discovered materials, the work may be considered a change and administered in accordance with the General Conditions. Should the disposition of discovered waste material require special procedures or handling by certified personnel, the Contractor will make all such arrangements. When it becomes necessary to obtain permits for transporting or handling discovered material, the Owner will obtain the permits.

01520.3.9.5 SPILLS AND NOTIFICATION - In the event of spills of petroleum-based products or hazardous wastes by the Contractor, the Contractor shall immediately notify the Engineer. The Contractor shall also notify the appropriate State environmental enforcement agency, unless the spill consists of less than one (1) gallon of petroleum based products. In no case will notification be made later than 24 hours after the discovery of the spill. In addition, written notification shall also be made within 5 calendar days of the discovery.

01520.3.9.6 COST OF CLEANUP - All costs for cleanup and disposal of hazardous materials due to spills, inappropriate handling, or negligence of the Contractor shall be borne by the Contractor.

01520.3.10 ENVIRONMENTAL COMPLIANCE

01520.3.10.1 REGULATORY COMPLIANCE - The Contractor shall comply with the applicable requirements of the National Historic Preservation Act as it relates to the preservation of ALL environmental resources. Clearance for protection of environmental resources located within the designated Work site is the responsibility of the Owner and such clearance has been obtained for the Contract, unless provided for otherwise in the Contract Documents.

01520.3.10.2 DISCOVERY OF HISTORIC/ARCHEOLOGICAL OBJECTS – The Contractor shall observe the following:

- DISCOVERY AND NOTIFICATION - If a suspected or unsuspected historic, archeological, or paleontological item, feature, or site is encountered, construction operations shall be immediately stopped in the vicinity of the discovery and the Engineer shall be notified of the nature and exact location of the findings. The Contractor shall not damage the discovered objects and shall provide written confirmation of the discovery to the Engineer within two (2) calendar days.

- RESTRICTION OF CONSTRUCTION - Should operations in the vicinity of a discovery be restricted, the Engineer will keep the Contractor informed concerning the status of the restriction. The Contractor should be aware that the time necessary for the Owner to negotiate the handling of the discovered is variable and is dependent on the nature and condition of the circumstances. It is possible that a delay of as much as three weeks in the vicinity of the discovery can be expected. The Engineer will inform the Contractor when the restriction is terminated. Changes required to accommodate delay or Work resulting from the discovery will be authorized in accordance with the General Conditions.

01520.3.11 OPERATIONS OUTSIDE OF THE PROJECT SITE

In the event the Contractor chooses to use any site or means of obtaining resources beyond those provided as part of the Contract, the Contractor shall retain the services of a qualified, certified environmental consultant to produce a research design or plan for obtaining any and all necessary environmental clearances for such use. The Contractor shall provide the plan to the Engineer for review and approval, as required, following which the plan shall be implemented. The Contractor shall submit evidence of environmental clearances and compliance before commencing any activities within the extended use area. At a minimum, clearances will include those listed below. Additional clearances may be required as necessary.

01520.3.11.1 CULTURAL RESOURCES (Archeological and Historic) - Clearance may require consultation with the State Historic Preservation Office.

01520.3.11.2 THREATENED AND ENDANGERED SPECIES - Compliance may require written clearance from the U.S. Fish and Wildlife Service.

01529.3.11.3 FLOOD PLAINS – May require consultation with the Federal Emergency Management Agency (FEMA) or corresponding state agency.

01520.3.11.4 WETLANDS AND OTHER BODIES OF WATER – May require consultation with the Army Corps of Engineers and/or appropriate state agency.

The Contractor is cautioned that obtaining environmental clearances can be costly and time consuming.

01520.4 METHOD OF MEASUREMENT

Not used.

01520.5 BASIS OF PAYMENT

Not used.

01560.1 DESCRIPTION

Construction staking procedures and responsibilities are broadly defined in the General Conditions and specific information is provided in this Section to define those procedures and responsibilities indicated in the General Conditions.

01560.2 QUALITY CONTROL

All construction staking, whether provided by the Contractor or the Owner, will be supervised by a land surveyor registered in the state in which the Work is located. Surveys will be performed consistent with professional practices and precision generally conducted by surveyors licensed in that state. Complete, legible survey notes will be maintained by the surveyors which show the locations and measurements required to establish construction staking. Such documents shall also provide information to identify the project, location of survey, date of survey, land surveyor's name and registration number. Copies of the Contractor's survey documentation shall be made available to the Owner upon request.

01560.3 OWNER RESPONSIBILITY

01560.3.1 FIELD LOCATION POINTS

Unless otherwise indicated in the Contract Documents, the Owner shall provide information on the Drawings and sufficient surveyed points in the field to locate all features and components of the Contract. Typically, field location points will be established to consist of the following:

01560.3.1.1 PRESSURE LINES - When pressure lines are located in established streets or areas with sufficient referencing features (curb, sidewalks, fence lines, etc.), no staking will be provided and location information shall be provided on the Drawings. When pressure lines are located in areas without sufficient referencing features, stakes will be set to establish the pipe centerline at 100-foot intervals. Where sloping of lines is critical (drain lines, etc.) cut stakes will be provided to indicate flow line elevation at beginning and ends of such lines.

01560.3.1.2 SEWER AND OPEN CHANNEL FLOW LINES AND MANHOLES - Manhole centerline locations will be shown with horizontal offset stakes and cut stakes to indicate the elevation of the flow line. In addition, cut stakes will be set to provide horizontal locations and grade 100-feet upstream on lines flowing into manholes.

01560.3.1.3 TANKS - Circular tank centerline location will be staked and a benchmark (grade) stake will be provided to establish floor top elevation. Exterior corners of rectangular tanks will be staked and a benchmark will be established for establishing floor top. Stakes locating rectangular tank corners will also be provided offset reference stakes.

01560.3.1.4 BUILDINGS AND OTHER STRUCTURES - Two reference points with offset reference stakes will be provided to establish horizontal location of one wall or the centerline. A benchmark (grade) stake will also be provided to establish vertical elevations of the building/structure/s components.

01560.3.1.5 ROADWAYS - In all roadway construction, offset stakes that identify location of the centerline of road will be set at intervals not to exceed 100-feet. When roadway construction requires specific grading, stakes will be set at the beginning points of cuts and fills with offset reference stakes. Hubs will be set to actual finished grades at the top edges of the subgrade and at each consecutive course of surfacing base. Hubs with offset reference stakes will be set on the centerline at the upstream and downstream lip of the flowline of all drainage pipes and structures. Staking intervals for roads with specified grading shall not exceed 100 feet in tangent sections and 50 feet in curved sections. When curbing and/or sidewalks are constructed along roadways, offset stakes with horizontal and vertical

referencing information will be set at intervals of not more than 50 feet. Bench marks for checking and establishing vertical elevations shall be set at intervals not more than 1000 feet apart.

01560.3.1.6 PONDS AND LAGOONS - Offset stakes which identify the centerline and cut/fill stakes with offset reference stakes will be set at intervals of not more than 100 feet as well as at the beginning and end of all curved sections of banks. At least one benchmark shall be provided for each cell of the pond for establishing and verifying vertical elevations.

01560.3.2 COST OF ERRORS

The Owner shall be responsible for the accuracy of any staking, measurements, grades and alignment set by its own surveys. The Owner shall cover costs resulting from staking errors attributable to the Owner's survey.

01560.4 CONTRACTOR RESPONSIBILITY

01560.4.1 ESTABLISHMENT OF GRADES, ETC.

The Contractor shall establish any grades, elevations and distances required for its construction operation from the control staking provided by the Owner and described above. The Contractor shall advise the Owner of anticipated conditions which will affect location of offset stakes and protect the control staking from its construction operation. Where control staking has been damaged or obliterated by the Contractor's operation, replacement of the staking shall be made in accordance with the provisions of the General Conditions.

01560.4.2 ERRORS IN CONSTRUCTION STAKING

When the Contractor observes discrepancies or errors in the control staking, such problems shall immediately be brought to the attention of the Engineer, and the Engineer shall take corrective action as necessary to resolve the problem.

01560.4.3 ACCURACY IN CONTRACTOR SURVEYING

The Contractor shall be responsible for the accuracy of any staking, measurements, grades, and alignments set by its own surveys. Any costs resulting from staking errors attributable to the Contractor shall be borne by the Contractor. The Engineer reserves the discretionary right to check the Contractor's staking, grades and measurements randomly at any time. When such checking is to be exercised, the Engineer will notify the Contractor of the location and the time at which the checking will commence. The Contractor shall then stop any respective part of the Work in progress until the Engineer has notified the Contractor that the checking has been completed and the Work has been found to be in accordance with requirements of the Contract Documents.

01580.1 DESCRIPTION

In general, the Contractor is responsible for providing and maintaining access to the Work, handling and storing of materials and equipment, safety and security within the Work site, and coordination and cooperation with the Owner, its representatives, governing authorities and other contractors working for the Owner in accordance with the provisions of the General Conditions. This section contains specific requirements which apply to these responsibilities.

01580.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 02005 – Traffic Control

01580.1.2 SUBMITTALS

Not used.

01580.1.3 DEFINITIONS

Not used.

01580.2 WORK SITE ACCESS

01580.2.1 INVESTIGATION OF WORK SITE AREA

The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting ingress and egress to the site of the work.

01580.2.2 HAUL ROADS

It shall be the Contractor's responsibility to construct and maintain any new haul roads required for its construction operations.

01580.2.3 USE OF PUBLIC STREETS AND ALLEYWAYS

Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work, unless shown otherwise in the Contract Documents.

01580.2.4 CLOSURE OF PUBLIC ROADWAYS

No street, road, or highway shall be closed to the public without first obtaining permission from the proper governmental authorities and the Engineer. Where excavation is being performed in streets or highways, one lane in each direction shall be kept open to traffic at all times, unless otherwise authorized by the Contract Documents or the Engineer. Toe boards, or other measures, may be required by the Engineer to retain excavated material when deemed necessary.

01580.2.5 INTERFERENCE WITH UTILITIES

The Contractor shall so conduct operations as not to interfere unnecessarily with the infrastructure of utility companies or other agencies in such streets, alleyways, or parking areas.

01580.3 PUBLIC SAFETY AND ACCESS

Fire hydrants, approaches to fire stations, police stations and hospitals on or adjacent to the Work shall be kept accessible at all times. Appropriate measures shall be taken by the Contractor, to assure the use of sidewalks, and the proper functioning of all gutters, sewer inlets, water mains, drainage facilities and other infrastructure.

The Contractor's responsibility for Work safety or liability for Work site accidents is not lessened by the presence of the Engineer or his or another inspector performing monitoring of Work site safety conditions.

See also Section 02005 – Traffic Control.

01580.4 CONTRACTOR'S USE OF THE WORK SITE

The Contractor's use of the Work site shall be limited to its construction operations. Written approval by the Engineer will be required for any other use of the site, such as material and equipment storage, personnel vehicle parking, on-site fabrication facilities and field office.

01580.5 OFF-SITE STORAGE

The Contractor shall make arrangements for, bear any use costs associated with, and obtain written permission from the Engineer prior to using any off-site storage or shop areas or facilities determined necessary for execution of the Work. Storage facilities shall be equipped with fences and/or lockable entries that will prevent entry by unauthorized parties. Before off-site storage facilities are placed in use, the Contractor shall provided the Owner keys or combinations to locking devices used to secure the facility.

01580.6 COOPERATION WITH OTHER CONTRACTORS

Prior to authorizing other contractors to work on or adjacent to the Work site, the Owner shall notify the Contractor in writing and provide the name and address of the contractor, the name of its supervisor, a description of the work to be performed, and a schedule which shows the dates and planned segments of the work to be completed by the other contractor. In the event that conflicts or interferences occur between the Contractor and the other contractor's operation, the Engineer shall be notified immediately. The Engineer shall then take appropriate action needed to resolve the problem.

DIVISION 2

SITEWORK

SUNRISE
ENGINEERING

02000.1 DESCRIPTION

This section describes various tasks associated with project execution and close out. Mobilization shall include: preparatory work and materials necessary for obtaining clearances for the Work; moving personnel, equipment, supplies and incidentals to and from the Project Site; quality control; clean-up; temporary utilities and quarters; permits, bonds and insurance; dust abatement, storm water control, and noise abatement; waste and rubbish disposal and control; sanitation; and project close-out operations.

02000.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01200 - Contract Closeout
Section 01510 - Protection of Existing Property
Section 01520 - Environmental Controls
Section 02005 - Traffic Control

02000.1.2 SUBMITTALS

02000.1.2.1 VISUAL RECORDS - The Contractor shall furnish at least one copy of all visual records, as described below in 02000.3.2, to the Owner. If the Owner has more exacting requirements for visual records, those requirements shall be detailed in the Special Provisions to these Specifications.

02000.1.2.2 SERVICE CONNECTION LOCATION AND DOCUMENTATION - The Contractor shall deliver all signed tie-sheets (see 02000.3.3 below) to the Engineer not less than forty-eight hours prior to when the service connection is to be installed.

02000.1.3 DEFINITIONS

Sign - A complete assembly including panel and posts, with fasteners, installed at designated locations.

DVD Record - Photography on DVDs of areas potentially liable for disturbance as a result of the Work required by this Contract.

Service Connection Interview & Documentation - Interviews with potential system users and the documentation of location data for service connections to the respective property from utility lines being installed under this Contract.

Tie Sheets - Forms provided by the Engineer for use in documenting the location of service connection/s of system users.

Service Connection - Piping extending from the main utility line to the property line, or designated connecting point, of any user of the system.

02000.2 MATERIALS

02000.2.1 SIGN PANELS

5/8-inch thick (A or B) exterior grade plywood sheets with best quality exterior enamel paint for face painting and lettering, fastened to posts with at least four 1/2-inch galvanized bolts.

02000.2.2 POSTS

4x4 Cedar or treated Pine commercial fence posts at least eight-feet long or as shown on the Drawings.

02000.2.3 VISUAL RECORD

Records shall be made on professional quality, standard DVD format recording. DVD's shall be provided with protective covers and shall be labeled to indicate the area covered by the photography.

02000.3 CONSTRUCTION REQUIREMENTS

02000.3.1 PROJECT SIGN

The Contractor shall provide project signs, which includes furnishing all materials and labor to fabricate, deliver, install and maintain any and all project identification signs as detailed on Drawings and at location(s) shown thereon.

02000.3.2 VISUAL RECORDS

Prior to any disturbance of the area, the Contractor shall produce a DVD photography of all areas, including but not limited to right-of-ways, streets and roadways, haul-roads and access routes, storage areas, construction sites, and buildings or structures, which will be, or may be, affected by the Work. Such photography will be of a quality to allow accurate determination of location, size, and condition of existing features and improvements taken prior to any occupancy or execution of Work by the Contractor.

02000.3.3 SERVICE CONNECTION LOCATION AND DOCUMENTATION

Unless called for differently, the Contractor shall contact and interview the owners of all properties indicated on the Drawings and obtain from them sufficient information for location of workable service connections for each property. The Contractor shall document those locations on the tie sheets and obtain a confirmation signature from the connection owner.

02000.4 METHOD OF MEASUREMENT

02000.4.1 MOBILIZATION

Mobilization shall be measured by the lump sum.

02000.4.2 PROJECT SIGN

Measurement for project signs shall be made by counting each sign installed and accepted.

02000.4.3 VISUAL RECORDS

Pre-Construction Photography shall be measured by the lump sum.

02000.4.4 SERVICE CONNECTION DOCUMENTATION

Service Connection Documentation shall be measured by the lump sum.

02000.5 BASIS OF PAYMENT

02000.5.1 The accepted quantity(s) shall be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
Mobilization	Lump Sum
Project Sign	Each
Pre-Construction DVD	Lump Sum
Service Connection Documentation	Lump Sum

02000.5.2 PAYMENT SCHEDULE

The amount bid or identified in a schedule of values for Mobilization shall not exceed 10% of the total contract bid amount. The following payment schedule percentages shall be based on amount bid or identified in a schedule of values for Mobilization up to a maximum of 10% of the total contract bid. Any portion of the mobilization bid amount which exceeds 10% of the total contract bid amount, will be paid to the Contractor after final acceptance of the Work, with the last mobilization payment. (See "overage amount" in the payment schedule table below).

Partial payments for Mobilization will be made in accordance with the payment schedule table below.

MOBILIZATION PAYMENT SCHEDULE

Payment	Amount	When Paid
1ST	25% of mobilization	With first partial payment after 3% of the original contract amount earned by the Contractor.
2ND	25% of mobilization	When amount earned by Contractor is 10% of the original contract price.
3RD	25% of mobilization	When amount earned by Contractor is 50% of the original contract price.
4TH (last)	25% of mobilization + "overage amount"	When project is complete and accepted.

02015.1 DESCRIPTION

This section covers the removal of vegetation, debris, and other obstacles from the defined rights-of-way and limits of the project area and/or construction work site.

02015.1.2 RELATED WORK

Section 01510 - Protection of Existing Properties
Section 02200 - Trench Excavation and Backfill
Section 02500 - Removal and Replacement of Surface Improvements
Section 02900 - Landscaping

02015.1.3 DEFINITIONS

Clearing - consists of removal and disposal of trees, stumps, logs, limbs, sticks, vegetation, rubbish, debris and other material on the natural ground surface.

Grubbing - consists of removing and disposing of roots (one-inch and larger diameter), tree stumps, buried logs, debris, and other underground obstructions.

02015.2 MATERIALS

Not used

02015.3 CONSTRUCTION REQUIREMENTS

Clear, grub, remove and dispose of all trees, vegetation and debris within the staked limits of the roadways, trenches, channels, easements, embankments, structures, and other designated areas. Do not injure or damage trees, shrubs, or other vegetation and objects to remain intact as designated by the Engineer or the Owner. Such items are to be fully protected from injury at the Contractor's expense.

02015.3.1 CLEARING

Areas within the limits of excavation and embankment slope stakes shall be cleared.

Tree branches extending over the area to be cleared and which hang within 12 feet of the ground surface shall be cut off in a neat and workmanlike manner. When such branch removal is necessary, the Contractor shall remove other adjacent branches on the tree under the direction of the Engineer so as to present a balanced appearance. Scars resulting from the removal of branches shall be treated with a heavy coat of approved tree sealant.

02015.3.2 GRUBBING

Grub all areas within the limits described as follows:

02015.3.2.1 FOR CONSTRUCTION OF ROADWAYS - Grub the area between the limits of the excavation and embankment slope stakes to a depth of two (2) feet below natural ground level to remove all stumps, roots, buried logs and other underground debris. However, when the roadway embankment already is two feet or more above the natural ground level, stumps cut less than 6 inches above natural ground, together with roots and other non-perishable obstructions, may remain in place.

02015.3.2.2 FOR CONSTRUCTION OF PONDS OR LAGOONS AND STRUCTURES - completely grub the pond area within the boundaries of the dikes or structures to a depth of two (2) feet and remove all stumps, roots, buried logs and other underground debris. Grubbing of this area shall include removal of the top 6-inches of organic laden topsoil and stockpiling it for later distribution over areas shown in the Contract Documents or directed by the Engineer.

02015.3.3 BACKFILLING

All stump holes, cuts, depressions and other holes resulting from clearing and grubbing operations within areas designated to receive pipelines, structures, or embankments shall be backfilled and compacted to the density of the surrounding ground.

02015.3.4 DISPOSAL

The Contractor shall dispose of all materials resulting from clearing and grubbing operations as required in the Contract Documents and in accordance with Section 01520 of these Specifications.

02015.3.5 MARKERS, MONUMENTS AND DATA POINTS

Land monuments, property markers or official datum points shall be protected until their removal is approved. When movement of monuments or markers is deemed necessary and approved by the Engineer, all such monuments or markers shall be carefully referenced for re-establishment before removing.

02015.4 METHOD OF MEASUREMENT

02015.4.1 SEPARATE PAYMENT

Measurement for “Clear and Grub” shall be made either as lump sum or by counting the number of acres. to the nearest tenth (10th), of area actually cleared and grubbed within the limits shown on the Drawings or as directed and approved by the Engineer. For areas where ponds or lagoons are to be constructed, this measurement shall include the removal and stockpiling of the first six (6) inches of topsoil in addition to grubbing to the required depths.

02015.4.2 NO MEASUREMENT

02015.4.2.1 NO PAY ITEM FOR CLEAR & GRUB - When the Bid Schedule does not contain a pay item for "Clear and Grub", then that work will be considered incidental to other Work items which require clearing and grubbing and no separate measurement shall be made.

02015.4.2.2 ROADWAY EXCAVATION and/or BORROW - Material used for filling depressions will be measured separately only when “Roadway Excavation” and/or “Borrow” appear as separate pay items on the Bid Schedule. Measurement will be made by counting the number of cubic yards of material moved and placed as designated on the Drawings or as directed and approved by the Engineer. If “Roadway Excavation” or “Borrow” are not included in the Bid Schedule, material used for filling depressions will not be measured separately, but will be considered incidental to the Work.

02015.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price.

PAYMENT ITEM	UNIT
Clear and Grub	Lump Sum
Clear and Grub	10th of Acre

02020.1 DESCRIPTION

Furnish and provide labor and equipment for investigation of existing miscellaneous pipelines, wires or cables, and other miscellaneous sub-surface features as required by the Engineer.

02020.1.1 RELATED WORK

Section 01510 - Protection of Existing Improvements

02020.1.2 SUBMITTALS

Not used.

02020.1.3 DEFINITIIONS

Not used.

02020.2 MATERIALS

The Contractor shall provide a backhoe and qualified operator; laborer with hand shovel: appropriate fuel and lubricants, necessary equipment servicing materials; and appropriate equipment for transporting the backhoe to perform the investigation. The backhoe shall be a rubber tired CASE 580 backhoe, or an approved unit of equivalent or greater size and capacity, having accumulated not more than 5,000 hours operating time.

02020.3 CONSTRUCTION REQUIREMENTS

02020.3.1 EXPOSURE BY EXCAVATION

When directed by the Engineer, the Contractor shall excavate and expose miscellaneous pipelines, structural features, soil materials and other underground features which may be present at the work site. The location and extent of exposure shall be determined on site by the Engineer. Designation of such areas shall be made in writing, usually in the form of a Work Order, by the Engineer.

02020.3.2 REPLACEMENT OF EXCAVATED MATERIALS

Work required hereunder shall include replacement of excavated materials sufficiently to restore the site to a safe condition as determined by the Engineer. Full restoration of materials such as pavement, concrete slabwork, sod, etc., in the investigated area will be accomplished in accordance with the Contract Documents and as directed by the Engineer.

02020.4 METHOD OF MEASUREMENT

02020.4.1 MEASUREMENT BY HOURS OF WORK

Measurement of subsurface investigation shall be made by counting the actual number of hours of work completed by the machine and operator to investigate miscellaneous underground features as required by the Engineer. No allowance of time will be made for transporting the backhoe to and from the job site when the backhoe is located on the site of the Contract.

02020.4.2 MEASUREMENT FOR OTHER ITEMS OF WORK

When restoration of the excavated area requires provision of pavement, concrete slabwork, sod, etc., separate measurement will be made for those materials in accordance with the respective requirement(s) for measurement of that item in the Contract Documents.

02020.5 BASIS OF PAYMENT

The accepted quantity of work will be paid for at the contract unit price of:

PAYMENT ITEM	UNIT
Subsurface Investigation	Hour

When provision of designated materials is required for restoration of the excavation, payment for such materials shall be made in accordance with the respective provisions of the Contract documents.

02105.1 DESCRIPTION

This section covers obtaining permission, permits, clearances, etc.; as necessary to develop source(s), purchasing or manufacturing, loading, hauling, placing and compacting earthwork materials described herein, as shown on the Drawings and/or required by these Specifications.

02105.1.1 RELATED WORK

Section 02200 - Trench Excavation and Backfill

02105.1.2 SUBMITTALS

When the Bid Schedule indicates quantities of materials described in this section in excess of 50 cubic yards or 50 tons, or when requested otherwise by the Engineer, the Contractor shall provide test results from a certified independent laboratory which has sampled and performed the prescribed test(s) for those materials.

02105.1.3 DEFINITIONS

Granular Material - Material for which the sum of plasticity index (AASHTO T-90) and the percent of material passing a No. 200 sieve (AASHTO T-27) shall not exceed 23.

Silt - Material which passes the No. 200 (AASHTO T-11) sieve and has a plasticity index not greater than 10.

Clay - Material which passes the No. 200 sieve and has a plasticity index greater than 10.

Bedding - Materials placed immediately around and adjacent to pipe installed in trenches.

Borrow - Material obtained from a source away from the site on which installed and/or excavated and used to supplement insufficient quantities of material required.

02105.2 MATERIALS

02105.2.1 ON-SITE TRENCH OR STRUCTURAL BACKFILL

On-site trench or structural backfill consists of material excavated during trenching or foundation excavation which is free of cinders, ashes, wood, vegetation, frozen or other deleterious material or rocks with a maximum particle size not greater than 6-inches. Material may be required to be processed or transported along the excavation.

02105.2.2 IMPORTED TRENCH OR STRUCTURAL BACKFILL

Imported trench or structural backfill consists of granular material obtained from sources indicated on the Drawings, designated in the Special Provisions or approved by the Engineer. Borrow materials shall be free of cinders, ashes, wood, vegetative matter, frozen or other deleterious matter with a maximum particle size not greater than 6-inches. Pit Run Borrow may be used as backfill in trenches, excavations for structures, in roadway subgrades, or as otherwise shown on the plans or called for by the Engineer. Material may be processed or may be pit run.

02105.2.3 ON-SITE PIPE BEDDING

On-site pipe bedding consists of material excavated during the trenching operation which is free of cinders, ashes, wood, vegetation, frozen or other deleterious material or rocks with a maximum

particle size not greater than that shown below in Table 1. Material may be required to be processed or transported along the trenching operation.

02105.2.4 IMPORTED PIPE BEDDING

Imported pipe bedding consists of granular material excavated from an approved borrow source which is free of cinders, ashes, wood, vegetation, frozen or other deleterious material or rocks with a maximum particle size not greater than that shown in Table 1 below. Material may be processed or may be pit run.

Table 1 - MAXIMUM PARTICLE SIZE FOR PIPE BEDDING

Pipe	Size
Corrugated Metal and Welded Steel	1”
Polyethylene, Galvanized Steel and PVC	3/4” in Utah or 1”in other states
Ductile Iron, Cast Iron, Concrete, and HDPE	2”

02105.2.5 SAND

Sand shall be graded granular material which passes a 3/8-inch sieve, with not more than 10 percent passing the No. 200 sieve (AASHTO T-27) and free from cinders, ashes, wood, vegetation, frozen or other deleterious material.

02105.2.6 UNTREATED BASE COURSE

Untreated base course consists of processed natural gravel and crushed rock with an approved soil binder without any deleterious materials, tested in accordance with AASHTO T-27 and T-11 which meets the gradation requirements in Table 2 below.

Table 2 - PARTICLE SIZE FOR UNTREATED BASE COURSE

Sieve Size	Percent Passing
1-inch	100
½-inch	70-90
#4	40-60
#16	20-40
#200	5-12

02105.2.7 BITUMINOUS SURFACING

Plant mix bituminous material, with maximum particle size not greater than 3/4-inch, meeting the requirements of Section 02511 of these Specifications.

02105.2.8 DRAIN GRAVEL

Drain gravel consists of washed natural gravel or crushed rock, with a maximum particle size of 1-inch, with not more than 40 percent passing the No. 4 sieve, with 100 percent being retained on the No. 10 sieve, and without any deleterious material.

02105.2.9 RIPRAP

Riprap consists of durable, angular, sound and hard field or quarry stones free from cracks and structural defects. Source of supply shall be approved by the Engineer. Fifty percent of the stones shall be of sizes between one-half and two-thirds of the riprap layer thickness shown on the

Drawings. Not more then 10-percent of the stones by weight shall be of a size less than one-tenth of the riprap layer thickness shown on the Drawings and the specific gravity of the stones must range between 2.5 and 2.82 (AASHTO T-85). Durability of the stones shall be in excess of 40 percent (AASHTO T-210).

02105.2.10 SUBGRADE GRANULAR FILL

Subgrade granular fill consists of well graded granular soils with a maximum of 50 percent passing the No. 4 sieve and a maximum of 20 percent passing the No. 200 sieve and no materials greater than 4-inches in diameter.

02105.3 CONSTRUCTION REQUIREMENTS

02105.3.1 LOCAL GOVERNMENT SPECIFICATIONS

Differences may exist between the requirements of these Specifications for sitework materials such as backfill, bedding, untreated base course and bituminous surface course, and those of local government entities. Such differences may affect Contract prices; therefore, when Contract Work falls within the boundaries of any local government, the Contractor shall make himself aware of that entity's specifications for those materials. If differences exist between those specifications and these, unless otherwise approved by the Engineer, the more stringent ones shall apply.

02105.3.2 BORROW AND DISPOSAL SITES

The Contractor shall, at its own expense, secure all necessary access and borrow sites for acquisition or removal and to dispose of excess backfill or waste materials, unless otherwise shown on the Drawings.

02105.3.3 ON-SITE MATERIALS

Unless otherwise shown on the Drawings or directed by the Engineer, on-site pipe bedding and trench backfill will be used for installation of all pipe. In areas where suitable on-site material is not available, other material, which meets these Specifications, will be used when shown on the Drawings, provided for in these Contract Documents or approved by the Engineer.

02105.3.4 SCALES

When ton weight is to be used to determine quantities of earthwork materials used, the Contractor shall provide his own scales or access to other scales at his own cost. Scales shall be certified accurate. Include certification in submittals.

02105.4 METHOD OF MEASUREMENT

02105.4.1 NO MEASUREMENT

On-Site Pipe Bedding and On-site Trench or Structural Backfill will be considered part of the items for piping or excavation associated with structures included in the Bid Schedule and no separate measurement for these materials will be made.

02105.4.2 SEPARATE MEASUREMENT

02105.4.2.1 IMPORTED MATERIALS – Quantities of imported pipe bedding and imported trench or structural backfill shall be determined by measuring the lineal feet (lineal feet of trench requiring imported materials) of imported material in place and accepted. This measurement shall include

furnishing all necessary materials and equipment, labor, hauling, placement, compaction, and testing to produce an acceptable trench fill.

No allowance will be made for bedding and backfill materials required to fill voids caused by trenching operations, which exceed the dimensions shown on the Drawings.

02105.4.2.2 SAND – Quantities of sand shall be determined in cubic yards in place, calculated by multiplying the measured length of trench by the measured depth of bedding by the pay width shown on the Drawings, or as directed by the Engineer in the field.

No allowance will be made for materials required to fill voids caused by trenching operations, which exceed the dimensions shown on the Drawings.

02105.4.2.3 UNTREATED BASE COURSE - Quantities of untreated base course shall be determined in cubic yards in place, calculated by multiplying the measured length by neat line dimension shown on the drawings. If no neat lines are shown on the drawings, then the cubic yard calculations shall be determined by actual measurements in the field in place.

02105.4.2.4 BITUMINOUS SURFACING – Quantities of the respective compacted thickness of bituminous surfacing shall be determined in square yards by multiplying the length of material in place and accepted by the pay width shown on the Drawings, or as directed by the Engineer in the field.

02105.4.2.5 DRAIN GRAVEL - Quantities of drain gravel shall be determined in cubic yards calculated by multiplying the measured length by the measured depth of bedding in place by the pay width shown on the Drawings, or as directed by the Engineer in the field.

02105.4.2.6 RIPRAP - Quantities of riprap shall be determined in cubic yards by multiplying the measured length by the measured breadth by the measured average depth of material in place and accepted.

02105.4.2.7 SUBGRADE GRANULAR FILL - Quantities of subgrade granular fill shall be determined in cubic yards by multiplying the measured length by the measured breadth by the measured depth of material in place and accepted.

02105.5 BASIS OF PAYMENT

The accepted quantity shall be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
Imported Trench or Structural Backfill	Lineal Foot
Imported Pipe Bedding	Lineal Foot
Sand	Cubic Yard
Untreated Base Course	Cubic Yard
Bituminous Surfacing (Thickness)	Square Yard
Drain Gravel	Cubic Yard
Riprap	Cubic Yard
Subgrade Granular Fill	Cubic Yard

02200.1 DESCRIPTION

This section covers furnishing of equipment, labor, and materials to clear, excavate, backfill and compact trenches for utilities. Excavation and backfill for piping appurtenances such as manholes, inlets, transition structures, junction structures, vaults, thrust blocks, valve boxes, catch basins, etc., shall be included, as also shall be restoration of the disturbed ground surface in accordance with the Contract Documents.

02200.1.1 RELATED WORK

Section 02005 – Traffic Control
Section 01510 - Protection of Existing Properties
Section 02015 - Clearing and Grubbing
Section 02105 - Earthwork Materials
Section 02208 - Flowable Backfill
Section 02222 - Water Pipe Installation
Section 02224 - Sewer Pipe and Manhole Installation
Section 02315 - Boring and Jacking
Section 02320 - Pipe Encasement
Section 02500 - Removal and Replacement of Surface Improvements
Section 02900 – Landscaping
Section 02204 – Water for Construction

02200.1.2 SUBMITTALS

02200.1.2.1 MOISTURE DENSITY TESTING AND GRADATION DETERMINATIONS - A documentation system shall be maintained by the Contractor to record results from all moisture/density testing and gradation determinations. Records of these tests shall show the following information as a minimum:

- Date of test.
- Type of test.
- Name of person performing test.
- Location of sample taken.
- Results of test and comparison with specified value required for compliance.

Upon completion of each gradation test or moisture/density test, a copy of the record for the respective test shall be delivered to the Engineer within one (1) working day following the completion.

02200.1.2.2 COMPLIANCE TESTING - Documentation shall also be made, in field diaries, of all compliance tests performed by the Contractor. Documentation shall be made available to the Engineer upon request.

02200.1.3 DEFINITIONS

Trench Width - Shall not be more than 18 inches greater than the outside diameter of the pipe being installed at a point 12 inches above the top of the pipe unless otherwise shown on the Drawings. The width of the trench above that level shall be the minimum width required for safe working conditions, sheeting, bracing and for proper installation of the work.

Trench Grade - The vertical elevation of the flowline of the pipe being installed in the trench.

Open Trench - Shall include trench sections which have been excavated and are awaiting completion of pipe installation, backfill, compaction or installation of a temporary surface.
Surface Restoration - Shall include the Work required to restore the ground surface disturbed for trench excavation. Replacement of road surfacing, planting and landscaping removed for trench excavation, will not be considered as trench excavation and backfilling.

Consolidated Backfill - A condition of backfilling for which a specified compaction density is required. Maximum lift, prior to compaction, for consolidated backfill shall be 8 inches unless otherwise approved by the Engineer.

Unconsolidated Backfill - A condition of backfilling for which no compaction density is specified and the required compaction effort is layer placing and then compacting by wheel rolling or use of compacting equipment. Lifts of up to 24 inches are allowed for unconsolidated backfill.

Unclassified Excavation - A determination for excavating whereby no consideration will be given to different kinds of materials that are encountered.

02200.2 MATERIALS

Not used.

02200.3 CONSTRUCTION REQUIREMENTS

02200.3.1 PERMITS

For work which is to take place within state and/or federal road and highway rights-of-way, the Contractor shall be responsible for obtaining all required encroachment and construction permits prior to beginning any work within the rights-of-way.

All work in any city, town or county public right-of-way will also require an approved excavation permit from that entity. The Contractor shall be responsible for obtaining all required encroachment and construction permits prior to beginning any work within the rights-of-way.

02200.3.2 CLEARING AND GRUBBING

On areas outside of established roadways, the area to be disturbed by the trenching operation shall be cleared and grubbed in accordance with Section 02015 prior to beginning the trenching operation.

02200.3.3 EXCAVATION

02200.3.3.1 UNCLASSIFIED EXCAVATION - All excavation for this project shall be unclassified excavation, unless otherwise determined by the Engineer.

02200.3.3.2 STAKING - Location staking of piping will be provided by the Owner in accordance with the provisions of Section 1560 unless indicated otherwise in the Contract Documents.

02200.3.3.3 EXPOSURE OF UNDERGROUND FEATURES - Before any trench excavation is started, the Contractor shall locate and expose all existing underground utilities, structures, etc., which may interfere with, or conflict with, the trench being excavated. In case of conflicts, the Contractor shall make adjustments in the location of the excavation at the direction of the Engineer. Such adjustments shall be made at no additional cost to the Owner.

02200.3.3.4 The Contractor shall perform all excavation to the depth specified in the Drawings and/or as required to accomplish the Work. During the excavation operations, excavated materials which are suitable for use as backfill for trenches or around structures, shall be piled separately at sufficient distance from the edge of the excavation to be out of the way of equipment and to prevent slides and cave-ins from embankment overloading. All excavated materials not suitable for, or not required for, fill or backfill shall be separated and removed promptly from the site of the Work and disposed in an approved site in accordance with Section 1520.

02200.3.3.5 PUBLIC TRAVEL - Materials excavated within roadways, regardless of their disposition, shall be piled in such manner that will cause the minimum of inconvenience to public travel and always allow for emergency vehicle passage.

02200.3.3.6 OPEN TRENCH - At no time shall the Contractor allow more than 500 cumulative feet of trench to be open for the overall project, unless otherwise approved by the Engineer.

02200.3.3.7 SHORING - Shoring and/or trench boxes shall be used wherever needed to protect workers and adjacent structures and property of the Work in accordance with OSHA requirements. The arrangement of bracing of shoring shall not be set so as to stress any portion of completed work.

02200.3.3.8 BARRICADING OPEN WORK - Excavations left open at the end of the work day shall be surrounded by barricades and warning tape.

02200.3.4 EXCAVATION IN ROCK

02200.3.4.1 SOLID ROCK EXCAVATION – If:

- The Contract Documents contain provisions for “Solid Rock Excavation”, and
- If rock has been encountered in the excavation, and
- If the Contractor has made three attempts to remove the rock using a "Kelly" or similar type ripper having not less than 235 fly wheel horsepower, then

the excavation of such material will be considered as "solid rock excavation".

02200.3.4.2 BLASTING - When blasting is deemed necessary for rock removal, the Contractor shall comply with all applicable State and Local laws, ordinances, and provisions for blasting safety and obtain written approval from the Engineer prior to starting of drilling and/or blasting operations.

In all cases, blasting shall be performed by experienced, qualified blasters. The Contractor is responsible for any and all damage caused by blasting, and blasting will not be allowed within 15 feet of any existing structures.

02200.3.5 OVER-EXCAVATION

02200.3.5.1 UNAUTHORIZED OVER-EXCAVATION - Care shall be taken to not excavate below the depth required by the Drawings. Any unauthorized over-excavation shall be refilled and compacted with material meeting the requirements of Section 02105 and approved for use by the Engineer at the expense of Contractor.

02200.3.5.2 ROCK - Whenever rock is encountered in the trench bottom, the trench shall be over-excavated a minimum of 6 inches below the design elevation of the bottom. of the pipe. The over-excavated portion of the trench shall be filled with approved bedding material and the bedding compacted, all at the expense of the Contractor, unless otherwise approved by the Engineer and the Owner.

02200.3.5.3 UNSTABLE NATIVE FORMATIONS - The Contractor shall notify the Engineer if soft, spongy, or otherwise unstable native formations, that are not suitable for structure or pipeline foundations, are encountered in excavations. In the event the Engineer determines that the existing foundation materials are unacceptable, the Contractor will be directed to over-excavate, remove and replace the unsuitable soil materials. The over-excavation shall be backfilled with approved select materials and compacted in accordance with the requirements described herein. Such situation will be considered as a changed condition and the Contractor will be compensated in accordance with Subsection 00700.13 of the General Conditions.

02200.3.6 PIPELINE ACCESSORY INSTALLATION

02200.3.6.1 EXCAVATION FOR ACCESSORIES - The Contractor may excavate to place the sides of manholes, vaults, valve boxes, inlet structures, catch basins or other accessory structures directly against the excavated surface, provided that the faces of the excavation are firm and unyielding and are at all points outside the structure lines shown on the plans. If the native material is such that it will not stand without sloughing, the Contractor shall over-excavate to place the structure and this over-excavation shall be backfilled and compacted, using the same material required for the adjoining pipeline trench.

02200.3.6.2 ACCESSORY SUPPORT - To prevent displacement of valve boxes and other accessory structures, trench backfill shall be compacted to at least 95% of maximum density as determined by AASHTO T-99 for 6 feet along the trench on each side of the box or structure.

02200.3.7 TRENCH BOTTOM PREPARATION

The bottom of the trench shall be accurately graded to provide uniform bearing and support for each section of the pipe. Bell or coupling holes shall be made in accordance with the recommendations of the pipe manufacturer after the trench bottom has been graded. Such depressions shall be of sufficient width to provide clearance for connecting and/or bolting. Holes for depressions shall be excavated only as necessary to permit proper joining of pipe sections.

02200.3.8 SURFACE IMPROVEMENTS

When surface improvements must be removed, or are damaged or disturbed by the Work, their removal and restoration shall be accomplished by the Contractor in accordance with Sections 01510 and 02500 of these Specifications.

02200.3.9 PROTECTION OF EXISTING UTILITIES

The Contractor shall protect all existing utilities, either above or below ground, in accordance with the provisions of Section 01510 of these Specifications.

02200.3.10 IRRIGATION DITCHES, PIPES AND STRUCTURES

The Contractor shall contact the owners of all irrigation facilities to be encountered by the work and make arrangements for construction clearances and/or facility shutdown schedules. All irrigation ditches, dikes, headgates, pipe, valves, culverts, etc., damaged or removed by the Contractor shall be restored by the Contractor to their original condition, or better, in accordance with Section 02500 of these Specifications, at no additional cost to the Owner.

02200.3.11 BUILDING FOUNDATIONS AND STRUCTURES

Where trenches are located adjacent to building foundations and structures, the Contractor shall take all necessary precaution against damage to such facilities. Water settling of backfill material

in trenches adjacent to structures will not be permitted unless authorized in writing by the Engineer. The Contractor shall be liable for any damage caused by the construction, and shall restore or replace damaged property in accordance with Section 02500 of these Specifications.

02200.3.11.1 SIDEWALK, CURB AND GUTTER - Where sidewalk, curb, and gutter exist, excavation may be made by tunneling provided the following requirements are met. Excavation shall be vertical and as near to the curb or sidewalk as possible. The length of the tunnel shall not exceed the width of the sidewalk, curb and gutter. Where a separate sidewalk and curb exist, an excavation shall be made between the sidewalk and the curb. At least three feet of undisturbed earth shall be left under the sidewalk. Where the excavation does not meet these requirements, a section of sidewalk from joint to joint shall be removed and replaced.

Gas Lines and Water Lines may be jacked, augured or jetted under sidewalk, curb and gutter provided the resulting hole diameter does not exceed one (1) inch plus the outside diameter of the pipe installed.

Backfill of Sidewalk Tunnels. Where the sidewalk has been tunneled, the hole shall be filled from each end with earth compacted with mechanical tampers to 90% of AASHTO T-180, Method C. A 3'-0" section of trench on each side of the tunnel and any space between the sidewalk and curb shall be backfilled with mechanically compacted earth as specified.

02200.3.12 WATER

02200.3.12.1 WATER FLOW - The Contractor's operation shall always ensure the free flow of water in gutters, culverts, and natural watercourses. In irrigated land areas, excavated materials shall be piled on the downhill sides of trenches.

02200.3.12.2 GROUNDWATER – Unless provided with geotechnical information by the Owner, the Contractor shall have the responsibility of determining the presence and location of groundwater at the work site.

02200.3.12.3 DEWATERING - Grading and other protective measures shall be performed as necessary to prevent surface or ground water from flowing into trenches or other excavations. Any water accumulated therein during construction, from surface or from underground sources, shall be promptly removed by pumping or by other approved methods at the Contractor’s expense.

Unless given as a separate item in the Bid Schedule, dewatering shall be performed at the expense of the Contractor. When geotechnical information is given, groundwater must be in excess of ± 2 feet before a change in work will be considered.

02200.3.12.4 INSTALLATION IN WATER - No backfill, subgrade materials, concrete or masonry footings, foundations, floors, equipment, or pipe shall be placed or laid in water. Water shall not be allowed to rise over such work for at least 24 hours following the pour or placement of any concrete or mortar used in the work. Water shall not be allowed to rise unequally against structure walls for a period of 14 days following concrete placement or masonry erection.

Groundwater or surface water in piping trenches shall not be allowed to enter and flow through the piping while installation of pipe is in progress.

02200.3.12.5 DISPOSAL - The Contractor shall dispose of all water from the work in a suitable manner without damage to adjacent property

02200.3.13 BEDDING AND PIPELINES

02200.3.13.1 USE OF ON-SITE MATERIALS - Unless directed otherwise in these Specifications, on-site materials complying with Section 02105 shall be used for bedding. If an act, or failure to act on the part of the Contractor creates a need to use imported bedding materials, the Contractor shall bear the cost of all additional excavation, transportation and installation for new bedding, and for removal and disposal of unacceptable materials, as required to correct that situation.

02200.3.13.2 INSUFFICIENT ON-SITE MATERIALS - When sufficient bedding material cannot be developed from on-site materials, and no provision is contained in the Contract Documents for importing bedding materials, the Engineer shall be notified as soon as possible. Alternative measures will be considered and a change can then be negotiated to provide additional materials in accordance with the General Conditions.

02200.3.13.3 BEDDING INSTALLATION - Pipe bedding shall be installed according to applicable sections of these Specifications for pipeline construction.

02200.3.14 BACKFILL

02200.3.14.1 BACKFILL MATERIALS AND PLACEMENT - Backfill shall be accomplished using acceptable materials as described in Section 02105 as follows:

- All backfill materials shall be at ± 2% of optimum moisture content when placed in the trench or other excavation.
- Unless provided otherwise on the Drawings, consolidated trench backfill shall be placed in lifts not greater than 8 inches.
- Unsuitable excavated material, or material with incorrect moisture content shall be removed and replaced.
- Soft spongy material that causes areas which "pump" when heavy loads pass over them, shall be removed and replaced with suitable material.
- Dry material that will not "ball" shall be removed and replaced.

  (The two foregoing conditions shall be considered sufficient evidence, without further testing, that the moisture content is incorrect and shall be grounds for removal and replacement of the material. Such replacement, if required, shall be at the sole expense of the Contractor.)

- Placement of backfill against cast-in-place concrete structures shall not be started until the concrete has been cured for the time required by the Contract Documents or prescribed by the Engineer.

02200.3.14.2 COMPACTION – Compaction procedures shall be as follows:

- The Contractor shall be responsible for obtaining construction water needed for compaction in accordance with Section 02204 of these Specifications.
- Bedding and consolidated backfill material shall be compacted with tamping, vibrating or conventional wheeled compaction equipment. Use care not to damage pipe while compacting bedding materials.
- The use of wheel rolling for compaction shall only be approved for compacting unconsolidated backfill materials.
- For work within state or federal highway rights-of-way, compaction shall meet the requirements of the respective applicable specifications.
- Backfill shall be thoroughly compacted to densities not less than those shown in the following table:

TABLE OF MINIMUM DENSITY REQUIREMENTS
(based on AASHTO-99 and T-91 and on ASTM D-2922 and E-3017)

Location	From Surface to 2-Feet Below Surface	From 2-Feet Below Surface to Top of Bedding	Bedding
Within 6 feet of, and/or under, any existing or proposed structure, pavement, curb, sidewalk, roadway or similar construction included in the Contract:	100% for granular and 95% for non-granular materials	95% for all materials	95% at all locations
Around any structure outside 6 feet:	90% for all materials	90% for all materials	90% at all locations
Cultivated and landscaped areas:	85% for all materials	85% for all materials	85% at all locations
Undeveloped Land:	Unconsolidated – see definition	Unconsolidated - see definition	85% at all locations

02200.3.15 SETTLING AND SUBSIDENCE

Dips or uneven surfaces caused by subsidence or post-construction settlement of fill or backfill in any trenches, excavations, fills, or embankments within the work, which become apparent within the warranty period, shall be repaired by the Contractor at no additional cost to the Owner.

02200.3.16 SAMPLING AND TESTING

02200.3.16.1 TESTING BY INDEPENDENT LABORATORY - As directed by the Engineer, the Contractor shall provide for all sampling and testing through a qualified, independent testing laboratory at the Contractor's own expense.

02200.3.16.2 SCHEDULE OF SAMPLING AND TESTING - The following schedule of sampling and testing provides minimum requirements, to assure compliance with all materials and compaction requirements described herein. The number of samples and tests shown shall be considered minimum, and field conditions may necessitate additional sampling and testing to be required by the Engineer.

GRADATION DETERMINATION (AASHTO T-27 and T-11)

Trench Location	Testing Required
Materials imported or manufactured at a site determined by this contract	One test per site or source
On-site excavated materials along trenches.	One test per geographical area where material composition and gradation visually appears consistent.

MOISTURE/DENSITY RELATIONSHIP (Proctor)
(AASHTO T-99 or T-180 Method D)

Trench Location	Testing Required
Materials imported or manufactured at a site determined by this Contract.	One test per site unless the material visually appears to change.
On-site excavated materials along trenches.	One test per geographical area where material composition visually appears consistent.

COMPACTION COMPLIANCE TESTING REQUIREMENTS
(AASHTO T-191 or Portable Nuclear Gauges)

Trench Location	Testing Required
Street crossing with gravel or bituminous surfacing.	One test per lift for each crossing.
Parallel to centerline of bituminous or gravel surfaced streets or roadways.	One test per lift for each 500-feet of trench length.
Along unsurfaced roads or in cultivated or landscaped areas.	One test per lift for each 1,000-feet of trench length with at least one test per area.
Under or adjacent to manholes, wetwells, enclosures, boxes, etc.	None, unless geological conditions are inconsistent and requested by the Engineer.

NOTE: The term "test" shall mean a single test with acceptable results, equal to or better than specified minimums. In the event compaction test results fall below the required minimum density; the Contractor shall re-compact and test the material until a test with acceptable results is obtained. Any test failure shall result in additional tests as required by the Engineer, at no cost to the Owner, to ensure that overall project quality objectives are met.

02200.4 METHOD OF MEASUREMENT

02200.4.1 NO MEASUREMENT

02200.4.1.1 SOLID ROCK EXCAVATION - Unless the Contract Documents contain provisions for "Solid Rock Excavation", no separate measurement or payment will be made for work requiring rock excavation.

02200.4.1.2 TRENCH EXCAVATION AND BACKFILL - Trench excavation and backfill will be considered incidental to other items shown in the Bid Schedule and separate measurement will not be made unless prescribed otherwise in the Contract Documents.

02200.4.2 SEPARATE MEASUREMENT

When listed as a separate item in the bid schedule, quantities of solid rock excavation shall be determined by the foot/foot unit, using a tape measure or other accurate measuring device to find the length of cut in lineal feet along the plane of cut and the average depth of cut in the rock and multiplying the two numbers together. This measurement shall include all labor, equipment, materials, and related work, including, but not limited to, ripping, sawing, boring, hammering, blasting, rock trenching, excavating, removing, hauling, and disposal, if required, of the existing bedrock deemed qualified by the Engineer for payment of completed rock excavation.

02200.5 BASIS OF PAYMENT

Separate payment will not be made for trench excavation unless prescribed otherwise in the Contract Documents.

PAYMENT ITEM	UNIT
Solid Rock Excavation	Foot/Foot

02201.1 DESCRIPTION

This section covers furnishing all equipment, labor, and other facilities to excavate, remove, backfill, compact, grade and shape earth materials required for construction of buildings, bridges, retaining walls, head walls, box culverts and other structures, in accordance with the Contract Documents.

02201.1.1 RELATED WORK

Section 01510 - Protection of Existing Properties
Section 02015 - Clearing and Grubbing
Section 02105 - Earthwork Materials
Section 02500 - Removal and Replacement of Surface Improvements
Section 02900 - Landscaping

02201.1.2 SUBMITTALS

Not used.

02201.1.3 DEFINITIONS

Consolidated Backfill - A condition of backfilling for which a specified compaction density is required. Maximum allowable lifts for consolidated backfill under this Section shall be 8 inches unless otherwise approved by the Engineer.

Unconsolidated Backfill - A condition of backfilling for which no compaction density is specified and the required compaction effort is layer placing and then compacting by wheel rolling or use of compacting equipment. Lifts of up to 24 inches are allowed for unconsolidated backfill.

Unclassified Excavation - A determination for excavating whereby no consideration will be given to different kinds of materials that are encountered.

Embankment Fill - The placement and compaction of suitable materials to raise the existing grade to the established elevations, and the placement and compaction of suitable materials within areas where unsuitable materials have been removed. Maximum lift for embankment fill under this Section shall be 6 inches unless otherwise approved by the Engineer.

02201.2 MATERIALS

Not used

02201.3 CONSTRUCTION REQUIREMENTS

02201.3.1 PERMITS

For work within state or federal highway rights-of-way, the Contractor shall be responsible for obtaining all required encroachment and construction permits prior to beginning any work within the rights-of-way.

02201.3.2 SITE PREPARATION

02201.3.2.1 CLEARING THE SURFACE - Before proceeding with any ground surface disturbances for work under this Section, the area to be disturbed by excavation, grading or embankments shall be cleared and grubbed in accordance with Section 02015.

02201.3.2.2 TOPSOIL - Unless otherwise indicated, the Contractor will not be required to separate, stockpile and replace topsoil on the Work site. When required in the Contract Documents, topsoil shall be removed and stockpiled for later distribution in accordance with Section 02015.

02201.3.2.3 REMOVAL OF SUBSURFACE MATERIALS - Following completion of clearing and grubbing, the Contractor shall locate and remove existing underground debris, posts, piping, cables and other underground obstructions. Unless indicated otherwise in the Contract Documents, no separate allowance for costs associated with removal of these materials will be allowed to the Contractor.

02201.3.2.4 RELOCATION OF UNDERGROUND UTILITIES - When required by the Contract Documents or determined necessary by the Engineer, existing underground utilities or other objects shall be relocated to provide clearance for required structural components prior to starting any structural excavation.

02201.3.3 EXCAVATION

02201.3.3.1 UNCLASSIFIED EXCAVATION - All excavation shall be unclassified, unless otherwise indicated in the Contract Documents. The Contractor shall perform all excavation to the elevations and dimensions shown on the Drawings and/or as required to accomplish the Work.

02201.3.3.2 CUT SLOPES - Unless otherwise shown on the Drawings, or directed by the Engineer, cut and fill slopes, or cut slopes in soil, shall be no steeper than two horizontal to one vertical. Cut slopes in rock shall be no steeper than 1.5 horizontal to one vertical.

02201.3.3.3 STOCKPILING AND DISPOSAL OF EXCAVATED MATERIALS - During the excavation operations, excavated materials which are suitable for use as backfill or embankments around structures, shall be piled separately at sufficient distance from the opening to be out of the way of equipment and to prevent slides or cave-ins.

All excavated materials not suitable, or not required, for fill or backfill shall be removed promptly from the site of the Work and disposed of in accordance with Section 01520.

Excavated materials, regardless of their disposition, shall be piled in such manner that will cause the minimum of inconvenience to public travel, and provisions shall be made for emergency travel as necessary.

02201.3.3.4 SHORING AND BRACING - Shoring or bracing shall be provided in accordance with OSHA safety requirements on all excavations, to protect workmen and the progression of the Work. In addition, excavation walls shall be braced and supported as required to prevent ground collapse or movement of ground surfaces and structures adjacent to the excavation. Slides or settlements, which occur in the excavation, shall be promptly removed and corrected by the Contractor. The arrangement of shoring and bracing components shall be made so as not to place any stress on portions of completed work.

02201.3.4 EXCAVATION IN ROCK

02201.3.4.1 SOLID ROCK EXCAVATION - Demonstration of the presence of "solid rock excavation" may constitute a changed condition, and the Contractor will be compensated for removal of such material in accordance with the General Conditions. Before excavation will be considered as "solid rock excavation", the Contractor shall demonstrate an inability to remove rock by making three attempts to rip the rock using equipment having not less than 235 fly wheel horsepower with a "Kelly" or similar type ripper. After such demonstration has indicated the presence of solid rock, and the Engineer determines its removal is necessary, authorization for removal of the solid rock may be granted in accordance with Section 00700.13 of the General Conditions.

02201.3.4.2 BLASTING - When blasting is deemed necessary for rock removal, the Contractor shall comply with all applicable State and Local laws, ordinances, and provisions for blasting safety and obtain written approval from the Engineer prior to starting of drilling and/or blasting operations.

In all cases, blasting shall be performed by experienced, qualified blasters. The Contractor is responsible for any and all damage caused by blasting, and blasting will not be allowed within 15 feet of any existing structures.

02201.3.5 OVER-EXCAVATION

02201.3.5.1 UNAUTHORIZED OVER-EXCAVATION - Care shall be taken not to excavate below the depth required by the Drawings. Any unauthorized over-excavation shall be refilled and compacted with material meeting the requirements of Section 02105 and approved for use by the Engineer at the expense of Contractor.

02201.3.5.2 UNSTABLE NATIVE FORMATIONS - The Contractor shall notify the Engineer if soft, spongy, or otherwise unstable native formations, unsuitable for structure foundations, are encountered during excavation. In the event the Engineer determines that such formations are inadequate, the Contractor will be directed to over-excavate and remove the unsuitable materials. The over-excavation shall be backfilled with approved select materials and compacted in accordance with the requirements described herein. Such situation will be considered as a changed condition and the Contractor will be compensated in accordance with the General Conditions.

02201.3.6 WATER

02201.3.6.1 DEWATERING - The Contractor shall control all ground or surface water during excavation, grading and subsequent construction activities. Dewatering systems shall be provided and operated by the Contractor so as to prevent the removal of the natural soils. Grading shall be performed as necessary to prevent surface water from flowing into excavations. Any water accumulated, therein during construction, shall be promptly removed by pumping or by other approved methods at the Contractor's expense.

Dewatering efforts shall be sufficient to ensure that softening of the bottom of excavations or formation of "quick" conditions or "boils" shall be prevented. Natural or compacted materials within the excavated areas, softened by saturation with ground water or standing surface water, shall be removed and replaced as instructed by the Engineer, at no additional cost to the Owner.

02201.3.6.2 INSTALLATION IN WATER - No backfill, subgrade materials, concrete or masonry footings, foundations, floors, equipment, or pipe shall be placed or laid in water. Water shall not be allowed to rise over such work for at least 24 hours following the pour or placement of any concrete or mortar used in the Work. Water shall not be allowed to rise unequally against structure walls for a period of 14 days following concrete placement or masonry erection.

02201.3.6.3 DISPOSAL - Any water to be removed from the Work site shall be disposed of by the Contractor in a suitable manner without damage to adjacent property.

02201.3.6.4 REFERENCE - See also Section 02200.3.12.

02201.3.7 SCARIFICATION

After excavating to the lowest subgrade elevation shown on the Drawings, and prior to placement of the structure footings or foundation components, unless otherwise directed by the Engineer, the top 6 inches of the subgrade shall be scarified, brought to the proper moisture content, and compacted in accordance with the Table of Minimum Density Requirements below.

02201.3.8 EMBANKMENT FILL AND BACKFILL

02201.3.8.1 ON-SITE BACKFILL MATERIALS - Unless directed otherwise by the Engineer or the Contract Documents, on-site materials complying with Section 02105 shall be used for all embankment, fill and backfill materials. Before on-site material becomes unavailable, and when provisions are not included in the Contract Documents for importing suitable materials, the Contractor shall notify the Engineer so that a change can be negotiated in accordance with the General Conditions.

02201.3.8.2 PLACEMENT IN LIFTS - Unless provided otherwise on the Drawings, suitable embankment fill, backfill, and bedding materials shall be placed in lifts which will be not greater than 6 inches thick after compaction. Bedding materials shall be moisture conditioned (by wetting or drying), before being placed in layers for compaction in accordance with the requirements of the Table of Minimum Density Requirements below.

02201.3.8.3 UNSUITABLE FILL AND BACKFILL MATERIALS - Any unsuitable fill and/or backfill material found within excavated materials, or material with incorrect moisture content shall be removed and replaced. Soft spongy material, causing areas that "pump" when heavy loads are passed over them, shall be removed and replaced with suitable material. Dry material that will not "ball" shall be removed and replaced. The two foregoing conditions shall be considered sufficient evidence, without further testing, that the moisture content is incorrect and shall be grounds for removal and replacement of the material. Such replacement if required shall be at the sole expense of the Contractor, and shall be accomplished prior to placement of any further material.

02201.3.9 COMPACTION

02201.3.9.1 MININUM DENSITY REQUIREMENTS - After placement, all materials shall be thoroughly compacted to not less than the densities indicated in the table below. Compaction shall be achieved and verified in accordance with AASHTO T-99, ASTM D-1556, ASTM D-1557, ASTM D-2922 and/or ASTM D-3017 as applicable.

TABLE OF MINIMUM DENSITY REQUIREMENTS
(based on AASHTO-99 and T-91 and on ASTM D-2922 and E-3017)

Location	From Surface to 2-Feet Below Surface	From 2-Feet Below Surface to Top of Bedding	Bedding
Within 6 feet of, and/or under, any existing or proposed structure, pavement, curb, sidewalk or similar construction included in the Contract:	100% for granular and 95% for non-granular materials	95% for all materials	95% at all locations
Around any structure outside 6 feet:	90% for all materials	90% for all materials	90% at all locations
Cultivated and landscaped areas:	85% for all materials	85% for all materials	85% at all locations
Undeveloped land:	Unconsolidated - see 02201.1.3	Unconsolidated - see 02201.1.3	85% at all locations

02201.3.9.2 OTHER SPECIFICATIONS - For work within state or federal highway rights-of-way, compaction shall meet the requirements of the respective applicable specifications.

02201.3.9.3 COMPACTION EQUIPMENT - Embankment fill and consolidated backfill material shall be compacted with conventional tamping or vibrating compaction equipment of such capacity and weight to achieve the required compaction density. The use of wheel rolling for compaction shall only be approved for compacting unconsolidated backfill materials.

02201.3.9.4 PLACEMENT AGAINST STRUCTURES - Embankment fill or backfilling against cast-in-place concrete structures shall not be started until the concrete has been cured for the time required by these Specifications or prescribed by the Engineer. Compaction within 3 feet of any new or existing structure shall be by hand operated vibratory or tamping equipment.

02201.3.9.5 CONSTRUCTION WATER - The Contractor shall be responsible for obtaining construction water needed for compaction in accordance with Section 02204.

02201.3.10 SETTLING AND SUBSIDENCE

Dips or settlement of fill or backfill in any excavation or embankment within the Work, which occur within the warranty period, shall be repaired by the Contractor at no additional cost to the Owner.

02201.3.11 SAMPLING AND TESTING

02201.3.11.1 INDEPENDENT LABORATORY - The Contractor shall provide all required sampling and testing by an independent qualified testing laboratory as directed by the Engineer.

02201.3.11.2 SCHEDULE OF SAMPLING AND TESTING - The following schedule of sampling and testing provides minimum requirements, to assure compliance with all materials and compaction requirements described herein. The number of samples and tests shown shall be considered minimum, and field conditions may necessitate additional sampling and testing to be required by the Engineer.

GRADATION DETERMINATION (AASHTO T-27 and T-11)

Location	Testing Required
Materials imported or manufactured at a site determined by this contract	One test per site or source
On-site excavated materials along trenches	One test per geographical area where material composition and gradation visually appears consistent.

MOISTURE/DENSITY RELATIONSHIP (Proctor)
(AASHTO T-99 or T-180 Method D)

Location	Testing Required
Materials imported or manufactured at a site determined by this Contract.	One test per site unless the material visually appears to change.
On-site excavated materials along trenches.	One test per geographical area where material composition visually appears consistent.

COMPACTION COMPLIANCE TESTING REQUIREMENTS
(AASHTO T-191 or Portable Nuclear Gauges)

Location	Testing Required
Under Structure footing or foundation	One test per lift for each 100 linear feet.
Within an embankment erected to support a structure under structure floor slabs	One test per lift for each 1,000 square feet.
Within embankments for cultivated or landscaped areas.	One test per lift for each 5,000 square feet.

NOTE: The term "test" shall mean a single test with acceptable results, equal to or better than specified minimums. In the event compaction test results fall below the required minimum density; the Contractor shall re-compact and test the material until a test with acceptable results is obtained.

02201.3.12 GRADING

Upon completion of excavation, the site shall be accurately graded to the spot elevations and slopes shown on the Drawings, to allow proper installation of the structure in accordance with applicable Sections of these Specifications.

02201.4 METHOD OF MEASUREMENT

02201.4.1 NO MEASUREMENT

Separate measurement will not be made for earthwork for structures. Unless the Contract Documents contain provisions for "Solid Rock Excavation", no separate measurement or payment will be made for work requiring rock excavation.

02201.4.2 SEPARATE MEASUREMENT

When listed as a separate item in the Bid Schedule, quantities of solid rock excavation shall be determined by the foot/foot unit, using a tape measure or other accurate measuring device to find the length of cut in lineal feet along the plane of cut and the average depth of cut in the rock and multiplying the two numbers together. This measurement shall include all labor, equipment, materials, and related work, including, but not limited to, ripping, sawing, boring, hammering, blasting, rock trenching, excavating, removing, hauling, and disposal, if required, of the existing bedrock deemed qualified by the Engineer for payment of completed rock excavation.

02201.5 BASIS OF PAYMENT

Payment for earthwork for structures shall be included in the unit prices provided for the respective structure elements listed in the Bid Schedule. When listed as a separate item on the Bid Schedule, payment for "Solid Rock Excavation" will be made as follows:

PAYMENT ITEM	UNIT
Solid Rock Excavation	Foot/Foot

EARTHWORK FOR STRUCTURES — SECTION 02201SP

The following Section shall be added to 02201 of the standard specifications.

02201.3.13 Treatment Plant Earthwork

Contractor shall remove and dispose of all existing concrete in Fry Pond area and backfill with imported structural backfill per specification 02105.2.2 Earthwork and Materials. Backfill shall be compacted to a minimum of 95% of proctor density. Contractor shall perform all excavation, earthwork and provide earthwork materials for the treatment plant as shown on the plans and described in the specifications. Contractor shall provide finish grade according to the drawings and specification. Structural backfill shall then be topped with 6" minimum untreated base course as shown on the plans and as specified in these specifications.

The following Section shall be added to Section 02201.4 of the Standard Specifications.

02201.4.3 EARTHWORK

Measurement and payment for the Earthwork at the treatment plant area shall be paid as lump sum for all accepted work, and shall include all excavation, materials and labor necessary to demolish the fry ponds, remove and dispose of the structures, import and backfill with structural backfill, excavate for the treatment plant building, provide necessary import material as described on the plans, provide finish grading, and all other ancillary earthwork not specifically included with other measurements and payment.

Measurement and payment for UBC & Gravel for Treatment Plant Area shall be paid as lump sum for all accepted work, and shall include all materials and labor necessary to install UBC and Gravel over the parking and travel areas as shown on the drawings.

The following items shall be added to the Basis of Payment in Section 02201 of the Standard Specifications.

PAY ITEM	UNIT
Earthwork for Treatment Plant Area	Lump Sum
UBC & Gravel for Treatment Plant Area	Lump Sum

02204.1 DESCRIPTION

Furnish and apply water for: dust control, pre-wetting, mixing or compacting earth materials for road, site, and/or trench construction, and for other needs associated with the Work.

02204.1.1 RELATED WORK

Not used.

02204.1.2 SUBMITTALS

Not used.

02204.1.3 DEFINITIONS

Not used.

02204.2 MATERIALS

Water shall be free of dirt and silt or any substances injurious to plant life. A separate supply of potable water shall be provided for drinking when it becomes necessary to provide water for workers.

02204.3 CONSTRUCTION REQUIREMENTS

Water provided for construction shall be obtained from a source approved by the Engineer and sufficient to provide for the anticipated needs of the contract.

Water hauling equipment shall have watertight tanks of known capacity and shall be equipped with a pressure pump and spray system with the capability of applying the whole load uniformly. The spray system shall have a positive shut-off control. The water tank shall have a minimum capacity of 1,000 U.S. Gallons, and the capacity shall be clearly marked on the tank. The Contractor may be required to verify the tank capacity.

A water meter may be used for water dispensing, providing its measurement can be verified.

02204.4 METHOD OF MEASUREMENT

Unless indicated otherwise in the Bid Schedule, no separate measurement will be made for water used for pre-wetting, mixing, or compaction of earth materials or for dust control.

When shown in the Bid Schedule, water shall be measured to the nearest 1/10th of 1000 gallons in calibrated tanks or tanks with approved metering devices that indicate volume in 100-gallon quantities.

02204.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
Water	M Gallons (1,000 US Gallons)

02222.1 DESCRIPTION

This section covers furnishing and installation of pipe and fittings of the type, class and size designated for the water system defined on the Drawings, in these Specifications, and elsewhere in the Contract Documents.

02222.1.1 RELATED WORK

Section 02105 - Earthwork Materials
Section 02200 - Trench Excavation and Backfill
Section 15110 - Pipe and Piping Systems
Section 15230 - Waterline Valves and Hydrants
Section 15232 - Water System Control Valves
Section 15234 - Water Service Connections
Section 15236 - Water Main Flow Meters

02222.1.2 SUBMITTALS

02222.1.2.1 MATERIALS AND EQUIPMENT - The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, couplings, coatings, linings, supports, mechanical restraints, thrust blocks and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall be provided with each delivery of material.

02222.1.2.2 TESTING - As construction proceeds, the Contractor shall submit test documentation in accordance with this section of these Specifications.

02222.1.3 DEFINITIONS

Fitting - Any component of a pipeline, excluding the pipe itself and valves and meters, which is used for connecting pipe sections; changing line direction or size; connecting meters, valves, tanks, etc.; or starting or terminating pipelines.

Mains - Water distribution pipes, located in streets or rights-of-ways, to which water service connections are made for users of the system.

Run - Any identified section of a pipeline.

Saddle - A fitting placed on a pipe to reinforce the pipe wall, through which a tapping hole is drilled.

Service Lateral – The line which connects to the water meter or to the service stub at the property line extending from there, on private property, to the plumbing at the foundation of a house or business.

Service Stub – The line running from the tap on a main to the meter or to the property line as appropriate.

Tap - The actual connection made to water mains which includes drilling an opening into the main, threading, installing a tapping saddle when appropriate, and installing a valve into the opening.

02222.2 MATERIALS

02222.2.1 PIPE AND FITTINGS

See Section 15110

02222.2.2 PIPELINE LOCATION IDENTIFIERS

Pipeline location identifiers generally take the form of marker posts, warning tape, and tracer wire.

02222.2.2.1 TRACER WIRE - Unless otherwise described on the plans or herein, the tracer wire shall be an insulated, #12, direct bury copper wire designed and manufactured for this purpose.

02222.2.2.2 WARNING TAPE - The warning tape shall be an inert, plastic, direct bury type with a 2-inch minimum width, of the appropriate safety color, and specifically manufactured for underground utility identification. The tape shall have wording imprinted on it identifying the type of utility it is protecting.

02222.2.2.3 MARKING POSTS - Shall be fiberglass compound, aluminum, or other corrosion resistant metal of 5-foot length and 4 inches wide, or otherwise as shown on the Drawings. They shall be fitted with a deterioration resistant warning notice or label appropriate to the application.

02222.2.3 MISCELLANEOUS FITTINGS AND MATERIALS

02222.2.3.1 POLYETHYLENE ENCASEMENT - Where soil conditions are determined to be severely corrosive and when shown on the Drawings or required in the Contract Documents, tubular polyethylene encasement shall be installed around buried ductile iron piping and fittings in accordance with ANSI/AWWA C-105.

02222.2.3.2 CASING PIPE - Where casing pipe is called for on the Drawings or is required by the Engineer, the Contractor shall furnish and install the casing in accordance with Sections 02315 and 02320 of these specifications.

02222.2.3.3 PIPE PENETRATION OR CASING SEALS - Where required on the Drawings or in these Specifications, the Contractor shall furnish and install pipe-to-wall linked rubber seals in core drilled structures, walls, pipe sleeves, or casings in accordance with the manufacturer's instructions. Seals shall be link seals by Thunderline Corporation, or an approved equal.

02222.2.3.4 PIPE RESTRAINTS – Pipe restraints shall be as follows:

- Concrete thrust blocking shall be formed, sized, and placed as described herein and shown on the Drawings. Reinforcing bars used in thrust block construction shall be preformed and fusion bonded epoxy coated.

- Mechanical restraint of piping shall be accomplished with one of the following restraining systems or an approved equal:

  ⇒ Grooved Ductile Iron AWWA Couplings by Victaulic Company of America (use only with exposed piping systems).

  ⇒ MEGALUG thrust restraints by EBAA Iron Sales, Inc.

⇒ FIELDLOK restraint gaskets by U.S. Pipe Company. Without the written approval of the Engineer, use of this restraint device is limited to joints in carrier pipe installed in a casing pipe.

All joints of pipe installed under streambeds or canal crossings, or installed in casing pipes, shall be protected with mechanical restraint.

Restraint protection of above ground or exposed piping in buildings or enclosures shall be accomplished only with mechanical restraints.

02222.3 CONSTRUCTION REQUIREMENTS

02222.3.1 HANDLING AND APPROVAL OR REJECTION OF MATERIALS

All materials delivered to and used at the job site are subject to approval of the Engineer or the Owner. Care shall be taken during handling of pipe, to avoid any impact which might cause damage. Dropping pipe during unloading will not be permitted. Pipe will be carefully inspected in the field before and after laying. If any cause for rejection is discovered in a pipe before or after laying, it shall be removed and replaced by the Contractor, at no additional cost to the Owner. Any pipe found to be unfit or rejected due to cracks, broken bells or spigots, irreparable chipped lining, etc., shall be removed from the job site.

02222.3.2 DIAGRAMMATIC LAYOUT

Piping layout on the Drawings shall be considered diagrammatic for all piping not shown with detailed dimensions. When this is the case, pipe size and location are provided, but the Drawings are not intended to show every offset, fitting, or structural difficulty that will be encountered during project construction.

02222.3.3 ALTERATION OF ALIGNMENT

At no additional cost to the Owner, and with written permission from the Engineer, piping alignment may be varied from that shown on the Drawings, to avoid structural or mechanical difficulties, or to avoid the work of other trades. The Contractor still will be liable to provide all materials and labor required to complete all work in accordance with the best practice of the trade, and to the satisfaction of the Engineer.

02222.3.4 INSTALLATION

02222.3.4.1 DEWATERING - Prior to pipe laying and jointing, sufficient dewatering effort shall be provided to maintain the ground water level at or below the surface of the trench bottom or base of the bedding course. The dewatering operation; however accomplished, shall be carried out in such a manner as to not permanently disturb natural underground water conditions.

02222.3.4.2 CONNECTION TO EXISTING FACILITIES - When connections are to be made to any existing pipe or appurtenances, for which the actual elevation or position cannot be determined without excavation, the Contractor shall excavate for, and expose the existing pipe or appurtenances before laying any new pipe. The Engineer shall be allowed to inspect the existing pipe or appurtenances before any connection is made. The Contractor shall make any adjustments in line or grade which may be necessary to accomplish the intent shown on the Drawings.

Where new fittings, valves, meters, restraints etc., are required to be installed in, or attached to, existing piping, or where connections are to be made to existing piping, the Contractor shall

furnish and install the necessary components needed to accomplish the work, whether or not specifically indicated on the Drawings.

02222.3.4.3 CAPPING PIPE END - At the close of each workday, or whenever the work ceases for any reason, the end of the pipe shall be securely closed, unless otherwise permitted by the Engineer.

02222.3.4.4 JOINING – Joining of pipe shall be as follows:

- When making connections, pipe shall be cut and beveled in a neat and workmanlike manner, so as to provide a smooth, beveled end at right angles to the axis of the pipe. Pipe and fittings shall be assembled so there will be no distortion or springing of the pipelines. Flanges, unions, flexible couplings and other connections shall come together at the proper orientation. The fit shall not be made by springing any piping, nor shall orientation or alignment be corrected by taking up on any flange bolts. Flange bolts, union halves, flexible connectors, etc., shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to fit.

- PVC pipe, 2 inches and smaller in diameter, shall be joined by solvent welding. No disturbance of joints, including from trench backfill operations, will be allowed until solvent welded joints are cured.

- PVC pipe, larger than 2 inches in diameter, shall be joined by means of gasketed joints.

- With bell and spigot joints, care should be taken to properly align the pipe before joints are forced home. Gaskets shall be lubricated in accordance with manufacturer's instructions. During insertion of the spigot end, the pipe shall be partially supported by hand, sling, or crane to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned. Since the most flexible gasketed joints tend to creep apart when the end pipe is deflected and straightened, such movement shall be held to a minimum once the joint is home.

- Where fusion of polyethylene pipe joints is required, sections of pipe shall be joined in a continuous length on the job site above ground. Joining shall be by the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. Equipment used for butt fusion joining shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment, and fusion pressures.

02222.3.4.5 LAYING - All pipe laid shall be retained in position, using mechanical means if necessary, so as to maintain alignment and joint closure until sufficient pipe bedding and backfill have been completed to adequately hold the pipe in place. All pipe shall be laid to conform to the prescribed line and grade shown on the plans, within specified limits. No blocking of any kind shall be used to adjust the pipe to grade, except when used with concrete embedment. Bedding materials shall be placed so the bottom surface of the pipe will have full bearing for the entire barrel length. The pipe shall rest on not less than 1/4 of its outside perimeter. Bell holes shall be dug as required to assure uniform support along the barrel but shall be no larger than necessary.

Unless otherwise approved by the Engineer, pipe shall be laid upgrade from the point of connection on the existing pipeline or from a designated starting point. Pipe shall be installed with the bell end forward or upgrade, unless approved otherwise. When pipe laying is not in progress, the forward end of the pipe shall be kept closed with an approved temporary plug.

02222.3.4.6 PIPE RESTRAINT – Pipe restraint work shall be as follows:

- The Contractor shall provide and install either concrete thrust blocks or mechanical pipe restraints on all pressure piping not connected with bolted flanges or welded joints.

- For projects involving pipeline construction covered under this section of the Specifications, a pipe restraint schedule is included in the Drawings. Pipe restraints (thrust blocks and/or mechanical restraints) shall be furnished and/or constructed and installed as shown on the Drawings and described in the schedule.

- Pressure pipe shall be properly blocked or restrained at all fittings, wherever the pipeline makes a change in direction of 11.25 degrees or more, wherever it changes sizes, or wherever it ends.

- Placement of concrete thrust blocking shall provide bearing against undisturbed vertical earth banks or approved compacted backfill, sufficient to absorb thrust from line pressure, and in a configuration so that pipe joints and fittings will be accessible.

- All restraints shall be in place before any hydrostatic testing and flushing are performed on the system.

- The Contractor shall allow visual inspection of every thrust block or mechanical restraint before it is buried.

02222.3.4.7 FINISH BEDDING - After the pipe is laid, additional bedding material shall be placed in 6-inch lifts to a level even with the spring line of the pipe and compacted. The portion of the trench from the spring line to 12 inches above the top of the pipe shall then be filled and compacted in the same way.

02222.3.4.8 REQUIREMENTS FOR INSTALLATION NEAR SEWER LINES - Locate potable water piping at least 10 feet horizontally (measured edge to edge) from any existing or proposed <u>parallel</u> sewer or wastewater leach line. Should conditions prevent the 10-foot separation, upon the Engineers approval the water line may be laid closer than 10 feet to sewer lines (but <u>not</u> leach lines) provided:

- The water line is laid 18 inches above the top of the sewer line, but deep enough to prevent freezing, and

- There is no groundwater impacting the trench, and

- No sewer force main exists, and

- The water line is laid in a separate trench, or

- The water line is laid on an undisturbed earth shelf on one side of the sewer line trench, or

Where potable water lines <u>cross</u> sewer lines, the bottom of the water line shall be at least 18 inches above the top of the sewer line for ten feet on each side of the sewer line, measuring perpendicularly from the water line to the sewer line. When such vertical separation is impossible to achieve, a vertical separation of less than 18 inches may be allowed provided:

- In new construction for both water line and sewer line they shall be constructed of ductile iron pipe or thermoplastic pipe joined by either mechanical or bolted flange joints.

- In situations with an existing sewer line, the new water line shall be constructed as previously described.

- And, when making such crossing, install the water line in such manner that the center of a full length of pipe is on the centerline of the sewer line to isolate the water line joints as far as possible from the sewer line.

02222.3.4.9 EXPOSED PIPING - No exposed piping shall be installed until all equipment to which the pipe is to be attached has been installed and it can be determined where piping and fittings shall be located to make a neat, efficient arrangement. Piping shall be aligned with equipment connections such that no external load or stress will be transferred to any equipment from the piping. Piping shall be installed with a sufficient number of unions, flexible couplings, or flanged joints, in addition to those shown on the Drawings, to allow for convenient inspection and maintenance.

Exposed pipe work shall be suspended or supported, to prevent sagging or over-stressing of the pipe and connections. Assembly of pipe and fittings shall be accomplished so there will be no distortion or springing of the pipe. The fit shall not be made nor the alignment corrected by taking up on any flange bolts. Joints shall come together in proper orientation, and Flange bolts, union halves, flexible couplings, and etc. shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to make the fit meeting the above requirements.

Exposed pipe shall be installed in straight runs parallel to the axis of the structures. Pipe runs shall be horizontal and vertical; except that gravity drain lines shall be pitched down in the direction of flow at a slope not less than 1/8 inch per foot.

All exposed pipe shall be painted in accordance with Section 09910 of these Specifications. Factory finished items are not required to be field painted except touch-up. The color and type of paint used shall be submitted to the Engineer for his approval.

02222.3.4.10 DRAINS AND OTHER SYSTEMS - In addition to other requirements in this Section, all irrigation and other lines fitted with drains shall be installed such that continuous slope is maintained to designated drain locations. In areas where there are both culinary water pipelines and irrigation pipelines, exposed portions of irrigation water piping shall be identified by distinctive coloring or other marking. Culinary and irrigation lines and extensions shall be completely separated, installed in separate trenches, and there shall be no cross-connection between the systems under any circumstances.

02222.3.5 SPECIAL CONSIDERATIONS FOR HDPE PIPE

02222.3.5.1 HANDLING AND STORAGE – Polyethylene pipe is able to withstand normal installation handling. However, unusually rough handling of polyethylene pipe can result in damage to the pipe wall. Care shall be taken to avoid pushing or pulling polyethylene pipe over or around sharp projections. Polyethylene pipe is subject to impact damage when dropped from excessive heights or when heavy objects are dropped upon it, particularly during cold weather. Kinking or buckling shall be avoided and any section of pipe which has been damaged in this manner shall be cut out and replaced. If a scratch depth is greater than 10% of the pipe wall thickness, then the section shall be removed and replaced.

02222.3.5.2 FUSION JOINT INSPECTION – The field technique for evaluating a butt fusion joint is bead appearance. The recommended procedures should result in the desired appearance. The Contractor shall inspect the entire circumference of the fused joint for uniform non-porous bead alignment. Improper fusion shall be redone. The Contractor shall comply with the Butt Fusion Joint Appearance Guide recommended by the manufacturer.

02222.3.5.3 PIPE PLACEMENT – Polyethylene pipe can be joined either above ground or in the ditch as the situation dictates. Though most joining can be accomplished above ground, joining which must be done in the ditch shall be well planned to ensure that enough space is available and that proper alignment is achieved. Care shall be taken to avoid buckling, gouging, and other mechanical damage when lowering polyethylene pipe into the ditch. The pipe should be laid so that there are no bends with a radius less than 20 times the pipe diameter and no joints within 3 feet of any bends. (90 times the pipe diameter at fusions.)

- Align all pipe and fitting joints true to line and grade. Extremely cold weather makes polyethylene pipe stiffer and increases the likelihood of impact damage.

- Because plastic pipe contracts as it cools, it is desirable in hot weather to snake the pipe in the bottom of the trench. This provides for "slack" in the pipeline to be taken up as the pipe cools and contracts in the ditch prior to backfilling. It is recommended that backfilling be accomplished after the pipe has cooled in the shade of the trench.

02222.3.5.4 HYDROSTATIC LEAK TESTING – Hydrostatic testing of the HDPE pipeline shall be performed on as complete of sections of the installed pipeline as possible and in the presence of the Engineer. Hydrostatic testing procedures shall be as described by "DriscoPlex" Bulletin: PP 802-TN, Test Phase Alternate #1 (www.driscoplex.com). Under no conditions except with the written consent of the Engineer shall pneumatic testing be allowed. Pressure recordings and other testing data shall be kept by the Contractor and supplied to the Engineer upon successful completion of the testing procedures.

02222.3.6 FLUSHING AND CLEANING

02222.3.6.1 FLUSHING WITH WATER - Prior to proceeding with pressure testing (and/or disinfection if required) of completed lines, the Contractor shall fill the test section with clean, potable water and flush the lines. The Contractor shall furnish all equipment and labor to complete the flushing as required by this section. Water for flushing shall be provided by the Owner.

02222.3.6.2 DIFFICULT CONTAMINANTS - Certain contaminants, especially in caked deposits, resist flushing at any velocity. If, in the opinion of the Engineer, such contaminants have entered the line during construction, the interior of the pipe shall be swabbed, as necessary, to remove the debris prior to proceeding with flushing.

02222.3.6.3 MINIMUM FLUSHING FLOW AND VELOCITY - The Contractor shall make all arrangements, to establish a minimum 2.5 feet per second (fps) flow velocity in the line during the flush. Flushing shall proceed until the installed pipe is free of debris. The flows needed to produce the required flushing velocity indicated above are provided in the table below.

FLUSHING FLOW AND VELOCITY

Pipe Diameter (inches)	Flow (gpm) to Produce 2.5 fps
4	100
6	200
8	400
10	600
12	900
16	1600

NOTE: With 40 psi residual pressure, 2 1/2 inch and 4-1/2 inch hydrant outlet nozzles will have the ability to discharge approximately 1,000 GPM and 2,500 GPM respectively.

02222.3.7 TESTING

The Contractor shall perform all testing, and shall furnish all materials, equipment, and labor necessary to complete this work as required. Any work that fails to meet the acceptance criteria of prescribed testing shall be repaired and/or replaced at no additional cost to the owner. All repaired work shall be re-tested. This sequence shall be repeated until the work meets the acceptance criteria.

02222.3.7.1 PRESSURE TESTING - All pipelines constructed for carrying potable, non-potable, and water-borne products shall be pressure tested for leakage when they are completely assembled, unless directed otherwise in these Specifications or in writing by the Engineer.

WARNING - The hydrostatic test procedures described herein are not applicable to air pressure testing.

Prior to pressurization all required flushing shall have been completed. Pipeline sections to be tested shall be isolated from any connecting lines. Air release taps shall be provided at points of highest elevation, the test section shall be filled with clean potable water, and all air shall be removed from the line. Pressure on the test section shall then be brought to full test pressure and maintained at that level for a period of not less than 4 hours. Pipelines shall be tested at 50 psi over normal static pressures shown on the Drawings or to the manufacturer's class rating, which ever is lower. Permanent plugs shall be inserted into the air release tap holes after the test has been completed.

02222.3.7.2 LEAKAGE TESTING - The leakage test shall be conducted concurrent with the pressure test. Amount of leakage, if any, will be determined by measuring the quantity of additional water required to maintain the prescribed hydrostatic pressure test during the test period. Accurate means shall be provided to measure the quantity of water required to maintain full pressure on the line for the 4-hour test period, the measured leak rate shall not exceed the rate "L" computed as follows:

$$L = SD(P^{0.5})/133{,}200$$

where:
L = Leakage rate (gal/hour)
S = Length of tested pipe (feet)
D = Nominal diameter of pipe (inches)
P = Average test pressure (psi)

When the allowed amount of leakage is exceeded, leaks shall be located and repaired and the system shall then be re-tested by the Contractor until compliance is achieved.

All visible leaks in exposed pipe shall be repaired.

02222.3.7.3 OPERATIONAL TESTING (*pressurized irrigation only*) - Pressurized irrigation systems shall be tested for proper system operation after backfill is in place and sprinkler heads have been adjusted to final position. This test shall demonstrate that the system meets coverage requirements (based on operation of one circuit at a time) and that all automatic controls function properly.

02222.3.7.4 NON-RIGID PIPE DEFLECTION TESTING - At the Engineer's request, the Contractor shall test requested portions of all non-rigid pipe after being installed and backfilled to ensure that circumferential deflection does not exceed 5% of the diameter. Such test will consist of passing a mandrel through an open section of pipe, sized appropriately to detect non-compliance. The mandrel shall be sized in accordance with the requirements provided in Section 02224 for checking sewer pipe. In the event deflection non-compliance is found, the Contractor shall make

repairs as outlined in Section 02224 and additional testing of other sections of pipe will be requested.

02222.3.7.5 TESTING DOCUMENTATION - The Contractor shall maintain a record of all testing performed, together with the test results obtained, for each line installed under this Contract. Minimum information to be included in these records shall be as follows:

- All Documents:
  - Date of issuance of the record
  - Name of Contract
  - Contractor's name and address

- Disinfection Report:
  - Name and address of treatment supervisor
  - Disinfection method used
  - Location and boundary description of section to be disinfected
  - Time and date of disinfectant introduction
  - Time and date of disinfectant release
  - Initial disinfectant residual (PPM) for each outlet tested
  - Time and date of flushing after disinfection
  - Signature of treatment supervisor (signifies completion of disinfection activities)

- Bacteriological Report:
  - Date issued
  - Project name and location
  - Laboratory's name, certification number, address and phone number
  - Test location
  - Time and date of sample collection
  - Name of person collecting sample
  - Time and date of laboratory test start
  - Coliform bacteria test results for each sample
  - Certification that water conforms (or fails to conform) to bacterial standards of the appropriate state public drinking water regulations
  - Bacteriologist's signature

- Test Report:
  - Type of test
  - Location of test
  - Sizes, types, and lengths of pipe in test section, and test boundary description
  - Date and Time test started
  - Date and Time test completed
  - Test pressure (*Pressure Test only*)
  - Amount of leakage/allowable leakage (*Pressure Test only*)
  - Mandrel dimensions(*Obstruction and Non-Rigid Pipe Deflection Tests only*)
  - Test result (*pass/fail*) (*All Tests*)
  - Printed Name/Signature and Date of Test Supervisor (Contractor's representative) (*All Tests*)
  - Printed Name/Signature of Inspector (Engineer’s representative) witnessing and approving the test (*All Tests*)

02222.3.8 DISINFECTION

02222.3.8.1 REGULATORY COMPLIANCE - All pipelines to be used for culinary water service shall be disinfected in accordance with the requirements of state and local public drinking water regulations.

02222.3.8.2 METHODS - The Contractor may use any method which complies with the above referenced standards; however, the "slug method", prescribed in ANSI/AWWA C-651, is preferred. This method basically consists of filling the line with potable water and then injecting a "slug" of concentrated chlorine solution (100 mg/L) at the upstream end of the line. The "slug" is then moved through the line by slowly draining the low end. When properly conducted, this procedure provides contact to the interior pipe surfaces with a heavily concentrated dose of chlorine to achieve disinfection.

02222.3.8.3 FLUSHING - After disinfection, the lines shall be flushed until residual chlorine is reduced to the levels safe for consumption. Samples for bacteriological testing can then be taken. The Contractor shall safely and legally dispose of contaminated water used for disinfection after consultation with the local authorities. Under no circumstances shall heavily chlorinated water be allowed to mix with "live" waters, meaning waters in lakes, rivers, streams or wetlands.

02222.3.9 PIPELINE LOCATION IDENTIFIERS

The Contractor shall furnish and install such identifiers as shown on the Drawings and/or prescribed in these Specifications.

02222.3.9.1 TRACER WIRE – Tracer wire shall always be installed in the trench with non-metallic pipelines, during or immediately following their installation and may be required in the installation of metallic pipelines where electric conductance is necessary and is not provided through the pipeline because of its type of construction. Tracer wire placement shall be as shown on the Plans but shall generally be immediately beneath (preferred), to the side, or above the pipeline with approximately 4 inches of separation. Tracer wire shall be brought to the surface of the ground at all valves and risers and where otherwise shown on the plans.

Tracer wire shall be installed as shown in the Plan details. Where splices in the wire are required, the Contractor shall use the manufacturer recommended splice nut (cap) to provide a watertight joint. Extend electrical tape well over the wire insulation in all directions.

The Contractor shall provide all necessary labor, equipment, and materials to perform an electrical continuity test prior to acceptance on all installed tracer wire. The test shall be performed in the presence of the Engineer or an appointed representative. The continuity test shall be conducted using an ohmmeter. Continuity must be demonstrated to pass the test. In the event of a failed test, the Contractor shall make all necessary repairs required to provide a tracer wire system that complies with the testing requirements of this section.

Some soil conditions and/or installation circumstances may require the additional installation of cathodic protection for the tracer wire. When this is the case, cathodic protection will appear as a separate bid item and details for its installation will appear on the Plans and elsewhere in these Specifications.

02222.3.9.2 WARNING TAPE – A continuous ribbon of warning tape shall be installed during the backfill operation. Tape shall be placed a minimum of 12-inches above the top of the pipeline or at a depth approved by the Engineer, or otherwise as shown on the drawings. At roll ends and at places where the tape has been broken, the loose ends shall be tied together to prevent separation during the rest of backfill.

02222.3.9.3 MARKING POSTS – Marking posts shall be installed at the placement intervals shown on the Plans. Posts shall not be deformed or damaged during installation. The Contractor shall use a post hole digger to install markers when there is danger of damage to posts from pounding or hammering

02222.3.10 CLEANUP

Following acceptance of testing and completion of backfilling and surface restoration, the Contractor shall prepare the work for contract closeout in accordance with Section 01200 of these Specifications.

02222.4 METHOD OF MEASUREMENT

02222.4.1 BURIED WATER LINES

The amount of buried water line pipe shall be determined by measuring the lineal feet of pipe in place and accepted, including the lengths of fittings, valves, couplings, and portions of pipe within casings, unless called out otherwise in the Contract Documents.

Measurement of lines passing through, or connecting to control valves or other operating devices enclosed in vaults or manholes, shall be made only up to the pay limit of the enclosure or vault as shown on the Drawings. If no pay limit is shown, measurement will be made to a point five (5) feet outside of the enclosure.

Measurement of ductile iron pipe shall include polyethylene encasement where that material is required.

02222.4.2 PIPELINE LOCATION IDENTIFIERS

Measurement of tracer wire and location markers installed with non-metallic pipe shall be included in the measurement of the waterline pipe unless they are separate bid items in which case measurement for tracer wire shall be the same as the length of waterline installed and location markers shall be measured by counting the number of markers installed.

02222.4.3 EXPOSED PIPELINES

Exposed water pipe shall not be measured in connection with the installation of water lines but shall be included in the measurement of the structure or facility where the exposed pipe is located, and payment for such pipe shall be included in the payment for those bid items.

02222.4.4 FITTINGS

Unless specifically called out for separate payment on the Bid Schedule, fittings for pipelines and piping systems will be considered appurtenant to the line or system being installed, and measurement for such fittings will be included in the measurement for that pipeline or piping system.

02222.4.5 MISCELLANEOUS

Separate measurement for valves and vaults and enclosures and their contents will be as described in other sections of these Specifications.

02222.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
(*size*) PVC Pipe (*Class*) [AWWA C-900] or [*Pressure rated*]	Lineal Foot
(*size*) DI Pipe (*Class*)	Lineal Foot
(size) HDPE Pipe [IPS] or [DIPS] C906 SDR (#)	Lineal Foot
(*size*) Galvanized Iron Pipe (*Schedule*)	Lineal Foot
Pipeline Location Markers	Each

No separate payment will be made for fittings unless called for on the Bid Schedule.

02226.1 DESCRIPTION

Includes furnishing all labor, equipment and materials required to install pipe, dispose of unsuitable materials, perform trench backfilling and compaction in conformance with Section 02200 and provide pavement restorations in conformance with Section 02500.

02226.1.1 RELATED WORK

Section 02105 - Earthwork Materials
Section 02200 - Trench Excavation and Backfill
Section 02500 - Removal and Replacement of Surface Improvements

02226.1.2 SUBMITTALS

Submit manufacturer's certification that all material furnished is in compliance with specifications, standard references, and contract requirements in accordance with Section 01300.

02226.1.3 DEFINITIONS

Pipe Zone - The area around the pipe in the trench width and up to 12-inches over the pipe.

Drainage Pipe - Perforated and non-perforated pipe used for collection and transmission of subsurface drainage.

Culvert - Pipe used for transmission of surface water under and around roadways.

02226.2 MATERIALS

The Contractor shall not change pipe size, material or class without written approval from the Engineer. Provide the type, class and size of pipe shown on the Drawings and conforming to the following:

02226.2.1 REINFORCED CONCRETE PIPE

Use Class A or B with Type II cement, which conforms to AASHTO M-170. Elliptical pipe shall be Class A or B, which conforms to AASHTO M-207 with tongue and grove joints.

02226.2.2 CORRUGATED POLYETHYLENE CULVERT PIPE

Corrugated polyethylene culvert pipe shall be Class A or B conforming to the requirements of AASHTO M-294.

02226.2.3 CORRUGATED GALVANIZED STEEL PIPE AND PIPE-ARCH

Corrugated galvanized steel pipe and pipe-arch shall be Class A, B or C, which conforms to the requirements of AASHTO M-36.

02226.2.4 CORRUGATED ALUMINUM PIPE AND PIPE-ARCH

Corrugated aluminum pipe and pipe-arch shall be Class A, B or C, which conforms to the requirements of AASHTO M-196 and M-197.

02226.2.5 PVC DRAIN PIPE

Solid wall and perforated drain pipe with rubber gasketed joints, which conforms to the requirements of ASTM D2729. Perforation shall follow the ASTM D2729 perforation pattern of 2, one-half inch holes 120° apart with 5-inch spacing.

02226.2.6 PE DRAIN PIPE

Corrugated solid wall and perforated drainpipe with rubber gasketed joints, which shall conform to ASTM F405.

02226.2.7 DRAIN GRAVEL

Drain Gravel shall comply with the requirements provided in Section 02105.

02226.2.8 GEOTEXTILE FABRIC

Geotextile Fabric shall be as called for on the Drawings and specified in Section 02950.

02226.3 CONSTRUCTION REQUIREMENTS

02226.3.1 HANDLING AND STORAGE OF PIPE

The Contractor shall handle and store pipe to prevent damage by crushing or piercing and in such a way as to prevent contamination. Any pipe delivered to the Work site, which does not conform to specifications or is scratched, bent, cracked, chipped or otherwise damaged, shall be rejected. The Contractor shall protect pipe and components against dirt and damage during shipment and storage and shall store pipe in strict conformance with the manufacturer's recommendations. The Contractor shall not store PE or PVC plastic pipe in direct sunlight for more than 30 days.

02226.3.2 PREPARATION

The Contractor shall verify location of existing utilities and structures ahead of pipe laying operation. If pipe adjustment is necessary due to location of other utilities, secure approval from Engineer prior to proceeding.

02226.3.3 TRENCHWORK

The Contractor shall excavate trenches in accordance with Section 02200. The Contractor shall repair unstable subgrade for pipe installation by over-excavating to stable soils or a minimum 8-inches depth and replace with approved stabilization material.

02226.3.4 DEWATERING

The Contractor shall keep the pipe trenches free from water during pipe installation by a method acceptable to the Engineer.

The Contractor shall be responsible for damages of any nature resulting from the dewatering operations, notwithstanding approval of the method by the Engineer.

02226.3.5 SHORING

The Contractor shall provide trench shoring and protection in accordance with applicable OSHA standards and Section 01510.

02226.3.6 INSTALLATION

02226.3.6.1 PLACEMENT – Pipe placement shall be as follows:

- The Contractor shall handle and install pipe as per manufacturer's specific instructions.
- The Contractor shall make bellholes and depressions only of such length, depth and width as required for properly accommodating the particular type of pipe joint being installed.
- The Contractor shall join pipe in accordance with manufacturer's recommendation or as specified in piping specification section.
- Pipelines shall be laid on uniform grades.
- Do not install pipe at a grade less than 0.5%.
- Lay gravity flow pipe upgrade beginning at lower end.
- Pipe shall not be installed without continuous support under the barrel.
- The Contractor shall obtain written approval from the Engineer to deflect pipe from true line and grade. Do not exceed deflection allowed by pipe manufacturer's recommendation.
- The Contractor shall not lay pipe in water or when trench conditions or weather are unsuitable for such work.
- The Contractor shall place circular concrete pipe which contains elliptical reinforcing so that the reference lines designating the top of the pipes will not be more than 5° from the vertical plane through the longitudinal axis of the pipe.
- Not more than 300 feet of continuous pipe placement will be allowed without the installation of an inlet box, catch basin, combination box, clean-out box, manhole or other such structure.

02226.3.6.2 CUTTING TOOL - The Contractor shall use an approved machine or cutting tool recommended by the pipe manufacturer to cut pipe.

02226.3.6.3 DAMAGED PIPE - The Contractor shall remove and relay any section of pipe already placed which is found to be out of alignment, defective or damaged.

02226.3.6.4 PLUGS - The Contractor shall provide plugs for pipeline branches, stubs or other open ends, which are not to be immediately connected. The Contractor shall use a joint comparable to the main line joints and thrust block as required to secure plugs.

02226.3.6.5 GALVANIZED PIPE - The Contractor shall provide protection to galvanized pipe to prevent scratches or abrasion and assure that the coating is not damaged. Remove and replace damaged pipe sections when directed by the Engineer. Provide proper facilities for lowering sections of pipe into trenches.

02226.3.6.6 CONNECTION TO CONCRETE - The Contractor shall form, size and finish structures connecting piping in accordance with the details of the Drawings and Section 03100. The Contractor shall install mortar in joints at catch basins, clean-outs, manholes, etc. Remove all loose material and soil from the surface on which concrete will be placed. Non-metallic pipe shall be thoroughly wetted prior to pouring the collars.

02226.3.6.7 PIPE BEDDING - Unless otherwise shown on these Contract Documents, culverts shall be bedded with on site bedding materials or imported bedding, which conforms to Section 02105. Drainage piping shall be bedded in accordance with the details shown on the Drawings with material which also conforms to Section 02105.

02226.3.6.8 BACKFILL - The Contractor shall compact trench backfill in accordance with the requirements of Section 02200 and 02222.

02226.3.7 INSPECTION

Prior to starting backfill of trenches, the Contractor shall notify the Engineer of completion of pipe laying and allow the Engineer to check all installed drain piping and culverts. When access to installed pipe is determined necessary for checking by the Engineer, the Contractor shall open any covering as requested. If defects are found, the Contractor shall make the necessary corrections at no cost to the Owner. If no defects are found, the cost of uncovering and recovering shall be an additional expense covered by the Owner in accordance with the General Conditions (Section 00700).

02226.4 METHOD OF MEASUREMENT

02226.4.1 PIPE AND CULVERTS

Measurement of drainage piping and culverts shall be made by using a tape measure or other accurate measuring device to determine the number of lineal feet of pipe or culvert, along the centerline of the pipe, installed and accepted. This measurement shall include the lengths of all in-line fittings and shall stand as the measurement of all other work involved with the pipe installation such as trenching, backfilling, and site restoration as required.

02226.4.2 ENTRANCE AND EXIT STRUCTURES

Measurement of culvert or drainage pipe entrance and exit structures and measurement of culvert end sections shall be separate from the lineal measurement of the pipe and shall be made by counting the number of such structures built and accepted.

02226.4.3 OTHER WORK AND MATERIALS

The method of measurement for other work and materials such as drain rock, geotextile fabric, and import bedding and backfill will be described separately when called for on the Drawings, in these Specifications, or required by the Engineer.

02226.4.4 DEWATERING

Dewatering of trenches is considered incidental to the construction. The Contractor shall include all associated costs for trench dewatering in the lump sum contract price.

02226.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
(Diameter, Type) Culvert Pipe	Lineal Foot
(Diameter, Type) Drain Pipe	Lineal Foot
Entrance/Exit Structures	Each
Culvert End Section	Each

Payment for other materials, (i.e., drain rock, imported bedding and backfill, geotextile fabrics, etc.) will be made in accordance with their respective specification requirement.

02500.1 DESCRIPTION

This work includes removal and restoration of existing features, public or private, including but not limited to asphalt or concrete pavement, concrete structures, curb and gutter, sidewalk, gravel surfacing, driveways, crosswalks, landscaping, field crops, irrigation ditches, fences, culverts, buried or exposed utilities, abandoned utilities, small utility buildings and the disposal of resulting waste materials and debris.

02500.1.1 RELATED WORK

Section 01510 - Protection of Existing Properties
Section 02015 - Clearing and Grubbing
Section 02200 - Trench Excavation and Backfill
Section 02511 - Hot Plant Mix Bituminous Surfacing
Section 02520 - Pavement Cutting
Section 02900 - Landscaping

02500.1.2 SUBMITTALS

When any improvement not owned by the Owner is designated for restoration work, then, upon completion of such restoration, the Contractor shall obtain a written statement of acceptance or release from the responsible owner of the feature. This statement, in turn, will be submitted to the Engineer for his review and approval prior to acceptance of the work for payment.

02500.1.3 DEFINITIONS

Not used.

02500.2 MATERIALS

02500.2.1 GENERAL

When restoration of a feature is indicated in the Contract Documents, such work shall be accomplished so as to restore the feature to its original, or better, condition and/or function as it existed prior to removal.

It is recognized that exact duplication of materials cannot always be achieved, but reasonable effort is expected from the Contractor to restore the feature with materials which will provide the same or better service and appearance as observed prior to removal.

All materials shall be new.

02500.2.2 BITUMINOUS SURFACE

02500.2.2.1 PRIMER OR TACKER COAT – Shall be an approved bituminous material such as type MC-70-250, SS1, or CS-1.

02500.2.2.2 PATCHING AND REPAIR - Plant mix material that meets or exceeds the requirements of Section 02511 herein, or of the local State Department of Transportation for asphalt surface road repair, shall be used for patching and repair.

02500.2.2.3 SURFACING – Shall be hot or cold mix bituminous surfacing, meeting or exceeding the requirements of Sections 02511 or 02512 herein, or of the local State Department of Transportation for asphalt surface road repair.

02500.3 CONSTRUCTION REQUIREMENTS

02500.3.1 UNCLASSIFIED REMOVAL AND RESTORATION

02500.3.1.1 EXISTING IMPROVEMENTS - All existing facilities disturbed by the Contractor in prosecution of the Work, including but not limited to asphalt or concrete pavement, concrete structures, curb and gutter, sidewalk, gravel surfacing, driveways, crosswalks, landscaping, field crops, irrigation ditches, fences, culverts, buried or exposed utilities, abandoned utilities, small utility buildings or any other structures or obstructions designated to be removed on the Drawings, by the Engineer, or these Specifications, shall be removed, cleaned up, and then restored or replaced in kind by the Contractor in new condition.

02500.3.1.2 ADJACENT IMPROVEMENTS - Care shall be exercised in such removal to assure that adjacent facilities or structures, which are to remain, are not disturbed. Any damage to such existing facilities or structures resulting from carelessness or negligence on the Contractor's part shall be satisfactorily restored to new condition at the Contractor's expense.

02500.3.1.3 VEGETATION - Trees, shrubs, and other landscape plants designated to be saved for replanting shall be carefully removed, bundled, set aside and protected for replanting by the Contractor. Turf Sod to be saved for replanting shall be removed by machine cutting. In lieu of removal and replacement of turf sod or field crops, the Contractor may, upon approval of the property owner, remove and replant the same. Such agreements shall be documented on the final property release to be signed by the property owner.

Replanting of landscape items shall be performed in accordance with Section 2900.

02500.3.2 TOPSOIL

02500.3.2.1 REMOVAL AND PROTECTION - In all construction areas where re-growth of vegetation is desired, and when called for by the Contract Documents, the Contractor shall remove, segregate, stockpile, store, and protect topsoil during excavation in accordance with Section 02900. Topsoil shall be kept free from contamination from foreign materials and other soils. The Contractor shall arrange construction activities to avoid damage or disturbance to the stockpiled soil.

02500.3.2.2 REPLACEMENT - When backfill operations have been completed, the topsoil shall be replaced and restored to the original contours or as called for on the Drawings, in accordance with Section 2900 of these Specifications.

02500.3.3 GRAVEL SURFACE

02500.3.3.1 REMOVAL - When restoration of graveled driveways, roadways, or parking areas is required, the existing gravel surfacing shall be graded off and stockpiled safely away from ongoing work activities, to prevent contamination with subsurface materials. It may then be reapplied and compacted during restoration activities.

02500.3.3.2 RESTORATION - Areas to be restored shall be backfilled and graded to uniform lines and compacted to the density prescribed for trenching in Section 02200. Existing gravel surfacing materials shall then be replaced in uniform 3 inch layers compacted to 95% of maximum density. After compaction, the affected area shall be graded smooth. Sufficient new material of equal or better quality shall be applied and mixed in, to replace materials lost during prosecution of the Work, to ensure a 3-inch minimum gravel cover after compaction and grading.

02500.3.4 BITUMINOUS SURFACE

02500.3.4.1 REMOVAL - Bituminous pavement surface shall be removed and restored in accordance with this paragraph unless provisions for restoration are made in other Sections of these Specifications. The pavement surface, public or private, designated for removal shall be removed to neat lines, which shall be cut in accordance with Section 02520. No ripping or rooting will be permitted outside of the limits of the cut lines.

Existing driveways, sidewalks, etc., which do not match the new finish grade as shown on the Drawings, also shall be removed preparatory to restoration work.

02500.3.4.2 DISPOSAL - Surfacing materials removed shall be disposed of in accordance with Section 1520 of these Specifications, and will not be permitted in the backfill, except as specifically authorized by the Engineer and in accordance with local requirements.

02500.3.4.3 RESTORATION – Restoration of bituminous surface shall proceed according to the following steps:

- First, the sub-grade shall be graded to a uniform surface, and 6 inches of Untreated Base Coarse (UBC) gravel shall be placed over the area in lifts not thicker than 3 inches, compacted to 95% of its maximum density.

- Then, the exposed edges of existing pavement shall be primed with a material approved for this purpose.

- Unless shown otherwise on the drawings or required otherwise by the Engineer, hot or cold mix bituminous surfacing shall be spread and compacted in individual, 3-inch maximum lifts over the base course. Minimum thickness of the new bituminous surfacing layer shall be equal to the adjacent surface thickness, but shall be not less than 3 inches thick when compacted to 95% of its maximum density.

- Rolling operations shall be conducted in such a manner that shoving or distortion will not develop beneath the roller. The surface shall be finished to a smooth, uniform line and grade with surface deviations not exceeding plus or minus 1/4 inch in 10 feet, unless the surface is subject to more stringent State, County, or Municipal requirements. The determination of smoothness compliance may be made with a straight edge or string line at the option of the Engineer. Any irregularities shall be satisfactorily corrected at the sole expense of the Contractor.

- Existing driveways, sidewalks, etc., which were removed because they did not match the new finish grade, shall be replaced and restored to their original or better condition to match the new finish grade shown on the Drawings, or as directed by the Engineer.

02500.3.5 REMOVAL AND RESTORATION OF CONCRETE IMPROVEMENTS.

02500.3.5.1 REMOVAL - Existing concrete pavement in streets, alleys, driveways, sidewalks, etc., public or private, shall be cut in accordance with Section 02520, and removed to the lines indicated on the Drawings, or as directed by the Engineer. No ripping or rooting will be permitted outside of the limits of saw cut lines.

Existing driveways, sidewalks, etc., which do not match the new finish grade as shown on the Drawings, also shall be removed preparatory to restoration work.

02500.3.5.2 DISPOSAL - All materials removed shall be disposed of in accordance with Section 1520 of these Specifications, and will not be permitted in the backfill, except as specifically authorized by the Engineer and in accordance with local codes.

02500.3.5.3 RESTORATION - Sub surface preparations shall be the same as those in paragraph 02500.3.4.3 above.

- Concrete pavement including sidewalks, driveways, roadways, and parking area surfacing shall be replaced by the Contractor in accordance with Division 3 of these Specifications, unless otherwise directed by the Engineer

- Those existing driveways, sidewalks, etc., which were removed because they did not match the new finish grade, shall be replaced and restored to their original or better condition to match the new finish grade shown on the Drawings, or as directed by the Engineer.

- All other concrete improvements shall be restored in accordance with details shown on the Drawings, or as directed by the Engineer, and as required by the provisions of Division 3 of these Specifications.

02500.3.6 REMOVAL AND RESTORATION OF FENCES

When necessary to remove any fence to facilitate its operation, the Contractor shall obtain prior agreement with the owner of the fence for its removal. Temporary containment measures shall be provided, if needed, at no additional expense to the Owner. As soon as practical, the permanent fence shall be restored to its original condition or better.

02500.3.7 RESTORATION OF IRRIGATION DITCHES

Restoration of irrigation ditches shall be made in such a manner that the ditch configuration and size will be equivalent to its original condition and the ditch will be located on its original alignment. Any embankment required to restore the original slope of the ditch will be layer compacted with mechanical compaction equipment to 90% of maximum dry density determined by AASHTO T-99.

02500.3.8 CLEANUP

Areas of construction activity shall be left in a condition of uniform grade, blending into pre-existing contours and concealing, as much as possible, evidence of construction activity by back dragging or raking to conceal tire marks. Cleanup and disposal of surplus materials shall be performed in accordance with Section 1520.

02500.4 METHOD OF MEASUREMENT

02500.4.1 NO BID SCHEDULE LINE ITEM

When the Bid Schedule in the Contract does not contain a line item for "Removal and/or Restoration of Surface Improvements", then this work will be considered incidental to other items included in the Bid Schedule, and no separate measurement shall be made for this work.

02500.4.2 “DESIGNATED AREA” LINE ITEM

Measurement for removal and/or of surface improvements in a designated area shall be the "lump sum" of the work required to remove and properly dispose of materials resulting from removal.

02500.4.3 "DESIGNATED FEATURE" LINE ITEM

Measurement for removal and/or restoration of designated features shall be per unit as described in the Bid Schedule.

02500.4.4 BITUMINOUS SURFACE PAY LIMIT

Measurement for bituminous surface removal and replacement shall be made by multiplying the pay limit by the actual length of removal and replacement in lineal feet as determined using a tape measure or other accurate measuring device.

In general, for pipe trench excavation, the pay limit shall be determined by the formula W = OD + 18 inches (pay limit width equals pipe outside diameter plus 18 inches), rounded up to the nearest standard bucket width. Actual measurement may be modified according to information indicated on the Drawings or as directed by the Engineer.

The pay limit for removal of bituminous surface for other purposes shall be as shown on the Drawings or directed by the Engineer.

02500.4.5 DAMAGED ITEMS

Measurement of items damaged or removed as a result of the Contractor's negligence shall not be allowed and no payment will be made under this contract.

02500.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit prices as follows:

PAY ITEM	UNIT
Removal of Site Surface Improvements	Lump Sum
Removal of (*Name of Structures*)	Each
Removal of Sidewalk	Square Yard
Removal of Fences	Lineal Foot
Removal of Driveway Slabs	Square Yard
Removal of Curb and Gutter	Lineal Foot
Removal of Bituminous Surface	Square Yard
Replace (*Name of Structure*)	Each
Replace (*Thickness*) Sidewalks	Square Yard
Replace (*Thickness*) Driveway Slabs	Square Yard
Replace *(Thickness)* Bituminous Surface	Square Yard
Replace (*Description*) Fence	Lineal Foot
Replace (*Description*	Lineal Foot or Lump sum
Restore (*Description*)	Lineal Foot or Lump Sum

02510.1 DESCRIPTION

This section covers all sampling and testing of subgrade and pavement materials. The materials sampling and testing shall be done by an independent certified testing company and all testing reports shall be submitted to the Engineer within a reasonable time period.

02510.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 02200 – Trench Excavation and Backfill
Section 03050 – Portland Cement Concrete

02510.1.2 SUBMITTALS

All sampling and test reports shall be submitted in accordance with Section 01300.

02510.1.3 DEFINITIONS

Not used.

02510.2 MATERIALS

Not used.

02510.3 CONSTRUCTION REQUIREMENTS

02510.3.1 TESTING

The minimum testing requirements are as follows: All Materials sampling and testing shall be done by an independent certified testing company and all testing reports shall be submitted to the Engineer within a (2) two week time period or sooner.

02510.3.1.1 EMBANKMENT

• Maximum Laboratory Density	1 test in each soil type
• Field Density and Moisture	1 test per 2000 square yards

02510.3.1.2 BACKFILL

• Field Density and Moisture	2 tests per culvert or structure (Refer to Section 02200 for Trench Excavation and Backfill Testing)

02510.3.1.3 UNTREATED BASE COURSE

• Sieve Analysis	1 test per production day
• Maximum Laboratory Density	1 test per 10,000 tons
• Field Density and Moisture	1 test per 2000 square yards

02510.3.1.4 ASPHALT CONCRETE PAVEMENT

• Mix design (ASTM 1559 and AASHTO T-283)	1 mix design for the project
• Asphalt temperature	As necessary to assure compliance
• Gradation and Asphalt Content	2 tests per production day
• Field Density	1 test per 1600 square yards

- Mix and Laydown Temperature — As necessary to assure compliance
- Thickness — 1 test per 1600 square yards

02510.3.1.5 PORTLAND CEMENT CONCRETE

- Slump Test — 1 test per load of concrete
- Air Test — 1 test per load of concrete
- Strength Test — 1 compressive strength per 50 cubic yards

02510.4 METHOD OF MEASURMENT

Measurement for this pay item will be by the lump sum.

02510.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price:

PAY ITEM	UNIT
Materials Sampling and Testing	Lump Sum

02511.1 DESCRIPTION

Includes manufacturing, transporting, laying and compacting hot mixtures of bituminous surfacing for roads, parking areas, sidewalks and other traffic surfaces.

02511.1.1 RELATED WORK

Section 02500 – Removal and Replacement of Surface Improvements
Section 02513 - Asphalt Tack Coat

02511.1.2 SUBMITTALS

02511.1.2.1 MIX DESIGN - The Contractor shall develop and submit proposed mix-designs based on the Marshall Method for Hot Asphalt Paving Mixtures as established in AASHTO T 245. The submittal shall include a laboratory report incorporating all of the information required by that specification, together with curves developed from the mix designs showing varying percentages of asphalt by dry weight of mix versus unit weight, percent air voids, stability, flow and percent voids in mineral aggregate.

02511.1.2.2 JOB MIX FORMULA – At least 15 days prior to producing bituminous mixtures, the Contractor shall submit to the Engineer, in writing, a proposed job-mix formula for each mixture for use in setting the job-mix formula to be used with the proposed materials For bituminous mixtures, the proposed job-mix formula shall be based on a mix-design-run on aggregates, crushed or otherwise, produced for the project and using the bituminous material that will be furnished for the project.

Each job-mix formula shall propose definite single values (hereafter referred to as Target Values or TV) for:

- The percentage of aggregate passing each specified sieve based on the dry weight of aggregate. These percentages shall be within the range shown in Table 2-H.
- The percentage of bituminous material to be added based on the total weight of mixture.
- The temperature of the mixture as it leaves the mixer.
- The temperature of the mixture placed on the road immediately preceding initial compaction of the mixture.
- The kind and percentage of additives to be used (Hydrated lime may be added to prevent stripping).
- The kind and percentage of mineral filler to be used.
- The percentage of water, based on the total dry weight of mixture.
- The maximum specific gravity of dense graded hot mix bituminous paving mixtures as determined by AASHTO T 209 (For open graded hot mixes, the laboratory density developed during mix design shall be used as the TV. It shall be the maximum density for the TV bituminous content).
- The mixture shall have a minimum dry retained strength value of 200 psi.

After reviewing the Contractor's proposed job-mix formula, the Engineer shall determine a job-mix formula with single values for the nine parameters listed above, and so notify the Contractor in writing.

Should a change in source of material be proposed, or should a job-mix formula prove unsatisfactory, the Contractor shall establish a new job-mix formula and shall submit same to the Engineer.

02511.1.2.3 PENETRATION/VISCOSITY/TEMPERATURE RELATIONSHIPS - The Contractor shall submit penetration/viscosity/temperature relationships for the bituminous material to be used in the Work along with a certification from the supplier attesting to their accuracy. If the supplier finds it desirable or necessary to change crudes or blends of crudes, new relationships must be supplied along with a sample to use in running a new mix-design. This submittal shall be made not less than 15 days prior to delivery of material from the changed source of materials. The penetration and viscosity values shall be determined at the temperatures and by the procedures specified in AASHTO M 226.

02511.1.3 DEFINITIONS

Plant - Stationary machinery used for manufacturing mixtures of asphalt cement, liquid asphalt with aggregate to form a uniform mixture of bituminous surfacing. Sometimes referred to as "batch plant".

Aggregate - Crushed stone, gravel or slag with uniform particle sizes.

Gradation - A group of particle size limits that are prescribed for aggregate.

Job-Mix Gradation - A gradation of aggregate which has been developed by a contractor or material supplier which can consistently be produced from a given source.

Job-Mix Formula - A mixture of asphalt materials and aggregate which can be consistently produced from a given source with the available plant of a contractor or material supplier.

Course - A single layer of bituminous surfacing.

Mat - Single or multiple layers of bituminous surfacing which have been placed.

Lot - The amount of bituminous mixture placed during a production day.

02511.2 MATERIALS

02511.2.1 ASPHALT CEMENT

Shall meet the requirements of AASHTO M 20 for penetration-graded asphalt cement and AASHTO M 226 for viscosity-graded asphalt cement. When not shown otherwise, the Contractor shall use viscosity grade AC-20 asphalt cement for the bituminous mixture.

02511.2.2 AGGREGATES

Aggregates for hot bituminous mixtures shall be crushed stone, slag or gravel meeting the quality and gradation requirements shown below in Tables 1-H and 2-H, unless shown otherwise in the Contract Documents.

When crushed gravel is used, at least 50 percent by weight of the particles retained on the Number 4 sieve shall have at least one mechanically fractured face.

TABLE 1-H CRUSHED AGGREGATE QUALITY REQUIREMENTS FOR HOT BITUMINOUS PAVEMENT.

Description	AASHTO Test Method	Requirements
Percent Wear	T 96	40 max.
Durability Index, Coarse and Fine	T 210	35 min.
Sand Equivalent (Alternative Method Number 2)	T176	45 min
Stripping Test	T 182	Min. 95% coated**

** An approved chemical additive may be used to meet this requirement.

TABLE 2-H GRADATION LIMITS FOR CRUSHED AGGREGATE USED IN HOT BITUMINOUS SURFACING.

Sieve Size	Percent of Total Aggregate (dry weight)			
	1-inch (1)	¾-inch (2) (Non-rutting)	¾-inch (3)	½-inch (4)
1 inch	100			
¾ inch		100	100	
½ inch	75-91	74-99		100
3/8 inch		69-91	75-91	
No. 4	47-61	49-65	46-62	60-80
No. 8		33-47		
No. 16	23-33	21-35	22-34	28-42
No. 50	12-22	6-18	11-23	11-23
No. 200	5-9	2-6	5-9	5-9

When aggregate is produced and/or stockpiled in more than one size, the blend of sizes shall be based on results of mix design properties that yield the most ideal results. The blended gradations; however, must stay within the gradation limits given herein.

02511.3 CONSTRUCTION REQUIREMENTS

02511.3.1 BITUMINOUS SURFACE MIXING, PLACEMENT, AND FINISHING

02511.3.1.1 PLANT DESIGN AND EQUIPMENT - Plants shall be specifically designed and manufactured to produce a uniform bituminous mixture. The plant shall be capable of controlling and accurately proportioning both aggregates and asphalt cement. Automatic controls shall be provided to shut down the plant when a supply of aggregate or bituminous material is not available.

The plant shall be equipped with appropriate dust collectors and/or control equipment, which enable operation of the plant to meet local and State environmental and health requirements. Liquids from a wet scrubber, when used, shall not be discharged into live streams, lakes or ponds. Effluent from such equipment shall be collected and deposited according to applicable State and local requirements.

Thermometers shall be installed in the plant to accurately indicate the temperature of the bitumen at the charging value in the mixer unit and at the discharge chute of the mixer unit.

Accurate weight measurement of ingredients is essential. Bituminous mix plants shall have associated weight measurement equipment (scales, etc.) with an incremental accuracy of not more than 10 pounds to weigh materials.

02511.3.1.2 MIXING - The aggregates, bituminous material, additives, mineral filler and water shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula. The bituminous material shall be evenly heated to the specified temperature. A continuous supply of the bituminous material shall be fed to the mixer at a uniform temperature. The temperatures of asphalt cement delivered to the mixer shall be sufficient to achieve a kinematic viscosity of 150 to 300 centistokes.

Aggregate for pugmill mixing shall be heated, dried, and delivered to the mixing unit at a temperature within ±30°F of the temperature of the bitumen, temperature not to exceed 325 degrees F. Moisture content of the aggregate shall not exceed 1 percent at the time it is introduced into the mixing unit. Flames used for drying and heating shall be properly adjusted to avoid damage to, and soot formation on, the aggregate.

After the required amounts of all materials have been introduced into the mixer, the ingredients shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate have been obtained.

02511.3.1.3 HAULING - Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds that have been thinly coated with a material to prevent the mixture from adhering to the beds. Truck beds shall not contain any water or deleterious material prior to loading.

The Contractor, at no cost to the Owner, shall provide scales for weighing the vehicles used for hauling the bituminous mixture. If of the required accuracy, these scales may be the same as those used to weigh ingredients at the mix plant. The Contractor shall provide such scales at no additional cost to the Owner

02511.3.1.4 PLACEMENT - Except for small areas inaccessible to such equipment, hot bituminous mixtures shall be placed with bituminous pavers. Pavers shall be self-contained, power-propelled units, provided with an adjustable activated-screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material in lane widths and thickness' as shown on the Drawings. When shown on the Drawings, pavers shall be equipped with a control system capable of automatically maintaining the proper screed elevation.

Placement of the bituminous mixture shall be continuous. The mixture shall be spread and struck off to the grade and elevation established in the Contract Drawings. Unless otherwise shown on the Drawings, mix shall be placed in lifts which, when compacted, will not exceed 4-inches in thickness.

The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 6-inches, making sure that the joint in the top layer shall be at the center or dividing line of every two-lanes of traveled roadway. Transverse joints in succeeding layers and in adjacent lanes shall be offset at least 10-feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable (along forms, curbs, headers, walls and other places), the mixture shall be placed and finished using hand tools and then thoroughly compacted with hot hand tampers, smoothing irons or mechanical tampers.

Bituminous surface shall not be placed when: weather conditions prevent proper handling, hauling and placing of the mixture; when the base course is frozen; or when the average temperature of

the underlying surface is below 35 degrees F. and air temperature is rising. Placement on water covered surfaces will not be permitted.

02511.3.1.5 COMPACTION - Compaction shall be performed with vibratory or non-vibratory steel-wheel rollers and pneumatic-tire rollers. Initial breakdown rolling shall be accomplished while the mix temperature exceeds 250° F. Rolling shall be completed before the mix temperature drops to 175° F.

Rollers shall begin at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping 6-inches or two times the pavement depth, whichever is greater, gradually progressing to the center. When paving in echelons or abutting a previously placed lane, the longitudinal joint should be rolled first, then followed by the above rolling procedure. On super-elevated curves, the rolling shall begin at the low side and progress to the high side.

Rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back into the previous run to expose the full depth of the course. Heat shall be applied to contact surfaces of transverse joints just before additional mix is placed against them.

02511.3.2 EXCESS BITUMINOUS SURFACE MATERIAL.

Material trimmed from the edges, together with any other discarded bituminous mixture, shall be removed from the roadway and disposed of by the Contractor in an approved area.

02511.3.3 TESTING

02511.3.3.1 CONTRACTOR TESTING - The Contractor shall be responsible for providing the necessary tests for controlling and maintaining the mixture within the limits indicated in the approved job-mix formula. Sampling and testing will be performed on each lot of material as it is placed. Gradation and asphalt content samples will be taken immediately behind the paver at the following rate:

LOT TESTING

Lot Size –Sq.Yds.	Minimum Number of Samples
1500 and greater	4
Less than 1500	3

Density and thickness samples will be taken at a rate of one sample per each lot of up to 1500 square yards. When lot size exceeds 1500 square yards, two samples will be taken.

Checks for smoothness will be made at locations selected by the Engineer for each lot. Smoothness checks will not be required where design transitions will not allow compliance with the criteria.

Acceptance of bituminous material placed shall be made by comparing test results with the job-mix formula and the dimensions provided in these Specifications. Acceptance of each lot will be given when test results are within the following tolerances:

BITUMINOUS TEST

Test	Maximum Deviation
Asphalt Content	Mean of tests on each lot is less than 1%
Gradation	Mean of tests for any sieve size is less than 10%
Density	Any test is 92% or greater
Thickness	Any test is less than 0.5-inches

Smoothness	0.25-inches in 10-feet longitudinally or transversely

Any corrective measures necessary to bring the bituminous surface into compliance must be made while the surface temperature is still greater than 175° F.

See Subsection 02511.5.2 – PRICE ADJUSTMENTS, below.

02511.3.3.2 ENGINEER TESTING – At his own discretion, the Engineer also may spot-check the bituminous mix for acceptability and for determination of compliance with installation requirements. These spot-checks will not be used for acceptance but for guidance. On request, the results will be made available to the Contractor by the Engineer.

02511.4 METHOD OF MEASUREMENT

02511.4.1 NO SEPARATE MEASUREMENT

No separate measurement shall be made for furnishing and installing bituminous surface when it is an integral component of a structure or facility shown as another line item in the Bid Schedule.

02511.4.2 SEPARATE MEASUREMENT

When bituminous surface is shown as a separate pay item in the Bid Schedule, measurement shall be made by counting and adding together each square yard of surface in place and accepted. This measurement shall include furnishing all necessary materials and equipment, labor, weighing, mixing, hauling, placement, compaction, and testing to produce an acceptable bituminous surface.

02511.5 BASIS OF PAYMENT

02511.5.1 ACCEPTED QUANTITIES

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
(Depth) Hot Plant Mix Bituminous Surfacing	Square Yards

02511.5.2 PRICE ADJUSTMENTS

02511.5.2.1 DEVIATIONS FROM CRITERIA - For deviations from criteria provided by the approved job-mix formula and in these Specifications and Drawings, the unit price shown in the Bid Schedule will be adjusted by application of the pay factor shown in the tables below:

TABLE A - THICKNESS DEFICIENCY

Pay Factor	Average Core Thickness Deficiency (In Inches)
100	0.00 - 0.25
90	0.26 - 0.50
80	0.51 - 0.75
50	0.76 - 1.00
Remove and Replace	More than 1.00

TABLE B - NON-COMPLYING COMPACTION TESTS

Test Method	Pay Factor	Percent Of Bulk Density Target	
		Mean of all Tests	Lowest of all Tests
ASTM D 3203 (Rice Method)	1.00	95 to 100	90 or greater
	0.90	95 to 100	Less than 90
	0.80	92 to 95	90 or greater
	0.50	Less than 92	90 or greater

TABLE C - NON-COMPLYING BITUMEN CONTENT AND AGGREGATE GRADATION

Criteria	Pay Factor	Mean Deviation Of Number Of Tests In Test Lot															
		1 Test		2 Tests		3 Tests		4 Tests		5 or more Tests							
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max						
Bitumen Content	1.00	0.0	0.7	0.0	0.54	0.0	0.46	0.0	0.41	0.0	0.38						
	0.975	0.0	0.8	0.55	0.61	0.47	0.52	0.42	0.46	0.39	0.43						
	0.95	0.0	0.9	0.62	0.68	0.53	0.58	0.47	0.52	0.44	0.47						
	0.90	0.0	1.8	0.69	0.75	0.59	0.64	0.52	0.56	0.48	0.52						
	0.85	0.0	1.1	0.76	0.82	0.65	0.69	0.57	0.61	0.53	0.56						
½” and larger Sieve	1.00	0.0	10.0	0.0	7.3	0.0	6.3	0.0	5.6	0.0	5.2						
	0.975	11.0	12.0	7.4	8.3	6.4	7.1	5.7	6.3	5.3	5.8						
	0.95	13.0		8.4	9.3	7.2	7.9	6.4	7.0	5.9	6.4						
	0.90	14.0		9.4	10.3	8.0	8.7	7.1	7.7	6.5	7.1						
	0.85	15.0		10.4	11.3	8.8	9.5	7.8	8.4	7.2	7.7						
3/8” Sieve	1.00	0.0	9.0	0.0	6.9	0.0	5.9	0.0	5.3	0.0	4.9						
	0.975	10.0		7.0	7.8	6.0	6.6	5.4	5.9	5.0	5.5						
	0.95	11.0		7.9	8.7	6.7	7.3	6.0	6.6	5.6	6.1						
	0.90	12.0	13.0	8.8	9.6	7.4	8.0	6.7	7.2	6.2	6.6						
	0.85	14.0		9.7	10.5	8.1	8.9	7.3	7.9	6.7	7.2						
No. 4 Sieve	1.00	0.0	9.0	0.0	6.7	0.0	5.7	0.0	5.2	0.0	4.8						
	0.975	10.0		6.8	7.6	5.8	6.3	5.3	5.8	4.9	5.4						
	0.95	11.0		7.7	8.5	6.4	6.9	5.9	6.4	5.5	5.9						
	0.90	12.0	13.0	8.6	9.4	7.0	7.5	6.5	7.0	6.0	6.5						
	0.85	14.0		9.5	10.2	7.6	8.0	7.1	7.6	6.6	7.0						
No. 8 Sieve	1.00	0.0	7.0	0.0	5.6	0.0	4.8	0.0	4.3	0.0	4.0						
	0.975	8.0		5.7	6.3	4.9	5.4	4.4	4.8	4.1	4.5						
	0.95	9.0		6.4	7.0	5.5	6.0	4.9	5.3	4.6	4.9						
	0.90	10.0		7.1	7.7	6.1	6.6	5.4	5.8	5.0	5.4						
	0.85	11.0	12.0	7.8	8.5	6.7	7.2	5.9	6.4	5.5	5.8						
No. 16 Sieve	1.00	0.0	7.0	0.0	5.2	0.0	4.6	0.0	4.2	0.0	3.9						
	0.975	8.0		5.3	5.8	4.7	5.1	4.3	4.6	4.0	4.3						
	0.95	9.0		5.9	6.4	5.2	5.6	4.7	5.1	4.4	4.7						
	0.90	10.0		6.5	7.0	5.7	6.1	5.2	5.5	4.8	5.1						
	0.85	11.0	12.0	7.1	7.6	6.2	6.6	5.6	5.9	5.2	5.4						
No. 50 Sieve	1.00	0.0	6.0	0.0	4.3	0.0	3.8	0.0	3.4	0.0	3.2						
	0.975	7.0		4.4	4.8	3.9	4.1	3.5	3.8	3.3	3.5						
	0.95	8.0		4.9	5.3	4.2	4.5	3.9	4.1	3.6	3.8						
	0.90	9.0		5.4	5.8	4.6	4.9	4.2	4.4	3.9	4.1						
	0.85	10.0		5.9	6.4	5.0	5.5	4.5	4.9	4.2	4.5						

02511.5.2.2 REMOVAL OF MIX - The Engineer may order the removal of the mix if the mean result of the lot acceptance tests deviate from the job-mix formula for a particular sieve or sieves, or if the asphalt content is more than the values shown under the 0.85 pay factor in Table C. Where material not meeting this criteria is allowed to remain, a pay factor of 0.50 will be applied.

When the tested density percentage pay factor in Table B is multiplied by the pay factor shown in Table C, and the product is less than 0.80, the Engineer may order removal of the mix. Where material not meeting this criteria is allowed to remain, a pay factor of 0.50 will be applied.

02511.5.2.3 ADDITIONAL MIX - When a lot shows a deficient thickness of more than 0.5-inches, the Engineer may order additional material to be placed and additional payment for the material required will be allowed. When excess thickness is determined, the Engineer may allow it to remain in place; however, only 50 percent of the mix in excess of the 0.5-inch tolerance will be paid for.

02511.5.2.4 OPTIMAL ASPHALT CONTENT PERCENTAGE - Optimal asphalt content percentage will be determined from the job-mix formula provided by the Contractor unless the bituminous mixture is obtained from an established commercial asphalt plant. In such case, the optimum percentage may be determined from previous mixes which meet the criteria provided in these Specifications.

02520.1 DESCRIPTION

This section covers cutting through designated sections of bituminous and/or concrete pavement surface with approved equipment in preparation for pavement removal.

02520.1.1 RELATED WORK

Section 02200 - Trench Excavation and Backfill
Section 02208 - Flowable Backfill (required during winter months)
Section 02500 - Removal and Replacement of Surface Improvements

02520.1.2 SUBMITTALS

Not used.

02520.1.3 DEFINITIONS

Not used.

02520.2 MATERIALS

Not used

02520.3 CONSTRUCTION REQUIREMENTS

02520.3.1 SAW CUTTING

02520.3.1.1 NEATNESS IN CUTTING - Pavement cuts shall be made with a saw to produce straight vertical cuts through the full depth of the surfacing layer. The Contractor is responsible to preserve and maintain a neat clean edge on the cut pavement to facilitate pavement repair or replacement under Section 02500.

02520.3.1.2 CUT MATERIALS TO BE LEFT IN PLACE - Cut pavement materials shall be left in place. Removal of cut pavement will be included as part of other work items in this Contract.

02520.3.1.3 BROKEN PAVEMENT - When pavement has deteriorated or is severely cracked and broken, the Contractor shall discontinue cutting operations and obtain direction from the Engineer as to how cutting should proceed.

If pavement is broken after sawcutting and prior to replacement, the Contractor shall re-cut the pavement. Such re-cutting shall not be measured for payment.

02520.3.2 WHEEL CUTTING

With advanced written approval of the Engineer, wheel cutting may be substituted for saw cutting of bituminous pavement surface. Wheel cutting operations shall be subject to the same requirements as those for saw cutting pavement above.

02520.3.3 ROTOMILLING

Rotomilling of existing pavement is an acceptable alternative to saw cutting, providing that the resulting pavement edges are left clean and neat. Rotomilled material may be suitable for trench backfilling or as a substitute for road base. For such use, rotomilled material must meet the following conditions: that: no chunks or pieces larger than one inch in any dimension are used,

that it is placed in separate lifts from untreated base course, that it is compacted to 95% of its maximum density, and that it is acceptable to the Engineer and to the Owner.

02520.4 METHOD OF MEASUREMENT

Measurement for pavement cutting shall be made using a tape measure or other accurate measuring device to determine the number of lineal feet of pavement cut. This length shall be multiplied by the actual depth of the cut pavement layer, measured in inches, to give the number of inch feet of cut.

An alternative method of measurement is for the Engineer to determine that all pavement cutting shall be paid for by the measured lineal feet without regard to depth.

02520.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Pavement Sawing	Inch/Foot
Pavement Sawing	Lineal Feet

DIVISION 3

CONCRETE

SUNRISE
ENGINEERING

03050.1 DESCRIPTION

This section contains requirements for Portland cement concrete materials and concrete mix designs.

03050.1.1 RELATED MATERIALS AND WORK

Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 03300 - Concrete Structures and Slabwork
Section 03500 - Pre-Cast Concrete Components
Section 03600 - Grout and Mortar

03050.1.2 SUBMITTALS

03050.1.2.1 PROPOSED MIX DESIGN - Each proposed mix design shall be submitted at least 14 days prior to its use in the Work. Indicate whether mix has been designed for pumping. Mix design submittals shall include the following information:

- Water-cement ratio.
- Proportion of materials in the mix.
- Source and type of cement.
- Analysis of water to be used, unless potable.
- Type and name of admixtures applied. Indicate when accelerating or retarding admixtures are to be used and the resulting change in placement times.
- Slump, air content, and temperature of samples.
- Unit weights of fresh and dry light weight concrete.
- Any applicable and verifiable test documentation available if the submitted mix design has been used by the Contractor in prior projects.

03050.1.2.2 AGGREGATE TEST REPORT - Aggregate Test Report (submit for each aggregate source):

- Data of test analysis.
- Sieve analysis.
- Organic impurities.
- Sodium sulfate soundness test.
- Reactivity of aggregate.
- Complete identification of source of aggregate.

03050.1.2.3 CHANGES IN MIX DESIGN - After the design of the mix or mixes has been approved by the Engineer, neither the source, character, or grading of the aggregate, nor the brand or type of cement shall be changed, without 48 hours written notice to the Engineer. Should such changes become necessary, no concrete containing such new or altered materials shall be placed until the revised mix design has been submitted to the Engineer for review and approval.

03050.1.3 DEFINITIONS

Workability - The ease of placing, consolidating and finishing freshly mixed concrete.

Consolidation - Hand rodding or mechanically vibrating actions which give freshly mixed concrete the characteristics of a thick fluid so as to minimize voids when set.

Hydration - The chemical reaction between water and calcined limestone resulting in the excellent bonding properties of the cement particles with one another and with the aggregates in the mix.

Curing – Synonymous with the hydration reaction. May be enhanced by procedures which assure the retention of sufficient moisture to allow the reaction to go as far to completion as possible.

Strength - The maximum resistance of a mortar or concrete specimen to axial compressive loading expressed in psi.

Admixtures - Chemical additives to concrete mixes intended to adjust setting time, reduce water demands, increase workability and entrain air.

Air Entrainment - Introduction of chemicals to concrete mixtures which produce microscopic air bubbles which improve the workability and ability to resist deterioration due to freezing.

Reinforcement - Materials formed or mixed in concrete mixtures, to increase the ability of the concrete to withstand loading when set (hardened).

Water-Cement Ratio - The weight of the water divided by the weight of the cement in a concrete mixture.

Tempering - The addition of water to mixed concrete after arrival on site.

03050.2 MATERIALS

03050.2.1 CEMENT

03050.2.1.1 SITE-PLACED CONCRETE - For site-placed concrete, cement shall be Type II (low alkali) cement, meeting requirements of ASTM C-150, unless otherwise directed by the Engineer or these Specifications. Do not use cement containing lumps, or cement which has partially set. Do not mix cements originating from different sources or manufacturers.

03050.2.1.2 PRE-CAST CONCRETE - For pre-cast concrete, cement shall be Class 5000 (minimum) in accordance with ACI 318 for units to be installed above ground. For units installed below ground, concrete shall be Class 4000 in accordance with ASTM C 478 and ASTM C 858.

03050.2.2 WATER

Shall be potable or water which meets the requirements of AASHTO T-26.

03050.2.3 REINFORCEMENT

Shall be in accordance with Section 03200 of these Specifications.

03050.2.4 ADMIXTURES

03050.2.4.1 AIR ENTRAINMENT - Air entrainment of concrete shall meet the requirements of AASHTO M-154 (ASTM C-260).

03050.2.4.2 PLASTICIZERS - Water reducing agents (plasticizers) and set retarding agents shall meet the requirements of AASHTO M-194 (ASTM C-494). Only types A or F will be approved as water reducing agents and only types D or G will be approved as set retarding agents. Water reducing agents and set retarding agents shall be pre-measured and added in strict accordance with manufacturer's instructions. Calcium chloride will not be approved.

03050.2.4.3 FLY ASH - Pozzolan (fly ash) may be used to replace a percentage of cement in the mix design in accordance with ASTM C-618, under the following conditions:

- The minimum required cement content shall be expressed in the design formula before replacement calculations are made.
- The amount of Portland cement replaced by pozzolan shall not exceed 15% for exterior concrete (concrete exposed to weather) and 20% for interior concrete.
- The ratio of replacement by weight of pozzolan to cement shall be 1.25 to 1.0.
- Loss of ignition of pozzolan shall be less than 3 percent, and the water requirement shall not exceed 100 percent.
- All other requirements of this Section still apply.
- Mix designs including trial batches are required for each aggregate source and for each concrete class.
- See also Subsection 03050.2.6.4 below.

03050.2.5 AGGREGATE

03050.2.5.1 AGGREGATE RATIO - The combined weight of coarse and fine aggregate material passing the No. 200 sieve shall not exceed 1.75 percent of the total weight of aggregate. The ratio of coarse to fine aggregate shall not be less than one (1) nor more than two (2), nor shall the amount of coarse aggregate be great enough to cause difficulty in concrete placement or honeycombing in the structure.

03050.2.5.2 COARSE AGGREGATE - Coarse aggregate shall comply with AASHTO M-80, using gradations from the following table:

COARSE AGGREGATE GRADATIONS

	Percent Passing (by weight)							
	Sieve Size							
Aggregate Size	2½”	2”	1½”	1”	3/4”	½”	3/8”	No. 4
2” to No. 4	100	95-100		35-70		10-30		0-5
1½” to No. 4		100	95-100		35-70		10-30	0-5
1” to No. 4			100	95-100		25-60		0-10
3/4” to No. 4				100	90-100		20-55	0-10

Maximum coarse aggregate gradation shall not be larger than 1/5 of the narrowest dimension between sides of forms; shall not be larger than 1/3 the depth of slabs; shall not be larger than 3/4 of the minimum clear distance between reinforcing bars or between bars and forms, whichever is less; and shall not be larger than 2 inches.

The maximum percentage by weight of deleterious substances allowed in coarse aggregate materials shall be:

DELETERIOUS SUBSTANCES ALLOWED IN COARSE AGGREGATE

Substance	Percent
Soft fragments	2.0
Coal and lignite	0.3
Clay lumps	0.3
Other deleterious substances	2.0

03050.2.5.3 FINE AGGREGATE - Fine aggregate shall comply with AASHTO M-6 using gradations from the following table:

FINE AGGREGATE GRADATIONS

Sieve Size	Percent Passing (by weight)
3/8-inch	100
No. 4	95 to 100
No. 16	45 to 80
No. 50	10 to 30
No. 100	2 to 10

The maximum percentage by weight of deleterious substances allowed in fine aggregate shall be:

DELETERIOUS SUBSTANCES ALLOWED IN FINE AGGREGATE

Substance	Percent
Coal and lignite	0.3
Clay lumps	0.5
Other deleterious substances	2.0

03050.2.5.4 AGGREGATE SOUNDNESS AND REACTIVITY - As determined in accordance with ASTM C-88, potentially deleterious aggregates shall not be used unless service records have shown the aggregates to be innocuous, and the Engineer subsequently approves them in writing.

03050.2.6 MIXING REQUIREMENTS

03050.2.6.1 CONCRETE CLASSIFICATIONS - Mixing requirements for the specific concrete classes indicated on the Drawings and/or within these Specifications shall be as follows:

CONCRETE CLASSIFICATIONS

Concrete Properties	Concrete Classifications		
	5000	3500	2000
Coarse Aggregates (see requirements shown below)			
Maximum Water/Cement Ratio (gal/sack)	5.0	6.5	8.0
Minimum Cement Content (sacks/CY)	***	6.0	4.5
Slump (inches)**	2 to 4	2 to 4	2 to 5
Air Content (percent)	5.0 to 7.5	5.0 to 7.0	3.0 to 5.0
Required Average 28 Day Compression Strength Test (psi)****	5200	3700	2200
Required Minimum 28 Day Compression Strength Test (psi)****	4800	3300	1800

Notes:
- * All concrete installed shall be Class 3500 unless otherwise required in the Contract Documents.
- ** When water reducing agents are not used.
- *** Cement content shall be appropriate to produce a mixture meeting the requirements for water/cement ratio and workability for the specific job conditions.
- **** One compressive strength test shall consist of the average strength of two cylinders in the test sample.

03050.2.6.2 REQUIRED AVERAGE DAY COMPRESSIVE STRENGTH - The Contractor shall furnish and install concrete that will produce a Required Average (28) Day Compressive Strength as shown on the table above. The average of any three consecutive (28) day strength tests shall not fall below the required Minimum (28) Day Compressive Strength Test shown. If the average of any three consecutive tests falls below the Required Minimum, the average strength of the concrete shall be increased at the contractor's expense by increasing the cement content.

03050.2.6.3 WATER REDUCING AGENTS - When water reducing agents (plasticizers) are used in the concrete mixtures shown above, maximum slump requirements may be increased to 5 inches with low range water reducers and to 8 inches with high-range water reducers.

03050.2.6.4 FLY ASH - When fly ash is used in the mix, the cement in the water/cement ratio denotes the cement and fly ash combined. Cement shall be introduced into the batcher before the fly ash.

03050.2.6.5 CONCRETE PLACED IN WATER - For concrete deposited in water, add one additional bag of cement per cubic yard more than the design requires for concrete placed above water.

03050.3 CONSTRUCTION REQUIREMENTS

03050.3.1 STORING CEMENT

Bagged and bulk cement shall be stored in weatherproof enclosures to exclude moisture and contaminants.

03050.3.2 STOCKPILING AND HANDLING AGGREGATE

03050.3.2.1 CLEAN SITE - The site provided for stockpiling aggregates shall be clean with adequate space to provide separate stockpiles for coarse and fine aggregates.

03050.3.2.2 WASHING AGGREGATE - Washed aggregates shall be allowed to drain to a uniform moisture content, and stockpiles shall be built at least 48 hours before use.

03050.3.2.3 HEIGHT - Aggregate shall not be dropped more than 10 feet from the conveyor, nor shall cone shaped piles more than 10 feet high be built.

03050.3.2.4 STOCKPILE LAYERING - Stockpiles shall be built in thin layers (5 feet maximum) in such manner, to prevent spillage of aggregate over the sides of the stockpile.

03050.3.2.5 FROZEN MATERIALS - Stockpiles containing snow, ice, or frozen materials shall not be used.

03050.3.3 BATCHING MATERIALS

03050.3.3.1 SCALES - The Contractor shall provide scales or arrange for usage of scales that have been certified by State agencies within the past 12 months.

03050.3.3.2 BATCH MIXERS - Batch mixers shall be operated at the manufacturer's recommended drum speed. Drums and blades shall be kept free from excessive cement and mortar build up. Cement shall be introduced into the batcher before fly ash, and all admixtures shall be introduced to the mixer separately.

03050.3.3.3 CENTRAL MIXING PLANT - At central mix plants, all materials shall be mixed for at least 80 seconds at recommended drum speed. When more water is added to the cement mixture, the materials shall be mixed for an additional 30 seconds.

03050.3.3.4 MIXING PERIOD - The mixing period for truck mixers shall be maintained between 70 and 100 revolutions at mixing speed. Maintain a minimum of 90 revolutions for front end discharge trucks. Concrete mixing shall be completed before the truck leaves the batch plant yard.

03050.3.3.5 WATER REDUCING AGENTS - If water reducing agents are added at the site, they shall be added using injection equipment capable of rapidly and uniformly distributing the admixture. Prior to discharge, the concrete shall be mixed for a minimum of 5 minutes at a drum rate not less than 12 rpm or more than 15 rpm discharge.

03050.3.4 HEATING AGGREGATE AND WATER

03050.3.4.1 HEATING EQUIPMENT - When approved by the Engineer, the Contractor, at its own expense, may provide and operate heating equipment to heat aggregate and water because of cold weather conditions. All heating operations shall meet temperature limitations provided in these Specifications and shall conform to Standard ACI 306. The Contractor shall ensure that excessive heat does not cause "flash set" when the cement is added.

03050.3.4.2 UNIFORM HEATING - Aggregates shall be heated uniformly with steam or dry heat. Water shall be heated to between 70°F and 150°F when introduced into the mixer. Measures shall be taken to prevent overheating and hot spot development. No combustion products (ash, smoke, gas and etc.) shall contact the aggregate.

03050.3.5 COOLING CONCRETE MIXTURE

03050.3.5.1 COOLING EQUIPMENT - When approved by the Engineer, the Contractor, at its own expense, may provide and operate equipment to refrigerate water, provide ice or cool aggregate, to mix concrete due to hot weather conditions. All methods of cooling shall meet the requirements of ACI 305.

03050.3.5.2 USE OF ICE - When ice is introduced into the mixer, it shall be in such form as to be completely melted and dispersed throughout the mix at the completion of the mixing time. The mixing time shall be held to the minimum practicable, consistent with producing concrete meeting the specified requirements.

03050.3.6 CONCRETE TRANSPORT

03050.3.6.1 TRUCKS - Concrete mixtures shall be transported only in conventional transit mixers or agitator trucks with rating plates that are readable. Trucks shall be equipped with visible water meters and revolution counters and shall be capable of measuring all water introduced into the mixing drum.

03050.3.6.2 LOADING - Trucks shall not be loaded:

- In excess of their rated mixing capacity, or
- In excess of 63 percent of the drum gross volume, or
- In quantities less than 2 cubic yards

03050.3.7 CONCRETE TEMPERING

03050.3.7.1 ADDING WATER – Concrete may be tempered through the addition of water under the following conditions:

- Water shall be added within specified time limits. At no time shall water be added after testing has taken place.
- Wherever possible, water shall be added after the truck leaves the batch plant.
- Water shall not be added in excess of the water/cement ratio or in excess of that specified on the batch tickets.
- The mixing drum shall be rotated at least 30 revolutions at the manufacturer's recommended mixing speed when water is added, OR, addition of water for tempering shall be followed by 3 minutes of mixing at mixing speed prior to discharge.
- Water shall not be added after 1/2 cubic yard or more of concrete has been discharged from the drum.

03050.3.7.2 LOW SLUMP - When concrete arrives at the site with a slump below specification, the Contractor may temper the mix up to the maximum approved water/cement ratio, provided:

- The mix design allows for on-site water addition;
- The amount of water added is accurately measured to the nearest gallon;
- The maximum slump is not exceeded; and
- The person adding water is approved to do so by the Engineer and the concrete supplier.

03050.3.7.3 TEMPERING WITH PLASTICIZER - Do not deliver concrete containing plasticizer to the site unless the batch delivery ticket displays water/cement ratio prior to plasticizer addition. Tempering with plasticizer after delivery time window expiration shall not be allowed.

03050.3.8 CONCRETE PLACEMENT

Shall be in accordance with Section 03300.

03050.3.9 CONCRETE SAMPLING AND TESTING

03050.3.9.1 PROCEDURE - Tests for slump, air entrainment, strength and temperature by an independent certified testing facility shall be provided by the Contractor. Independent test facility can be changed by Engineer at any time. Sampling and testing will be performed at the expense of the Contractor and as directed by the Engineer.

03050.3.9.2 SAMPLING FREQUENCY - Concrete sampling frequency shall be as noted below:

- A minimum of one air test (ASTM C-231) and one slump test (ASTM C 143) shall be performed for each placement over 5 cubic yards. At least one air and one slump test shall be performed for each additional load of concrete placed.

- For each test, the concrete temperature and the time shall be verified and recorded. Air and slump test results shall be recorded on batch delivery tickets.

- If an air test fails, immediately retest the same load. The concrete shall be rejected if the second air test fails to meet specified requirements. If the second air test meets specified requirements, a third test will be performed to establish concrete acceptance or rejection.

- If the slump for an individual load cannot be corrected by tempering within the mix design requirements and within the requirements of these Specifications, the load shall be rejected.

- The testing facility shall prepare test cylinders for strength testing in accordance with ASTM C-31 & ASTM C-39.

- At least one strength test shall be performed for each placement over 5 cu. yd., and one additional test for every 50 cu. yards of concrete placed or more frequently at the Engineer's discretion. Three cylinders shall be prepared for each test. One cylinder from each test may be set aside at the Contractor's request for strength verification prior to form removal. The average compressive strength of two cylinders constitutes one compressive strength test.

- The Contractor shall provide space in the work area and protect sample cylinders from disturbance for 24 hours after they are cast or until they are moved from the work area by testing laboratory personnel or under the direction of the Engineer.

- The average compressive strength shall meet the requirements shown in the table in Section 03050.3.1 for the class of concrete placed.

03050.4 METHOD OF MEASUREMENT

Measurement for concrete placed in accordance with these Specifications shall be as described in Section 03300.

03050.5 BASIS OF PAYMENT

Acceptable quantities of concrete, when measured separately, shall be paid for at the contract unit prices described in Section 03300.

03050.2.6 MIXING REQUIREMENTS

The following shall be added to the concrete classifications table in section 03050.2.6.1-CONCRETE CLASSIFICATIONS

CONCRETE CLASSIFICATIONS

Concrete Properties	Concrete Classifications
	4000
Coarse Aggregates (see requirements shown below)	
Maximum Water/Cement Ratio (gal/sack)	5.5
Minimum Cement Content (sacks/CY)	***
Slump (inches)**	2 to 4
Air Content (percent)	5.0 to 7.5
Required Average 28 Day Compression Strength Test (psi)****	4200
Required Minimum 28 Day Compression Strength Test (psi)****	3800

03100.1 DESCRIPTION

Includes furnishing materials, accessories and labor required to form, finish and cure interior and exterior cast-in-place concrete.

03100.1.1 RELATED WORK

Section 03050 - Portland Cement Concrete
Section 03200 - Concrete Reinforcement
Section 03300 - Concrete Structures and Slabwork
Section 03500 - Precast Concrete Components
Section 03600 - Grout and Mortar

03100.1.2 SUBMITTALS

03100.1.2.1 SHOP DRAWINGS - When called for in these Specifications, the Contractor shall furnish shop drawings of forms for specific concrete items. Such drawings shall show general construction of forms, jointing, location of ties and other items affecting visibility.

03100.1.2.2 FORM RELEASE AGENT - Where concrete surfaces are scheduled to receive special finishes or applied coverings, which may be affected by the form release agent, submit manufacturer's instruction for use of agent.

03100.1.2.3 CHEMICAL HARDENER - Submit name, type, chemical analysis and manufacturer's recommended rate of application for chemical hardener, when specified.

03100.1.2.4 CURING COMPOUNDS - Submit manufacturer's specifications, test information, ingredients, certification, and installation recommendations for curing compounds. This information may become the basis of acceptance or rejection of the work cured by the material used. See also the submittal requirement under Membrane Curing Compounds in 03100.3.6.2 herein

03100.1.3 DEFINITIONS

Shoring - The framework installed to support formwork.

Re-Shoring - Framework installed or not removed which serves as support for form-work after concrete sets and there is less need for the support.

Form Coatings - Compound coated on forms, preventing concrete surface bonding to the forms.

Curing Compound - Liquid medium sprayed or coated on concrete to retain moisture.

03100.2 MATERIALS

03100.2.1 FORM TIES AND SPREADERS

Shall be removable or snap-off metal, designed to prevent form deflection and to prevent spalling concrete surfaces upon removal. Form ties shall be factory fabricated. Field fabricated ties will not be acceptable. The portion of the tie remaining within concrete after removal of exterior parts should be 1 inch below the outer concrete surface, and the remaining hole in the concrete surface shall not be larger than 1 inch diameter, unless approved otherwise by the Engineer.

03100.2.2 JOINT FILLER

Shall be furnished and installed in accordance with Section 03310 herein.

03100.2.3 FORM RELEASE AGENTS

Commercial formulation form release agent compounds shall be used. Form release agents shall not bond with, stain or adversely affect concrete surfaces requiring later bond or adhesion. They shall not impede the wetting of surfaces to be cured with water or curing compounds. Surplus oil on forms and form oil on reinforcing steel and construction joints shall be removed before concrete is placed.

03100.2.4 FILLETS FOR CHAMFERED CORNERS

Shall be wood strips 3/4 inch by 3/4-inch size and of maximum possible length.

03100.2.5 MORTAR AND GROUT

Shall be furnished in accordance with Section 03600 herein.

03100.2.6 LIQUID CHEMICAL HARDENER

Shall be a colorless aqueous solution, containing a blend of magnesium fluosilicate, zinc fluosilicate and a wetting agent. The mixture shall contain not less than 2 pounds fluosilicate per gallon and shall not interfere with adhesives and the bonding of finishes where such is indicated.

03100.2.7 WATER

Water for curing shall meet the requirements of Section 03050 herein.

03100.2.8 MOISTURE RETAINING SHEETING

Shall be white, waterproof paper, polyethylene film or burlap-polyethylene sheet which meets the requirements of ASTM C-171.

03100.2.9 MOISTURE ABSORPTIVE COVER MAT

Shall be clean cotton or burlap fabric roll goods.

03100.2.10 CURING COMPOUND

Shall be a clear type with fugitive dye conforming to ASTM C-309, Type 1, unless otherwise approved by the Engineer. **CAUTION!!** The method of application of curing compound specified herein requires more product than is normally suggested by the manufacturer and that is customary in the trade. The amounts specified herein shall be applied, regardless of manufacturer's recommendation or customary practice.

03100.3 CONSTRUCTION REQUIREMENTS

03100.3.1 SITE CONDITIONS

The Contractor shall examine the condition of the area on which forms are to be installed and conditions under which the work of this Section is to be performed, and shall correct

unsatisfactory conditions which would prevent proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

03100.3.2 DESIGN OF FORM-WORK

03100.3.2.1 LOADING - Form-work shall be designed to safely support all vertical and lateral loads that may be induced by wet concrete both during the placement and afterward, until such loads can be supported by the structure itself as the concrete sets and begins to cure. Forms and falsework shall be designed to include assumed values of live load, dead load, weight of moving equipment to be operated on form-work, concrete mix, height of concrete drop, vibrator frequency, ambient temperatures, foundation pressures, stresses, lateral stability and other factors pertinent to the safety of the structure during construction.

In form-work design, provide for all openings, offsets, keyways, recesses, moldings, reglets, chamfers, blocking, screed, bulkheads, anchorage, inserts and other features as required on the Drawings.

03100.3.2.2 TOLERANCES – Form-work design shall call out material and components of sufficient strength, thickness, number of ties, amount of bracing, etc., to withstand the pressure of newly placed concrete without bow or deflection.

03100.3.3 FORM-WORK CONSTRUCTION

03100.3.3.1 COMPLIANCE – Form-work shall be constructed in compliance with ACI 347, to the exact sizes, shapes, lines and dimensions shown, and as required to obtain accurate alignment, location, grade, and level and plumb work in finished structures.

03100.3.3.2 MATERIALS – Form-work shall be constructed from steel, steel reinforced panels, smooth grade plywood, or other materials which may be approved by the Engineer or shown on the Contract Documents for special purposes. Plywood material with raised grain, patches, or other defects that will mar the finished surface of the concrete surface shall not be used.

03100.3.3.3 ERECTION - Form facing materials shall be erected, supported, braced and maintained by structural members spaced to prevent deflection. Form-work shall be tight, to prevent leakage of cement paste during concrete placement. Joints shall be solidly butted together and backed up as required to prevent leakage and fins. Forms placed in successive units for continuous surfaces shall be fitted to provide accurate alignment, free from irregularities, and within allowable tolerances. Use selected materials to obtain required finishes.

Provide for all openings, offsets, keyways, recesses, moldings, reglets, chamfers, blocking, screed, bulkheads, anchorage, inserts and other features required. Accurately place and securely support items to be built into forms. Provide formed openings for elements to be embedded in or pass through the concrete. Install accessories in accordance with manufacturer's instructions and ensure items are not disturbed during concrete placement. 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.

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. Bevel wood inserts for forming keyways, reglets, recesses and the like, to prevent swelling and assure ease of removal

Form-work shall accommodate the work of all other trades where materials and products must be purchased and fabricated before the opportunity exists to verify the measurements of the adjacent

construction affecting their installations. Verify size and location of all openings, recesses and chases with the trade requiring such items, and ensure that forms for openings and construction which accommodate installation by other trades, be accurately sized and located as dimensioned on the Drawings.

03100.3.3.4 FORM RELEASE AGENT - Coat form/concrete 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.

03100.3.3.5 CLEANING - Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris just before concrete is placed.

03100.3.3.6 TOLERANCES – The Engineer recognizes that, given the realities of the physical world, there are times when formwork for concrete cannot be constructed closely enough to yield zero tolerances in the finished work. Therefore, the following tolerances are allowed but shall not be exceeded:

- In general, deviation in alignment of slabs and walls shall not exceed ¼ inch in the horizontal or vertical dimensions of a pour. All slabs which are indicated to be level shall have a maximum deviation of 1/8 inch in 10 feet without any apparent change in grade.

- The maximum tolerance from true level and plumb throughout the entire length and/or height of a structure shall be +/- ¼ inch and without any abrupt changes from one part of the pour to another.

- Form-work construction for circular structures shall be allowed a maximum deviation in the arc of ¼ inch in each 10 feet of radius; therefor, as an example, a tank with a 50 foot radius shall be allowed a maximum deviation of 1-1/4 inch from the center of the tank to the arc of the wall. In circular construction, the Contractor also is allowed to deviate from the finish line shown on the Drawings through the use of form panels, which will give chord lengths not to exceed 2 feet.

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.

03100.3.4 REMOVAL OF FORMS

03100.3.4.1 CONSIDERATIONS ASSOCIATED WITH FORM REMOVAL - Forms shall be removed in a manner to insure complete safety of the structure. Forms shall not be removed until concrete has sufficient strength to carry its own weight and the loads upon it with safety. Do not pry against face of concrete; use only wooden wedges.

03100.3.4.2 MINIMUM ELAPSED TIME - Forms shall not be removed sooner than the minimum elapsed times given in the following schedule unless allowed otherwise in the Contract Documents or as directed by the Engineer.

When directed by the Engineer, because of weather conditions or for other reasons, the forms shall remain in place for longer periods than stated below. The periods of time for form removal set forth below are minimums with no allowances for external loading. The periods of time set forth below are permissive only and do not relieve the Contractor from responsibility for risks associated with form removal.

MINIMUM ELAPSED TIME

Structural Component	Over 50°F	Between 40° and 50°F
Walls and perimeter forms at slab on grade panels	2 days	3 days
Underside of slabs	10 days	14 days
Side forms of beams	2 days	3 days
Underside of beams	10 days	14 days
Stairways	10 days	14 days

The time periods shown above are based on concrete materials being mixed and placed in accordance with these Specifications. When high early strength inducing admixtures are used in concrete, the Engineer may permit form removal after shorter times than those shown in the table. Form removal time also may be reduced if test cylinders of concrete, field cured along with the concrete they represent, have reached the strength specified in Paragraph 03050.3.1 of Section 03050 – Portland Cement Concrete.

03100.3.4.3 RE-SHORING - Where no re-shoring is planned, leave forms and shoring used to support weight of concrete in beams, slabs and other concrete members in place until concrete has attained its specified strength. Where re-shoring is planned, supporting form-work may be removed when concrete has reached 70 percent of specified strength, provided re-shoring is installed immediately.

Place re-shores as soon as practical after stripping operations are complete, but in no case later than the end of the working day on which stripping occurs. During re-shoring, do not subject concrete in beam, slab, column or any other structural member to combined dead, construction, and live loads in excess of loads permitted for developed concrete strength at time of re-shoring. Tighten re-shores to carry required loads without over stressing.

Re-shores shall remain in place until the supported concrete has reached its specified strength.

03100.3.5 CONCRETE FINISHING

03100.3.5.1 FINISHING FORMED SURFACES - Within 72 hours after forms are removed, the Contractor shall finish exposed surfaces in accordance with one of the procedures described below. Where no finish requirement is provided on the Drawings, formed concrete surfaces exposed to view and surfaces designated to receive paint shall be given a "Smooth" finish and slabs shall be given a "Trowel" finish. When workmanship is less than the acceptable standard, provide one of the rubbed finishes at no additional cost to Owner.

- F1 - As Cast Form Finish - No finish.
- F2 - Rough Finish - Patch defects and chip or rub off fins exceeding 0.33 inch height.
- F3 - Smooth Finish - In addition to the rough finish requirements, patch tie holes and defects and remove fins completely. When surface texture is impaired and form joints misaligned, grind, bush-hammer or correct such areas. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete. Repair major mortar leakage as a defective area.
- F4 - Smooth Rubbed Finish - Remove forms and perform necessary patching as soon after placement as possible. Finish newly hardened concrete no later than 24 hours following form

removal. Perform a smooth finish, then wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.

- F5 - Grout Cleaned Rubbed Finish - Undertake this operation after all contiguous surfaces are completed and accessible. Perform a smooth finish, then brush blast with abrasive basting to open surface pores. Wet surface of concrete sufficiently to prevent absorption of water from grout. Mix grout in accordance with Section 03600 and rub a uniform coat over surface to be finished. Immediately after grouting, scrub surface with cork float or stone to coat surface and fill voids. While grout is still plastic, remove excess grout by working surface with rubber float or sack. After surface whitens from drying, rub vigorously with clean burlap. Keep damp for at least 36 hours after final rubbing.

- F6 - Cork Floated Rubbed Finish - Remove forms within 2 to 3 days of placement where possible. Perform a smooth finish and then dampen wall surface. Mix mortar in accordance with Section 03600, and apply with firm rubber float or with trowel, filling all surface voids and compress mortar into voids. If mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with fog sprayer. Produce a final texture with a cork float using a swirling motion.

- F7 - Unformed Finish - After concrete is placed, strike smooth, tops of walls or buttresses, horizontal offsets and similar unformed surface occurring adjacent to formed surfaces. Float to texture which is reasonably consistent with formed surface. Continue final treatment on formed surfaces uniformly across unformed surfaces.

- F8 - Blasted Finish - Complete a smooth finish then perform abrasive blasting within 24 to 72 hours after casting. Coordinate with form-work construction, concrete placement schedule and form-work removal to ensure that surfaces are blasted at the same age for uniform results. Reapply curing protection after blast finishing.

- F9 - Architectural Finish - Finish in accordance with ACI 303.

- F10 - Tooled Finish - Dress thoroughly cured concrete surface with electric, air or hand tools to uniform texture, and give a bush hammered surface texture. Remove sufficient mortar to exposed coarse aggregate in relief and to fracture coarse aggregate for tooled finish.

03100.3.5.2 REPAIRING FORMED CONCRETE SURFACES - When the Drawings indicate repairs are required or when the Engineer determines areas are defective and require repair, the following procedure shall be taken to make repairs:

- Remove defective concrete to sound concrete and make edges perpendicular to surface or slightly undercut. Feathered edges are not permitted.

- Dampen area to be patched and at least 6 inches surrounding it.

- Prepare bonding grout by mixing to consistency of thick cream and brush into surface.

- Tie holes shall be cleaned, thoroughly dampened, and filled solid with patching mortar.

- Make any patches in concrete to closely match color and texture of surrounding surfaces. Determine mix formula for patching mortar by trial to obtain a good color match with concrete when both patch and concrete are cured and dry.

- Mix white and gray Portland cement as required to match surrounding concrete to produce grout having consistency of thick paint. Use a minimum amount of mixing water.

- Mix patching mortar in advance and allow to stand, without addition of water, and without frequent manipulation, until it has reached a stiff consistency. After surface water has evaporated from patch area, brush bond coat into surface. When bond coat begins to lose water sheen, apply patching mortar. Thoroughly consolidate mortar into place and strike-off to leave patch slightly higher than surrounding surface. Leave undisturbed for at least 1 hour before final finish. Keep patched area damp for 72 hours or apply curing compound.

- Do not use metal tools in finishing an exposed patch.

- Where as cast finishes are indicated, total patched area may not exceed 1 in 500 of as cast surface. This is in addition to form tie patches, if ties are permitted to fall within as cast areas.

- In any finishing process which is intended to expose aggregate on surface, patched areas must show aggregate. Outer 1-inch of patch shall contain same aggregates as surrounding concrete. After curing, expose aggregates together with aggregates of adjoining surfaces by same process.

03100.3.5.3 FINISHING SLAB SURFACES - In no case shall water be added to the surface (i.e., by sprinkling) to finish. Slab surfaces shall receive one of the following finish treatments as indicated on the Drawings:

- S1 - Floated Finish - After concrete has been placed, consolidated, struck-off and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared and surface has stiffness sufficient to permit operation. During or after first floating, check plainness of entire surface with a 10 foot long straightedge applied at 2 or more different angles. Cut down high spots and fill low spots to the required tolerance. Re-float slab immediately to a uniform sandy texture.

- S2 - Trowel Finish - Float finish the surface. Power trowel or hand trowel as required to provide a uniform surface. Do not apply (i.e. sprinkle) water or dry cement to surface of concrete when finishing. First troweling after floating shall produce smooth surface relatively free of defects, but may still show some trowel marks. Second trowel by hand after surface has hardened. Leave finished surface essentially free of trowel marks, uniform in texture and appearance. On surfaces intended to support floor coverings, grind off defects which would show through floor coverings.

- S3 - Broom Finish – Trowel finish the surface. Power trowel or hand trowel as required to provide uniform surface. Lightly brush surface parallel to direction of drainage with a hair broom. Coarseness of broom bristle may be varied slightly, to achieve desired degree of surface roughness.

- S4 - Exposed Aggregate Finish - Immediately after surface of concrete has been leveled to tolerance and surface water has dissipated, spread aggregate uniformly over surface to provide complete coverage to the depth of a single stone. Embed aggregate into surface by light tamping. Float surface until embedded aggregate is fully coated with mortar and surface has been brought to tolerance. Start exposure of aggregate after matrix has hardened sufficiently to prevent dislodgement. Flow ample quantities of water, without force, over surface of concrete while matrix encasing aggregate is removed by brushing with a fine bristle brush. Continue until aggregate is uniformly exposed. An approved chemical retarder sprayed onto freshly floated surface may be used to extend working time.

- S5 - Chemical Hardener Finish - Apply liquid chemical hardener finish to interior concrete floors where indicated. Do not apply liquid chemical concrete hardener on floor areas scheduled to receive synthetic matrice terrazzo, setting beds for tile, terrazzo, vinyl flooring or like items. Apply hardener after complete curing and drying of concrete surface in accordance with manufacturer's recommendations. Evenly apply each coat and allow 24 hours for drying between coats. After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

03100.3.6 CONCRETE CURING

03100.3.6.1 SURFACES WITH UNREMOVED FORMS - When forms are left in place (i.e., underside of beams, etc.) the Contractor shall proceed with curing adjacent surfaces without regard to the formed surfaces. When such forms are removed, curing shall then proceed over the entire surface.

03100.3.6.2 CURING CONDITIONS - Immediately after finishing of concrete surfaces (formed or slab) the Contractor shall verify concrete surfaces are ready for curing. The Contractor shall correct any conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. A minimum ambient temperature of not less than 40° shall be maintained for at least 7 days during concrete curing. Concrete shall then be cured by one of the following methods:

- Moisture Cover - Water or continuous water-fog spray shall be applied, or the concrete surface shall be covered with water saturated absorptive mat kept continuously soaked, for not less than 7 days and nights.

- Moisture Retaining Sheet - Place cover in widest practicable width with sides and ends lapped and sealed to prevent moisture loss for a period of not less than 7 days and nights. All holes or tears in the cover sheet shall be kept repaired during the curing period.

- Membrane Curing Compound – All required repairs, patching, and final finishing operations shall be completed prior to application. Curing compound shall be applied as soon as the concrete is firm enough to work on. Slab surfaces shall be coated with curing compound within one hour after form removal; if more than one hour has elapsed, the surface shall be water cured.

  The compound shall be thoroughly mixed and a minimum of two coats shall be applied, with each coat applied in a direction different from that used for the preceding coat. The surface shall be coated and re-coated in a continuous operation until the surface has a uniform appearance; is effectively and completely sealed; and until a coating film remains on the surface of the concrete that can be scraped from the surface at any and all points after drying for at least 24 hours. Continuity of the coating shall be maintained, and all damage to the curing compound membrane shall be repaired, during the specified cure period.

  Curing compound shall not be allowed within the silhouette of any construction joint. If any curing compound enters the construction joint, the joint shall be sandblasted prior to placing any new concrete.

  Curing compound shall not be used on surfaces to be painted or coated.
  Surfaces intended to contain potable water (tank interiors, etc.) shall not be cured with curing compounds.

  Curing compound shall not be removed in less than 7 days from the time of application without written approval from the Engineer. When approved and prior to such removal, the Contractor shall provide a detailed plan for adequately curing the concrete.

03100.4 METHOD OF MEASUREMENT

Unless otherwise noted in the Special Provisions, separate measurement will not be made for concrete included as components of items shown in the Bid Schedule. Separate measurement for formed concrete and slabs shall be in accordance with the requirements of Section 03300.

03100.5 BASIS OF PAYMENT

Unless otherwise noted in the Special Provisions, no separate payment will be made for concrete included as components of items shown in the Bid Schedule. Separate payment for formed concrete and slabs shall be in accordance with the requirements of Section 03300.

03200.1 DESCRIPTION

Includes steel bars, wire fabric and rod mats required for cast-in-place concrete, with the necessary support chairs, bolsters, bar support and spacers required for supporting the reinforcement.

03200.1.1 RELATED Work

Section 03050 - Portland Cement Concrete
Section 03300 - Concrete Structures and Slabwork
Section 04810 - Unit Masonry Assemblies

03200.1.2 SUBMITTALS

03200.1.2.1 MILL TEST CERTIFICATION - Manufacturer's mill test certificates of supplied concrete reinforcement, indicating physical and chemical analysis shall be submitted.

03200.1.2.2 WELDER CERTIFICATION - Each welder's certification data shall be submitted to and approved by the Engineer prior to performance of welding on the project.

03200.1.2.3 SHOP DRAWINGS - Shop Drawings shall be submitted and shall indicate the sizes, spacings, locations and quantities of reinforcing steel and wire fabric; bending and cutting schedules; any proposed splicing; and reinforcement support, spacing devices and stirrup spacing.

03200.1.2.4 BAR SUPPORT SAMPLES - The Contractor shall submit for the Engineer's approval, samples of all bar supports it proposes to use along with a written description of where each type of bar support would be used.

03200.1.3 DEFINITIONS

Not used.

03200.2 MATERIALS

03200.2.1 CONCRETE REINFORCEMENT MATERIALS

03200.2.1.1 STEEL REINFORCEMENT - Unless otherwise specified, reinforcing steel shall be grade 60 billet steel conforming with ASTM A-615, including supplementary requirements S1. All such reinforcing shall be deformed steel bars with deformations in accordance with ASTM A-615. Bars shall be either uncoated or coated as indicated. ASTM A-706 steel shall be used if welding is indicated or allowed. All reinforcement shall be supplied in the maximum lengths practical or as indicated, unless otherwise authorized by the Engineer.

03200.2.1.2 WIRE FABRIC - Welded steel wire fabric shall be in accordance with ASTM A-185 plain type. It shall be new stock and free of any rust when placed in the Work. Wire fabric may be supplied in flat sheets or coiled rolls, and may be either coated or uncoated as indicated.

03200.2.1.3 STIRRUPS - Stirrup steel shall be in accordance with ASTM A-82.

03200.2.1.4 SPIRAL REINFORCEMENT - Spiral reinforcement for columns or other components shall be cold drawn steel wire in accordance with ASTM A-82.

03200.2.1.5 DOWEL BARS - Plain dowel bars for expansion joints shall be in accordance with ASTM A-615, 60-ksi-yield grade steel. Dowel bars shall be epoxy coated in roadway pavements. Metal dowel

cans shall be provided at one end of dowel to permit longitudinal movement of the dowel within the concrete section. The Contractor shall provide for movement equal to the joint width plus 0.5-inch. Load transfer bars shall be painted with 1 coat of paint conforming to AASHTO M-254 and coated 1/2 with grease.

03200.2.2 ACCESSORY MATERIALS

03200.2.2.1 TIE WIRE - Tie wire shall be 16-gauge minimum cold drawn plain steel wire, and shall be in accordance with ASTM A-82.

03200.2.2.2 REINFORCEMENT SUPPORTS - Unless otherwise required in the Drawings or these Specifications, reinforcement supports bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place shall be wire type bar supports complying with CRSI recommendations. Wood, brick, and other unacceptable materials will not be allowed.

03200.2.2.3 SUPPORTS EXPOSED TO VIEW - Where support legs are in contact with forms on concrete surfaces exposed to view, supports shall be stainless steel or shall be provided with either hot-dip galvanized or plastic protected legs.

03200.2.3 FABRICATION

03200.2.3.1 STANDARDS - Steel reinforcement shall be cut, bent and fabricated in accordance with ACI 315 and with approved machine methods, in either the shop or the field.

03200.2.3.2 BENDING - Bars shall be accurately formed to the dimensions shown on the Drawings or applicable bending schedule. Bending or straightening in the shop or the field shall be accomplished so that the steel is not damaged. All bars shall be cold bent. Bends for hooks on bars shall be made around a pin having a diameter not less than 6 times the minimum thickness of the bar. Kinked bars shall not be used. Bars with bends not indicated on Drawings or final Shop Drawings shall not be placed in the Work. Reinforcement bars shall not be bent after they are embedded in concrete.

03200.2.3.3 SPLICES - Reinforcing splices not indicated on the Drawings shall be approved by the Engineer, and shall be located at points of minimum stress. The location of splices shall be indicated on Shop Drawings. Welding of reinforcing bars, when authorized by the Engineer, shall be performed in accordance with AWS D1.4. All rebar which is welded shall be grade 60 ASTM A706 material.

03200.3 CONSTRUCTION REQUIREMENTS

03200.3.1 DELIVERY AND STORAGE

03200.3.1.1 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.

03200.3.1.2 STORAGE - Take all means necessary to protect reinforcement materials before, during and after installation and to protect the installed work of other trades. Store all reinforcement materials in a manner to prevent excessive rusting and fouling with grease, dirt and other bond breaking coatings. Take all necessary precautions to maintain identification after bundles are broken. In the event of damage or errors, immediately make all repairs or replacements necessary and at no additional cost to the Owner.

03200.3.2 REINFORCEMENT ERECTION

03200.3.2.1 CLEAN AND SOUND MATERIALS - At the time of placement in the Work, reinforcement shall be free of loose mill scale, loose or excessive rust, paint, oil or grease, or other coating which may destroy its bond with the concrete. Bars with reduced cross-section due to rusting or other cause, even if all rust has been removed, shall not be allowed in the Work.

03200.3.2.2 CLEARANCE - Maintain the distance from vertical forms and between layers of reinforcement by means of prefabricated chairs, ties, hangers or other approved devices in accordance with "reinforcement support" paragraphs below. Placement and fastening of reinforcement in each section of the Work must be approved before concrete is placed.

03200.3.2.3 CLEAR DISTANCE - The clear distance between parallel bars shall not be less than one and one-half times the diameter of the bars, and shall in no case be less than 1 inch nor less than the maximum size of the coarse aggregate specified.

03200.3.2.4 MINIMUM COVER - Unless otherwise shown on the Drawings or approved by the Engineer, for all formed surfaces, the minimum concrete cover over the steel reinforcement shall be 1 1/2 inches for bars number 5 and smaller and 2 inches for bars number 6 through 18. The largest specified cover shall be used when different sized bars are encountered in the same face. No "bury" or "carrier" bars will be allowed unless specifically approved by the Engineer.

03200.3.2.5 CUTOUTS AND OPENINGS - Where reinforcing steel has to be cut to permit passage of pipe or to create openings with no detail available on the Drawings for extra reinforcement in such areas, the area of steel removed by the creation of the opening must be replaced by placement of at least double the area of the steel removed equally around the openings created. The steel shall be placed such that it extends 5 feet beyond the opening on each side, to provide for sufficient bond.

03200.3.2.6 METAL MESH - Sheets of metal mesh shall be bent as shown or required on the Drawings to fit the work. It shall be rolled or otherwise straightened to make a perfectly flat sheet before placement in the Work. Supports for metal mesh shall meet requirements for reinforcing bar supports.

Sheets of metal mesh shall be spliced in accordance with ACI 318 and shall be overlapped no less than 12 inches or one square plus 6 inches, whichever is greater, to maintain a uniform strength. The mesh shall be securely fastened at the ends, edges and at all supports to maintain clearances and overlaps.

03200.3.2.7 NOTICE TO OTHER TRADES - The Contractor shall ensure that all other crafts, sub-contractors, engineering support groups, and etc., whose work is related to concrete placement, are provided with ample notice and opportunity to introduce and finish required embedded items before concrete placement. All sleeves, inserts, anchors and any other embedded items shall be located and set in place prior to concrete placement. All voids in embedded items shall be temporarily filled to prevent entry of concrete.

03200.3.3 SPLICING

03200.3.3.1 ENGINEER APPROVAL - Except as shown on the Drawings, reinforcing steel shall not be spliced at any location without specific written approval of the Engineer. Splices in adjacent bars shall be staggered as directed by the Engineer.

03200.3.3.2 LAP SPLICES - Unless shown otherwise on the Drawings, or approved by the Engineer, bars up to and including number 11 shall be lap spliced in accordance with ACI 318 and shall be fastened together with steel wire.

Unless shown otherwise on the Drawings, or approved by the Engineer, bars at a lap splice shall be in contact with each other, and in no case shall the lap be less than 40 diameters of the spliced bars.

Unless shown otherwise on the Drawings, or approved by the Engineer, where bars are to be lap spliced at joints in the concrete, all bars shall project from the concrete first placed for a minimum length equal to the lap splice length as indicated on the Drawings. All concrete or other deleterious coating shall be removed from dowels and other projecting bars by wire brushing or sand blasting before the bars are embedded in a subsequent concrete placement.

03200.3.3.3 WELDING - Reinforcing steel shall be welded only if shown on the Drawings, or approved in writing by the Engineer. All welding of reinforcing steel shall comply with AWS D1.4.

03200.3.3.4 EXPANSION JOINTS - Reinforcement, or other embedded metal items bonded to the concrete, shall not be permitted to extend continuously through any expansion joint, with the exception of dowels in floors bonded on only one side of joint.

03200.3.4 REINFORCMENT SUPPORT

03200.3.4.1 PLACEMENT - All reinforcement shall be supported and retained in place, true to indicated lines and grades, by the use of approved bar supports, sized to position the steel in the exact location required on the Drawings. Supports shall be spaced at intervals of not more than 5 feet on center in any direction, to prevent movement of the steel during concrete placement. Deck steel shall be tied down to beams or forms at regular intervals not exceeding 5 feet on center in any direction.

03200.3.4.2 CONCEALMENT - Supports shall be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete.

03200.3.4.3 SAND PLATES - Supports with sand plates or horizontal runners shall be used for slabs on grade where the base material will not support chair legs.

03200.3.5 QUALITY COMPLIANCE

Reinforcing materials found to be damaged or at variance with the requirements of the Drawings or these Specifications for size, quantity, strength, position, arrangement, or other attribute, shall result in rejection of the concrete Work if they are not brought into compliance.

03200.4 METHOD OF MEASUREMENT

03200.4.1 NO MEASUREMENT

Unless shown otherwise, concrete reinforcement shall be included with the concrete item within which it is installed and no separate measurement shall be made.

03200.4.2 SEPARATE MEASUREMENT

When shown as a separate item on the Bid Schedule, measurement of reinforcing steel will be, based on the theoretical or calculated number of pounds placed and accepted according to the requirements of the Drawings and these Specifications. Measurement shall exclude splice bars used to replace test samples. No deductions will be made for any bends except for hooks. The length of the bar to be added to out-to-out dimensions of hooked bars will be shown on the plans. The weight calculations shall be based upon the following table:

WEIGHT CALCULATIONS FOR REINFORCING STEEL

Size	Lbs. per Lineal Foot	Size	Lbs. Per Lineal Foot
1/3 inch	0.167	#8	2.670
#3	0.376	#9	3.400
#4	0.668	#10	4.303
#5	1.043	#11	5.313
#6	1.502	#14	7.650
#7	2.044	#18	13.600

03200.5 BASIS OF PAYMENT

The accepted quantities of reinforcing steel will be paid for at the contract unit price. No allowance will be made for clips, wires or other material used for fastening reinforcement in place.

Payment will be made under:

PAY ITEM	UNIT
Reinforcing Steel	Pound

03300.1 DESCRIPTION

Covers concrete placement operations for cast-in-place structural building frames, slabs and other components.

03300.1.1 RELATED WORK

Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 03310 - Concrete Joints for Slabwork
Section 03600 - Grout and Mortar

03300.1.2 SUBMITTALS

03300.1.2.1 RECORD OF PLACED CONCRETE - Contractor's record of placed concrete, which indicate the date, time, temperature, location, quantity, names/types of any additives used, and type of curing materials or procedures used.

03300.1.2.2 DELIVERY TICKETS - Copies of delivery tickets which indicate the date and time of delivery; the producer and the truck number; the volume of delivery; and the amounts (weights) of cement, aggregates and any additives, including all water added at plant and in the field.

03300.1.3 DEFINITIONS

Not used.

03300.2 MATERIALS

03300.2.1 CONCRETE

Shall meet Class and material requirements of Section 03050.

03300.2.2 BONDING COMPOUND

Shall be polyvinyl acetate or acrylic base, non-rewettable type.

03300.2.3 VAPOR BARRIER

Shall be minimum 6 mil thick, polyethylene sheet, and the Contractor shall allow for 6 inch overlap at all edges, unless shown otherwise on Drawings. Vapor Barrier required for below grade application shall be free from pin holes, tears, scars and other defects.

03300.2.4 FORMS

Shall meet requirements of Section 03100.

03300.2.5 REINFORCEMENT

Shall meet requirements of Section 03200.

03300.2.6 COVERINGS AND CURING COMPOUND

Shall meet requirements of Section 03100.

03300.2.7 GROUT

Shall meet requirements of Section 03600.

03300.2.8 WATERSTOP

Water stop shall be of the materials described and placed in the joints where shown on the Drawings and called for in these specifications. Precautions to insure proper support and location for the water stop during concrete placement shall be taken.

03300.3 CONSTRUCTION REQUIREMENTS

03300.3.1 PREPARATION

03300.3.1.1 ENGINEER NOTIFICATION - The Engineer shall be given not less than 24 hours notice of a pour before it starts.

03300.3.1.2 REINFORCEMENT AND OTHER MATERIALS - All anchors, seats, plates, reinforcement and other items, to be embedded or cast into concrete, shall be accurately placed, held securely, and not impede concrete placement.

03300.3.1.3 CONSTRUCTION LOADS - The Contractor shall ensure that construction loads shall not exceed member capacity.

03300.3.1.4 PREVIOUSLY PLACED CONCRETE - The Contractor shall prepare previously placed concrete by bush hammering or cleaning with steel brush, as required by the Drawings or these Specifications, and by application of the required bonding compound in accordance with manufacturer's instructions.

03300.3.1.5 DOWELING TO EXISTING WORK - At locations where new work is to be doweled to existing work, the Contractor shall drill 1 inch minimum oversize holes 20 bar diameters deep into the existing concrete. Holes shall be thoroughly cleaned with oil free air filled with epoxy grout from the bottom out, then insert the dowel full depth.

03300.3.1.6 TEMPERATURES - Temperature at the time of placement shall meet requirements provided in Section 03050 and Subsection 03300.3.4.1 below.

03300.3.1.7 DELIVERY - The Contractor shall ensure that concrete delivery meets all requirements of Section 03050.

03300.3.2 CONCRETE PLACEMENT

Concrete shall be conveyed, deposited and consolidated by methods that preclude separation or loss of ingredients.

03300.3.2.1 CONVEYING OF CONCRETE – Conveying of concrete shall be carried out as follows:

- Chutes for conveying concrete shall be sloped to permit concrete of the required consistency to flow without segregation.
- Where necessary, chutes shall be supplied with baffle boards or a reversed section at the outlet.

- Concrete shall not be allowed to drop more than 6 vertical feet without the assistance of pipes or tremies.

03300.3.2.2 DEPOSITION OF CONCRETE – Deposition of concrete shall adhere to the following requirements:

- Concrete shall not be placed if the subgrade is muddy, soft, or frozen.
- Concrete shall be deposited as near to its final position as practical.
- Use of vibrators for shifting concrete is not permitted.
- Concrete shall be placed in horizontal layers insofar as practical with placement starting at the low point and proceeding upgrade.
- Concrete slabs or footings shall be placed on compacted soil surfaces and the subgrade shall have a dampened condition. To achieve the dampened condition, the subgrade may be sprinkled with water in advance of placing concrete.
- Concrete placement shall be continuous between construction joints and shall be terminated with square ends and level tops unless otherwise shown on the plans.
- Concrete shall not be placed in horizontal sections until the concrete in the adjoining vertical members has been consolidated and 2 hours has elapsed to allow for shrinkage.
- Where concrete is to be deposited against hardened concrete joints, placement shall not begin until a grout mixture has been coated on the joint. This grout mixture shall consist of mixture prescribed in Section 03600.

03300.3.2.3 CONSOLIDATION OF CONCRETE - Consolidation of concrete, except for slope paving and concrete placed underwater, shall be accomplished through the use of vibrators as follows:

- A sufficient number of spare vibrators shall be kept available to preclude interruption of concrete placement due to vibrator failure and to have the capacity to consolidate the concrete mass within 15 minutes after placement in the forms.
- The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without separation of the mortar and coarse aggregate, and without causing water or cement paste to flow to the surface.
- Vibrators shall be operated so as not to contact the subgrade, reinforcing steel or form work, and shall not be used to move the mass of concrete horizontally.
- External vibration, except for vibrating screeds, shall not be used, unless approved by the Engineer prior to the start of concrete placement.

03300.3.3 WATERSTOPS

Waterstops in the walls shall be carried into the slabs below and shall join the waterstops in the slabs with factory-made fittings or welded joints. All joints in water-bearing structures shall have waterstops, whether indicated on the plans or not. For other location requirements for waterstops, see the general notes of the plans.

03300.3.4 TIME LIMITATIONS

Mixed concrete shall be rejected if it is not placed within 90 minutes after water is introduced into the mixture and air temperature is 80°F or less, or if it is not placed within 60 minutes after water is introduced into the mixture and air temperature is above 80°F; or if the initial set has developed.

03300.3.5 HOT OR COLD WEATHER PLACEMENT REQUIREMENTS

03300.3.5.1 TEMPERATURE LIMITATIONS - Concrete temperature shall be between 50°F and 90°F at the time of placement in the forms.

03300.3.5.2 HOT WEATHER CONDITIONS - Hot weather conditions shall be considered to exist when ambient temperatures exceed 90^0 F, or when the ambient temperature is below 90^0 F but the temperature to humidity relationships shown in the following table for conditions below 90^0 F exist.

TEMPERATURE/HUMIDITY RELATIONSHIP

Relative Humidity Less Than (Percent)	Air Temperature Greater Than (°F)	Maximum Concrete Temperature (°F)
80	90	90
70	90	90
60	90	90
50	90	85
40	90	80
30	80	75
20	75	70

During hot weather conditions, the Contractor shall take the following steps to protect the concrete:

- The concrete ingredients shall be cooled before mixing to maintain concrete temperature at time of placement below the maximum acceptable values listed in the table below.

  Mixing water may be chilled, or chopped ice may be used to control the concrete temperature, provided the water equivalent of the ice is calculated into the total amount of mixing water. Ice shall be completely melted and dispersed throughout the mix at the completion of the mixing time.

  All methods and equipment for cooling of water and aggregate shall be subject to approval of the Engineer, and shall conform to ACI 305.

- Reinforcing steel shall be covered with water-soaked burlap as required, to prevent the steel temperature from exceeding the ambient air temperature immediately before concrete placement.

- Forms shall be thoroughly wet, but free of standing water, before concrete placement. Concrete should be placed in shallower layers than under normal weather conditions if necessary to assure coverage of the previous layer while it will respond readily to vibration.

- Fog spray shall be used during finishing whenever necessary to avoid surface plastic-shrinkage cracking. Fog spray shall also be used after finishing, before the specified curing is commenced, to avoid surface plastic-shrinkage cracking.

- Forms shall be kept covered and continuously moist. Once forms are loosened and during form removal, concrete surfaces shall be protected from drying, and shall be kept continuously wet by fog spraying or other approved means.

Additional costs due to concrete placement in hot weather conditions shall be the responsibility of the Contractor.

03300.3.5.3 COLD WEATHER CONDITIONS - Cold weather limitations shall apply when air temperature falls below 40°F. Procedures for protecting concrete shall be in accordance with ACI Standard 306, "Recommended Practice for Cold Weather Concreting." If concrete placement is necessary during low temperature conditions, the Contractor shall take the following steps to protect the concrete:

- The Contractor shall heat all water and aggregates uniformly in accordance with Section 03050 before mixing, to obtain a concrete mixture temperature between 60°F and 90°F at the time of placement.

- The Contractor shall not use calcium chloride, salt or other material containing antifreeze agents or chemical accelerators unless approved otherwise in writing by the Engineer.

- If temperatures are expected to drop below 32°F the night before the concrete is placed, all reinforcement, the forms, and the ground shall be blanketed. If the temperature falls below 20°F, the area shall be preheated at a minimum temperature of 40°F for a minimum of 12 hours prior to placement.

- The concrete shall be protected from freezing. The Contractor shall furnish all materials and equipment to insulate and to heat the work as necessary to maintain concrete temperatures above 50°F.

- Concrete temperature shall be maintained at not less than 50°F and not more than 70°F for the first 7 days after placement.

- Combustion type heaters, which produce carbon monoxide (CO), shall be adequately vented.

The Contractor shall assume all risk in connection with placing concrete in cold weather conditions. Permission given to place concrete in cold weather shall in no way relieve the Contractor of the responsibility for compliance with these Specifications. Any work not in compliance with these Specifications due to cold weather conditions shall be removed and replaced at the Contractor's expense.

03300.3.6 JOINTS

03300.3.6.1 COMPLIANCE - Construction joints shall be placed at the locations shown on the Drawings or as approved by the Engineer. Expansion and contraction joints and joint sealing shall be accomplished in accordance with Section 03310.

03300.3.6.2 CLEANING - Unless otherwise directed by the Engineer, all construction joints shall be cleaned prior to placement of concrete. All unsatisfactory concrete, latency material, stains, debris, and other foreign materials shall be removed. After cleaning, the surface shall be washed thoroughly to

remove all loose material. Excess water shall be disposed of in such manner that it will not stain, discolor, or otherwise affect adjacent surfaces of the structures.

03300.3.7 FINISHING

Finishing shall be accomplished as indicated on the Drawings and in accordance with the requirements of Section 03100. Water shall not be sprinkled on concrete surfaces during finishing.

03300.3.8 CURING

Curing shall meet the requirements of Section 03100.

03300.3.9 PROTECTION

The Contractor shall provide necessary barriers, walkways, etc. to protect freshly placed concrete from physical damage. Any damage sustained as a result of failure to provide such protection shall be corrected at the Contractor's expense.

03300.3.10 REPAIR OF DEFECTIVE CONCRETE

03300.3.10.1 REPAIR FOR NON-COMPLIANCE - All concrete that fails to conform to required material characteristics, dimensions, lines, finishes and elevations shown on the Drawings, or in accordance with these Specifications shall be replaced or corrected in accordance with these Specifications and as approved by the Engineer.

03300.3.10.2 ADDITIONAL TESTING - Any engineering analysis and additional testing required to determine the extent of repair will be provided by the Contractor at no additional cost to the Owner.

03300.3.10.3 REMOVAL OF SLABS WITH CRACKS - Removal of concrete sections with cracks in slabs which occur within 2 feet of expansion or construction joints may be deemed necessary by the Engineer.

03300.3.11 QUALITY COMPLIANCE

Concrete work may be rejected for failure to comply with the following requirements:

03300.3.11.1 SPECIFICATION NON-COMPLIANCE - Concrete work shall be rejected if the materials used in the work fail to comply with the requirements of Section 03050 and 03200.

03300.3.11.2 STRENGTH TEST FAILURE - Concrete work, for which the average of three 28-day compressive or flexural strength samples made from the same batch falls below the acceptance level, shall be rejected, unless otherwise directed by the Engineer.

03300.3.11.3 IMPROPER CURING - Concrete work for which the method of curing is not as specified, or that has been inadequately protected from extremes of temperature during the early stages of hardening and strength development, shall be rejected, unless otherwise directed by the Engineer.

03300.3.11.4 ACCIDENT AND INJURY - Concrete work that has been subjected to construction fires, accidents, mechanical injury or premature removal of formwork likely to result in deficient strength development, shall be rejected, unless otherwise directed by the Engineer.

03300.3.11.5 POOR WORKMANSHIP - Concrete work, subjected to poor workmanship that may result in deficient strength or load carrying capacity, including but not limited to honey combing, cold

joints, introduction of contaminants or embedded debris, improper placement location or dimensions, and etc., shall be rejected, unless otherwise directed by the Engineer.

03300.3.11.6 POOR FINISH - Concrete work that fails to meet the required finish in accordance with the requirements of Section 03100, or exposed concrete with defects adversely affecting the appearance of the specified finish shall be rejected, unless otherwise directed by the Engineer.

03300.4 METHOD OF MEASUREMENT

03300.4.1 NO MEASUREMENT

When concrete is not indicated as a separate item in the Bid Schedule, no measurement will be made and the concrete required for a structure shall be considered a component of another item or items shown in the Bid Schedule.

03300.4.2 SEPARATE MEASUREMENT

03300.4.2.1 CUBIC YARD - When concrete is indicated as a separate item on the Bid Schedule, measurement shall be made by counting the number of cubic yards placed and accepted as determined by calculating volumes using the dimensions shown on the Drawings. This measurement shall NOT include:

- Any allowance for reinforcing steel in concrete.
- Any allowance for concrete required for filling over-excavation for footings, walls or slabs.
- Any allowance for volume occupied by pipes (except culverts), reinforcing steel, anchors, conduits, or weep holes.

03300.4.2.2 SQUARE UNIT – Measurement for square feet or yards of concrete shall be made using an accurate measuring device to determine the length and breadth of concrete placed and accepted and then multiplying those values to find the amount of area covered.

03300.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price:

PAY ITEM	UNIT
Concrete (*Class* _____)	Cubic Yard
Concrete (*Class* _____)	Square Yard
Concrete (*Class* _____)	Square Foot
Concrete Structure (*Name*)	Lump Sum

TREATMENT AREA CONCRETE — SECTION 03305SP

03305.1 DESCRIPTION

03305.1.1 Furnish materials and construct steel building concrete foundation and concrete floor as shown on the DRAWINGS, as designed by steel building manufacturer, and as required by these SPECIFICATIONS. The foundation and floor shall consist of, but not necessarily be limited to, excavation, earthwork, earthwork materials, untreated base course, concrete, concrete floor, reinforcing steel, foundation design and all other miscellaneous items necessary to complete the foundation and floor as specified.

03305.1.2 Based on preliminary information it is anticipated that the footing size and layout shown will be adequate to handle the loads placed on it, however, the exact loadings placed on the foundation are not known until a steel building manufacturer has been approved and shop drawings of the steel building provided with design loads, it shall be the responsibility of the contractor to provide the steel building foundation design and shop drawings, at no additional cost to the owner. The foundation design submittals shall be stamped and signed by a Utah licensed registered professional engineer. Based on preliminary geotechnical information the Recommended Net Bearing Pressure for Real Load Conditions for footings placed on a minimum of 18 inches of granular structural fill is 2,500 pounds per square foot. Soil test reports are in Appendix A of the specifications, minimum recommendations provided in that report shall be followed.

03305.1.2 RELATED WORK

Section 02105 - Earthwork Materials
Section 02201 – Earthwork
Section 02201SP – Earthwork for Structures
Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 03500 - Concrete Structures and Slab Work
Section 13150SP - Steel Building

03305.2 MATERIALS

03305.2.1 Concrete class 4000 minimum as specified and in accordance with Section 03050 SP.

03305.2.2 Reinforcing Steel as specified and in accordance with Section 03200.

03305.3 CONSTRUCTION REQUIREMENTS

03305.3.1 The CONTRACTOR shall complete construction of the steel building concrete footings, foundation, foundation walls, concrete floor, untreated base course, drain gravel, etc. in a manner that conforms with the requirements of the DRAWINGS and these SPECIFICATIONS, using industry standard workmanship practices, and applicable building code regulations and these specifications. All floors footings and foundations shall have a minimum of 4” of drain rock and 18” of UBC placed under them.

03305.4 METHOD OF MEASUREMENT

03305.4.1 The method of measurement for the steel building foundation and floor shall be “lump sum” including all incidental materials and construction required to design the foundation and footings, complete the steel building foundation and concrete floors, stairs ADA accessible ramps and <u>all other concrete associated with the treatment area and within 10 feet of the treatment area</u> as shown on the DRAWINGS. Unless specified or described as included in another pay item.

03305.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
Treatment Area Concrete	Lump Sum

03310.1 DESCRIPTION

Furnish materials and install appropriate longitudinal and transverse expansion joints, construction joints and crack control joints in slabs and pavement.

03310.1.1 RELATED WORK

Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing, and Curing
Section 03300 - Concrete Structures and Slabwork

03310.1.2 SUBMITTALS

The Contractor shall submit the following to the Engineer for review and approval:

03310.1.2.1 PRODUCT CERTIFICATION – The manufacturer's certification that product was manufactured, tested and supplied in accordance with source control requirements specified herein, together with a report of the test results and the date each test was completed.

03310.1.2.2 INSTRUCTIONS – The manufacturer's instructions for joint preparation, type of cleaning and installation.

03310.1.2.3 DATA SHEETS – The manufacturer's product and safety data for each joint sealant product required.

03310.1.2.4 SAMPLES – A manufacturer’s sample of each joint sealant product required.

03310.1.3 DEFINITIONS

Not used.

03310.2 MATERIALS

03310.2.1 GENERAL

03310.2.1.1 COMPATIBILITY OF MATERIALS - Provide joint filler, sealant backings, sealants and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

03310.2.1.2 DELIVERY OF MATERIALS - Deliver materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time and mixing instructions for multi-component materials.

03310.2.1.3 STORAGE AND HANDLING OF MATERIALS - Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants or other causes.

03310.2.2 PRODUCTS

03310.2.2.1 JOINT VOID FORMER - Shall be of plastic with a waterstop and shall extend 1/3 of the depth of the concrete structural section.

03310.2.2.2 JOINT FILLER - J4 joint filler shall be the required standard and shall be used unless another filler from the list below is specified. Fillers shall be non-extruding, resilient, and meet the requirements of ASTM D-545:

- F1 Joint Filler – 13mm thick filler for expansion joints; bituminous (asphalt or tar) mastic in accordance with ASTM D-994; formed and encased between 3 layers of bituminous saturated felt or 2 layers of glass fiber felt.

- F2 Joint Filler - Cane or other cellulosic fiber in accordance with ASTM D-1751, saturated with asphalt.

- F3 Joint Filler - Granulated cork in accordance with ASTM D-1751; in an asphalt binder; encased between 2 layers of asphalt saturated felt or 2 layers of glass fiber felt.

- F4 Joint Filler - Sponge rubber fully compressible in accordance with ASTM C-1752, with resiliency recovery rate of 90 percent minimum.

- F5 Joint Filler - Cork in accordance with ASTM C-1752; impregnated and bound with asphalt; compressible with resiliency recovery rate of 90 percent if not compressed more than 50 percent of original thickness.

- F6 Joint Filler - Plastic foam (for cold-applied sealants only) pre-formed, compressible, resilient, non-waxing, non-extruding strips of flexible, non-gassing plastic foam; non-absorbent to water and gas; 20 lb/ft^3 density maximum; and of size and shape to control sealant depth and performance.

- Synthetic Sponge Rubber Filler - Synthetic sponge rubber filler shall be an expanded closed cell sponge rubber, manufactured from a synthetic polymer neoprene base. The material shall be No. 750.3 Ropax Rod Stock as manufactured by the Presstite Division of Interchemical Corporation; Bondtex as manufactured by Rubatex Corporation; or approved equal. The size of the material shall be 25 percent greater in diameter than the nominal joint width. The manufacturer's instructions for surface preparation and application shall be used as a guide for installation, except that the material shall not be installed by stretching beyond its normal length.

03310.2.2.3 SEALANT - Hot applied joint sealant shall be one of the following:

- HAS1 Sealant - Resilient and adhesive compound type in accordance with ASTM D-3405, for Portland cement concrete or asphalt concrete pavements.

- HAS2 Sealant - Thermoplastic type in accordance with ASTM D-3581, jet fuel resistant without rubber, unless indicated otherwise.

- HAS3 Sealant - Elastomeric type in accordance with ASTM D-1190.

- HAS4 Sealant - Elastomeric type in accordance with ASTM D-3406, one component, for Portland cement concrete pavements.

- HAS5 Sealant - Elastomeric type in accordance with ASTM D-3569, one component, jet-fuel resistant, for Portland cement concrete pavements.

Cold applied joint sealant shall be one of the following:

- CAS1 Sealant - Elastomeric type in accordance with ASTM C-920; chemically curing, for vehicular or pedestrian use and types of construction other than highway and airfield pavements and bridges and joint substrates indicated; Type S or M; Grade P or NS; Class 25; Use T, NT, M and O with the following characteristics:

  ⇒ Self leveling
  ⇒ 40 ± 5 ASTM D-2240 Shore A Hardness
  ⇒ 4 days minimum final cure
  ⇒ 10 to +150^0 F service range

- CAS2 Sealant - Mastic type in accordance with ASTM D-1850, single or multiple companion, for joints having a minimum width of 1/2 inch.

- CAS3 Sealant - Coal tar modified urethane type in accordance with FS SS-S-200; one part, jet fuel resistant; Type H.

- CAS4 Sealant – Elastomeric, pre-formed polychloroprene type with lubricant adhesive and indicated movement ratio which meets one of the following:

  ⇒ For concrete pavement seal; ASTM D-2628
  ⇒ For concrete bridge seal; ASTM D-3542

Synthetic rubber sealant shall be as follows:

- The sealant shall be a 3-part polyurethane compound.

- Sealant shall be designed to cure at room temperature to a firm, highly resilient rubber.

- Sealant shall have the following properties determined at conditions of 75° F and 50 percent relative humidity:

  ⇒ Base - polyurethane rubber
  ⇒ Solids - not less than 97 percent
  ⇒ Application time - not less than 3 hours
  ⇒ Cure time - not more than 5 days
  ⇒ Ultimate hardness - 35 ± 5 (Shore A Durometer)
  ⇒ Tensile strength (ASTM D412) - 300 pounds per square inch minimum
  ⇒ Ultimate elongation - not less than 300 percent
  ⇒ Color - gray to match concrete unless otherwise indicated

- All packages shall be code dated. No material shall be more than 6 months old when used. Material shall have been kept at temperatures lower than 80° F at all times.

03310.2.2.4 BACKER ROD – Backer rod shall be neoprene, butyl, EPDM, or silicone tubing complying with ASTM D-1056, water and gasoline non-absorbent, capable of remaining resilient at temperatures down to -26°F. Provide product with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

03310.2.2.5 BOND BREAKER TAPE – Bond breaker tape shall be self-adhesive polyethylene or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to joint filler materials or joint surfaces at back or bottom of joint.

03310.2.2.6 WATERSTOPS - Waterstop shall be rubber waterstop or PVC waterstop as designated on the Plans or in the Special Provisions and shall meet the requirements described herein.

- Waterstops shall be as manufactured by Burke Concrete Accessories Inc., Kirkhill Rubber Company, Williams Products Inc., Greenstreak, or approved equal:

- Waterstop shall be of the width and cross-section configuration shown on the Drawings or required in the Special Provisions.

- At expansion joints, only hollow centerbulb type waterstop shall be used.

Rubber waterstop shall meet the following requirements and conditions:

- Waterstop shall be manufactured to ensure an integral cross section which will be dense, homogeneous, and free from porosity and other imperfections.

- Minor surface defects, such as surface peel, covering less than 1 square inch and surface cavities or bumps less than ¼" in longest lateral dimension and less than 1/16" deep, will be acceptable.

- The rubber waterstop shall meet the following Specifications:

  ⇒ Hardness-Shore A Durometer – 60 to 70, ASTM D 2240
  ⇒ Elongation - not less than 450%
  ⇒ Tensile Strength - not less than 3,000 psi
  ⇒ Tensile Strength after aging 48 hours in oxygen at 70°C and 300 psi - not less than 80% of original
  ⇒ 300% Modulus - not less than 900 psi
  ⇒ Water absorption after 2 days at 158°F – not more than 5%
  ⇒ Compression set after 22 hours at 158°F - not more than 30%
  ⇒ Specific Gravity - 1.17 ± .03

Polyvinylchloride (PVC) waterstop shall be as manufactured by Greenstreak, or approved equal, and shall meet the following requirements and standards:

Property	ASTM Test	Nominal Value
⇒ Water absorption	D 570	0.15
⇒ Tear resistance	D 624	350/lb.in.
⇒ Ultimate elongation	D 638	390%
⇒ Tensile strength	D 638	2250 psi min.
⇒ Low temperature brittleness	D 746	$+35^0$F/$+37^0$C (passed at)
⇒ Stiffness in flexure	D 747	1190 psi
⇒ Specific gravity	D 792	1.37
⇒ Ozone resistance	D 1149	No failure
⇒ Volatile loss	D 1203	0.30%
⇒ Hardness (Shore A15)	D 2240	76+/3
⇒ Accelerated Extraction		
Tensile strength		2130 psi
Elongation		370%

PVC waterstop shall be heat weldable, have great inherent elasticity, be impervious to many waterborne chemicals, be suitable for above or below grade installation, not produce electrolytic reactions, and not discolor concrete or mortar.

See Subsection 03310.3.4 for waterstop installation specifications.

03310.3 CONSTRUCTION REQUIREMENTS

03310.3.1 WEATHER CONDITIONS

Do not proceed with installation of joint sealant under unfavorable weather conditions. Install elastomeric sealant only when temperature is stable within the temperature range recommended by manufacturer for installation.

03310.3.2 PREPARATION

03310.3.2.1 JOINT CLEANING - Clean, prepare and size joints in accordance with manufacturer's instructions. Remove any loose materials and other foreign matter. Do not proceed with installation of joint sealant until contaminants capable of interfering with sealant adhesive properties are removed from joint substrates. Remove any moisture on the substrate.

Remove protective coating and any oil from metals with solvent recommended by the sealant manufacturer.

03310.3.2.2 JOINT DIMENSIONS - Examine joint dimensions and size materials to achieve required width to depth ratio. Adjust joint depths to allow sealant to perform properly.

03310.3.2.3 MATERIAL COMPATIBILITY - Verify that joint shaping materials and release tapes are compatible with sealant.

03310.3.3 CONSTRUCTION

03310.3.3.1 FEATURES AND PURPOSES OF JOINT CONSTRUCTION - Construct all joints as follows:

- At right angles to top surface of placement.
- Straight unless indicated otherwise.
- Before uncontrolled shrinkage cracking takes place.
- To prevent concrete edge slump.

03310.3.3.2 BOND BREAKER TAPE - Install where needed or required by manufacturer's recommendations to ensure that elastomeric sealant will perform properly.

03310.3.3.3 EXPANSION JOINTS - Expansion joints shall be constructed as follows:

- They shall be placed in locations as shown on the Drawings or as approved by the Engineer.
- Joints in exterior concrete slab work shall be placed where shown on Drawings or as recommended by Portland Cement Association's "Design and Control of Concrete Mixture Manual".
- Pre-molded filler strips shall extend full depth in slab.

- Unless otherwise noted on the Drawings or directed by the Engineer, isolation joints shall be used in all areas where slabs abut vertical surfaces. Joint material shall be placed as called for and in good alignment.

- In no case shall the reinforcing or other fixed metal items embedded in or bonded to concrete be made to run continuously through an expansion joint.

- Concrete edges at joints shall be neatly finished with an edging tool providing a slightly rounded edge on each side of the joint filler material.

03310.3.3.4 CONSTRUCTION JOINTS - Other references to construction joints are located in Subsection 03300.3.6.

03310.3.3.5 CONTROL JOINTS – Control joints shall be constructed as follows:

- Tooled Joints. Tooled joints shall be formed by scoring the slab full depth with a steel trowel along a straight edge in locations as shown on the Drawings or, if not shown, not to exceed 625 square feet in area. The joint shall be finished using a joint tool guided by a straight edge leaving a slightly rounded edge on each side of the joint.

- Sawn Joints. Sawn joints shall be sawn into interior concrete floors as indicated on the Drawings and at Contractor's option in place of pre-formed metal keys. Joints shall be sawn with a power saw designed to saw depth and width as shown on Drawings. Hand held saws will not be accepted. Saw cutting shall occur within 12 hours after placement of concrete. The line of the saw shall be straight, true to line and square. Pourable joint sealant shall be poured into all sawn joints. Installation shall be in strict accordance with manufacturer's specifications which shall include preparation, priming, etc.

03310.3.3.6 JOINT SEALING - Installation of joint sealant shall adhere to the following procedures:

- Manufacturer's Instructions. Application shall be in strict accordance with the manufacturer's published instructions.

- Surface Preparation. All surfaces to which synthetic rubber sealant must bond shall be dry and free of dust, dirt, and other foreign residue and shall be primed with the manufacturer's recommended primer for the particular surface. Remove all oil, grease, wax, form release agents, curing compounds, bitumen, old caulking, and other latent material by sand blast or water blast, as recommended by the sealant manufacturer. Maximum angle for sand blasting is 25 degrees $\pm$ 5. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants. Remove frost and moisture in concrete joint substrates before commencing sealing.

- Installation. If necessary, joints shall be saw cut, to provide the required sealant thickness and depth. Application shall be by means of a pneumatic caulking tool or other approved method. Ensure that sealant is installed in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides. Except as otherwise indicated, fill sealant rabbet flush with surface. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

  Install sealant to depths indicated or, if not indicated, as recommended by sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:

⇒ For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but neither more than 5/8 inch deep nor less than 3/8 inch deep.

⇒ For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2 inch deep nor less than 1/3 inch deep.

⇒ For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in the range of 75 percent to 125 percent of joint width.

- Overflow and Spillage. Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.

- Overheating. Do not overheat hot applied sealants.

- Exposed Edges. Unless indicated otherwise, recess exposed edges of gasket and exposed joint filler slightly behind adjoining surface so compressed units will not protrude from joints.

03310.3.3.7 CURING AND PROTECTION – The Contractor shall follow the steps listed below regarding curing and protection of sealant:

- Cure sealant and caulking compounds in accordance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability.

- Follow procedures required for cure and protection of joint sealants during construction period so they will be without deterioration or damage (other than normal wear and weathering) at time of Substantial Completion.

- Protect joint sealant during and after curing period from contact with contaminating substances, or from damage resulting from deterioration through the time of Substantial Completion.

- If damage or deterioration occurs, immediately cut out and remove damaged or deteriorated joint sealant and reseal joint with new materials. Repaired area shall be indistinguishable from un-repaired area.

03310.3.3.8 CLEANUP - Clean off all excess sealant or sealant smears adjacent to joints as the work progresses. Use methods and cleaning materials approved by manufacturers of joint sealant and of the products in which joints occur.

03310.3.4 WATERSTOPS

03310.3.4.1 INSTALLATION - Waterstops shall be installed in concrete joints where and as indicated on the Plans. Waterstops shall be set accurately to the position and line indicated on the Plans. Where required at expansion joints, the hollow, centerbulb type waterstop shall be installed centered on the joint.

03310.3.4.2 CONTINUITY - All waterstops shall be continuous. Waterstops in walls shall be carried into lower slabs and shall join the waterstops in the slabs with appropriate types of fittings. Waterstops shall be terminated 3 inches from the top of finished surfaces of walls and edges of slabs unless otherwise specified or indicated on the Plans.

03310.3.4.3 FASTENING IN PLACE - Edges shall be held and securely fixed in position at intervals of not more than 24 inches to prevent movement during the placing of the concrete. Wires placed near the outer bulb and/or special clips may be used for this purpose, at the Contractor's option. No nails shall be driven through a waterstop in the vicinity of any construction joint.

03310.3.4.4 JOINTS – Waterstop joints shall meet the following requirements

- All waterstop joints shall be watertight.
- All joints shall be made by the use of factory-made fittings and unions, some of which will be special.
- Fittings and unions shall be cemented in place using clamps over the entire area of splice until the cement is bonded permanently.
- Welding of the waterstop without the use of factory-made unions and fittings will not be permitted.
- Split type waterstop may be used, at the option of the Contractor, provided that all junctions between standard solid type waterstop and split type waterstop shall be made with solidly welded and cemented unions between the two waterstops. This union may be split and re-cemented in accordance with the manufacturer's recommended method.
- Cement shall be as recommended by the manufacturer of the waterstop, and field cementing or solvent welding shall be in accordance with the manufacturer's directions.

03310.4 METHOD OF MEASUREMENT

Unless otherwise indicated in these Specifications, no separate measurement will be made for the materials and work covered by this section.

03310.5 BASIS OF PAYMENT

Unless otherwise noted in these Specifications, no separate payment will be made for items under this section. Compensation shall be included in the prices paid for the various contract items and no separate compensation will be allowed.

03500.1 DESCRIPTION

This is a generic specification covering furnishing and installing of pre-cast concrete units, complete with required accessories as shown on the Drawings and called out in these Specifications.

03500.1.1 RELATED WORK

Section 01300 - Submittals
Section 02224 – Sewer Pipe and Manholes
Section 03050 - Portland Cement Concrete

03500.1.2 SUBMITTALS

03500.1.2.1 SHOP DRAWINGS - Submit shop drawings showing unit design, signed and sealed by a Professional Engineer, in accordance with Section 01300. The Contractor shall not proceed with fabrication until shop drawings have been approved.

03500.1.2.2 UNIT DESIGN – Unit design shall incorporate the following:

- Pre-cast units shall be designed in accordance with ACI 318 and PCA design handbooks under the direction of a Professional Engineer experienced in the design of such units.
- Indicate unit locations, unit identification marks, fabrication details, reinforcement, connection details, pertinent dimensions, and erection support points.
- Units shall be designed to support the required shipping and handling loads, and the live, dead and construction loads.
- Component connections shall be designed to provide adjustment to accommodate misalignment of structure during installation.
- The Engineer may approve design deviations provided that equivalent units serving the same basic function and intent are furnished at no additional cost to the Owner. Such deviations shall only be approved upon written request and when accompanied with complete design calculations and drawings.

03500.1.3 DEFINITIONS

Not used.

03500.2 MATERIALS

03500.2.1 ACCESSORIES

Connecting and supporting devices shall be carbon steel in accordance with ASTM A 36. Bolts, nuts and washers shall be carbon steel or stainless steel as required on the Drawings. Grade 60 reinforcement shall be provided for all units.

03500.2.2 IDENTIFICATION MARKS

Unit identification marks shall appear on all manufactured units.

03500.2.3 FINISHES

Shall be in accordance with one of the following paragraphs. If no finish is prescribed on the Drawings, the Standard Finish will be provided.

03500.2.3.1 STANDARD FINISH - Produced in plastic or metal lined forms which impart a smooth finish. Small surface holes, normal form joint marks, minor chips and spalls may be approved. Major or unsightly imperfections, honeycomb or structural defects are not acceptable.

03500.2.3.2 COMMERCIAL FINISH - Produced in plastic or metal lined forms which impart a smooth finish. Remove fins and large projections and fill holes over 1/2 inch with sand-cement paste. Faces shall be true and well defined. Exposed ragged edges shall be corrected by rubbing or grinding.

03500.2.3.3 ARCHITECTURAL GRADE FINISH - Produced in plastic or metal lined forms which impart a smooth finish. Fill holes over 1/4 inch in diameter with sand-cement paste. Grind smooth form offsets or fins over 1/8 inch. Coat with neat cement paste using a float and after paste has dried, rub with burlap to remove loose particles.

03500.2.3.4 SPECIAL FINISHES - Finishes produced by sandblasting, acid washing, or form liners shall be specifically defined on the Drawings or in these Specifications and samples showing texture and color will be required for approval.

03500.2.3.5 PAINTABLE FINISHES - Where unit surfaces will be painted, only form release agents compatible with paints shall be used during fabrication.

03500.3 CONSTRUCTION REQUIREMENTS

03500.3.1 FABRICATION

Fabrication of pre-cast units shall proceed as follows:

03500.3.1.1 RECORDS - Maintain plant records and quality control program during production of structural pre-cast concrete. Make records available to Engineer.

03500.3.1.2 MOLDS - Use molds which are rigid and constructed of material that will result in uniform finished products.

03500.3.1.3 PLACEMENT AND VIBRATION - Place and vibrate concrete to ensure: proper consolidation, elimination of cold joints, and minimize entrapped air marks on finished surfaces.

03500.3.1.4 REINFORCEMENT AND FITTINGS - Provide required connecting devices, plates, angles, and connectors to steel framing members, bolts and accessories. Ensure reinforcing steel, anchors, inserts, plates, angles and other cast-in items are sufficiently embedded, anchored and properly located.

03500.3.1.5 LIFTING DEVICES - Embedded lifting or handling devices shall be capable of supporting units in positions anticipated during manufacture, storage, transportation and erection.

03500.3.1.6 FINISHED SURFACE - Ensure finished surfaces of pre-cast structural units are uniform.

03500.3.1.7 CURING - Cure units under identical conditions to develop specified concrete quality and minimize appearance of blemishes such as non-uniformity, staining or surface cracking.

03500.3.2 DELIVERY, STORAGE AND HANDLING

03500.3.2.1 DELIVERY - Unless otherwise approved in writing, do not deliver units to job site until required for installation.

03500.3.2.2 EDGE PROTECTION - Provide edges of units with adequate protection to prevent staining, chipping or spalling of concrete.

03500.3.2.3 HANDLING - Handle pre-cast units in positions consistent with their shape and design. Lift and support only from support points indicated on Shop Drawings.

03500.3.2.4 BLOCKING AND BRACING - Block and laterally brace units while in storage. Provide lateral bracing that is sufficient to prevent bowing and warping. Bracing shall be clean, non-staining and of a type that will not inhibit uniform curing of exposed surfaces.

03500.3.3 INSTALLATION

Do not install pre-cast units until concrete has attained its design compression strength. Install members plumb, level and in alignment. Clean weld marks or other marks, debris or dirt from exposed surfaces of units.

03500.3.4 REPAIR

Repair of damaged units may be acceptable if structural integrity or appearance is not impaired.

03500.4 METHOD OF MEASUREMENT

03500.4.1 NO MEASUREMENT

Separate measurement for pre-cast concrete units will not be made when the unit is a component of a building, assembly or enclosure for which identification is made in the Bid Schedule.

03500.4.2 SEPARATE MEASUREMENT

When pre-cast concrete units appear as a separate item on the Bid Schedule, they will be measured either by counting the number of units installed and accepted or by using a measuring tape or other accurate measuring device to determine the total number of lineal feet of units installed and accepted.

03500.5 BASIS OF PAYMENT

Separate payment for pre-cast concrete units will not be made when they are a component of building, assembly or enclosure identified in the Bid Schedule.

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Pre-Cast Concrete (*Describe*)	Each
Pre-Cast Concrete (*Describe*)	Lineal Foot

03600.1 DESCRIPTION

This section covers furnishing materials and placing Portland cement grout, epoxy grout, and mortar for finishing concrete surfaces, leveling beds for structural steel plates, sealing joints between piping and structures, and sealing joints between construction components.

03600.1.1 RELATED WORK

Section 03100 - Concrete Forming Finishing, and Curing
Section 03300 - Concrete Structures and Slabwork
Section 04100 - Brick Masonry
Section 04810 – Unit Masonry Assemblies

03600.1.2 SUBMITTALS

Provide description of mix components, which indicates proportions to be used, environmental conditions expected and ad mixture limitations. Indicate type, grade and class of materials which suit the requirements in accordance with Section 01300. Manufacturer's data shall be provided to the Engineer for all materials.

03600.1.3 DEFINITIONS

Not used

03600.2 MATERIALS

03600.2.1 PORTLAND CEMENT

Shall meet ASTM C-150, natural color, Type II (normal) or Type IIA (air entraining).

03600.2.2 HYDRATED LIME

Shall meet ASTM C-207, Type S.

03600.2.3 WATER

Shall be potable, or water which meets the requirements of AASHTO T-26.

03600.2.4 GROUT AGGREGATE

Shall be fine aggregate (generally masonry type sand), which meets the requirements of Section 03050 with a maximum particle size specified therein or on the DRAWINGS.

03600.2.5 PORTLAND CEMENT GROUT

Shall be one part Portland Cement to one part grout aggregate proportioned by volume. Mix for 5 minutes with sufficient water to achieve the consistency of thick cream. Minimum Compressive Strength - ASTM C-109, 2800 psi in 28 days.

03600.2.6 SHRINKAGE RESISTANT GROUT

Shall be a pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland Cement, shrinkage compensating agents, plasticizing and water reducing agents.

Minimum Compressive Strength - ASTM C-109, 6500 psi in 28 days. Maximum Shrinkage - ASTM C-827 and ASTM C-157, shall not exceed 0.5 per cent.

03600.2.7 EPOXY ADHESIVE GROUT

Shall be two component material suitable for use on dry or damp surfaces and shall comply with ASTM C-881. Minimum Pot Life shall be 5 minutes at 70°F. Minimum Tensile strength - ASTM D-638, 5000 psi in 14 days. Minimum Tensile Elongation - ASTM D-638, 2 per cent. Minimum Compressive Strength - ASTM D-695, 6500 psi in 24 hours at 70°F, 12,500 psi in 28 days at 70°F. Maximum Water Absorption - ASTM D-570, 1 percent. Minimum Bond Strength shall be: in Direct Shear - 400 psi; in Direct Tension - 250 psi; in Beam Break - 800 psi.

03600.2.8 MORTAR

Shall be a mixture of grout aggregate, all of which passes the No. 4 sieve size, Portland Cement, hydrated lime, and water blended to form a plastic putty meeting the requirements of ASTM C-270. Mortars for brick or concrete block masonry construction shall be Type S or M, mixed in the proportions indicated in the table shown below and manufactured in accordance with the Uniform Building Code. Type S mortar shall be used in masonry sections above grade and not subject to water submergence. Type M mortar shall be used in locations below grade and/or where water contact potential is high.

MORTAR MIXING PROPORTIONS (by volume)

Mortar	Portland Cement	Hydrated Lime	Clean Sand
Type "S"	1	½	4½
Type "M"	1	0	2½

03600.3 CONSTRUCTION REQUIREMENTS

The Contractor shall prepare and install grout and mortar materials in accordance with these Specifications. The materials shall be mixed in clean containers, which will not allow contamination from deleterious materials. After mixing, the Contractor shall immediately install the grout or mortar. Grout or mortar left unused one hour after mixing shall be discarded.

03600.4 METHOD OF MEASUREMENT

03600.4.1 NO MEASUREMENT

Grout for leveling of structural components, sealing joints and gaps, finishing concrete surfaces, and filling masonry cells for structures shall not be measured separately for payment.

Mortar used for installing brick or concrete masonry units, or for finishing concrete surfaces, shall not be measured separately for payment.

03600.4.2 SEPARATE MEASUREMENT

Grout installed under pressure for filling voids and pockets under footings and supporting sections and for sealing ground water movement shall be measured by the cubic foot of grout injected in place.

03600.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price for:

PAY ITEM	UNIT
Grout *(Description)*	Cubic Foot

DIVISION 5

METALS

SUNRISE
ENGINEERING

05010.1 GENERAL

This section of the Specifications covers metals and metal work required to furnish, fabricate, and to install the following nonexclusive list of items:

- Aluminum and miscellaneous nonferrous metals
- Anchors and anchor bolts
- Bolts
- Cast-iron frames and covers
- Grating and frames
- Ladders
- Louvers
- Manhole frames and covers
- Metal roof decking
- Miscellaneous metal items shown on the Plans or specified
- Miscellaneous structural steel
- Pipe handrails, pipe sleeves, inserts, and chains
- Platforms
- Sheet metalwork
- Special supports, hangers, and anchors
- Stairs and treads
- Steel lintels
- Supports for mechanical equipment
- Tread plates and frames

05010.1.2 RELATED WORK

Not used.

05010.1.3 SUBMITTALS

Certified copies, in duplicate, of mill tests or reports from a recognized commercial laboratory shall be furnished when requested as to the chemical, tensile, and bending properties of each shipment of structural metal or part thereof having common properties. All tests and analyses shall be made in accordance with the applicable ASTM Specification.

05010.1.4 DEFINITIONS

Not used.

05010.2 MATERIALS

05010.2.1 ALUMINUM

05010.2.1.1 SHEET ALUMINUM - Except as otherwise specified or indicated on the Plans, sheet aluminum shall be alloy 50050H14 conforming to the requirements of ASTM B 209 and shall be not less than 0.025 inch in thickness.

05010.2.1.2 STRUCTURAL ALUMINUM - Structural aluminum shall be 6061-T6, and extruded aluminum shall be 6063-T42.

Aluminum shapes and appurtenant materials shall conform to the requirements of ASTM B 221 and ASTM B 308 and shall be of aluminum alloy known commercially as 6061-T6. Materials not otherwise specified shall conform to the latest applicable Specifications of ASTM.

05010.2.1.3 BOLTS - All bolts for bolting aluminum shall be Type 304 or 316 stainless steel of sizes indicated on the Plans.

05010.2.2 STEEL

05010.2.2.1 SHEET STEEL - Galvanized sheet iron or steel shall conform to ASTM A 525, 1.25-ounce coating; black steel to ASTM A 569.

05010.2.2.2 STRUCTURAL STEEL – Structural steel shall be as follows:

- Unless otherwise specified, structural steel shall conform to ASTM A 36.
- Cast iron shall conform to ASTM A 48, Class 40B.
- Galvanized structural steel or iron shall be "hot dipped" galvanized after fabrication. Electro-galvanizing shall not be used unless specified otherwise.
- All structural steel shall be delivered free from mill scale, rust, or pitting.
- Items not galvanized or protected by a shop coat of paint shall be protected from the weather until erection and painting.

05010.2.2.3 STAINLESS STEEL - Stainless steel, unless specifically specified or indicated on the Plans otherwise, shall be Type 316 or Type 304, nonmagnetic.

05010.2.2.4 STEEL PIPE - Steel pipe shall conform to ANSI B 36.10, Table I.

05010.2.2.5 BOLTS - High tensile bolts shall conform to ASTM A 325.

05010.2.2.6 OTHER ITEMS

Other structural and miscellaneous metal items shall be as indicated on the Plans or as specified elsewhere.

05010.3 CONSTRUCTION (FABRICATION) REQUIREMENTS

05010.3.1 GENERAL

All structural or foundry items shall be carefully fabricated to true dimensions without warp or twist. Welded closures shall be neatly made; and where weld material interferes with fit or is unsightly in appearance, it shall be ground off smooth.

05010.3.1.1 INSTALLATION - Each structural item shall be installed true to level, plumb, alignment, and grade with all parts bearing or fitting the structure or equipment for which it is intended accurately and securely. It shall not be permitted to cock out of alignment, re-drill, reshape, or force to fit any fabricated item. It is the Contractor's responsibility to place anchor bolts or other anchoring devices accurately and to make any surfaces, which bear against structural items smooth and true to level to preclude the necessity of any springing, re-drilling, or reshaping.

05010.3.1.2 SPECIAL ALIGNMENT - Pipe railings, posts, and structural items needing a special alignment to preserve straight, level, even, smooth lines shall be rigidly supported and braced and kept braced until concrete, grout, or dry pack cement mortar has hardened for a period of not less than 48 hours.

05010.3.1.3 FIT - The Contractor shall be responsible for the correct fitting of all metalwork in the field. The Contractor shall take all measurements necessary to properly fit its work in the field, and it shall be governed by and be responsible for these measurements and the proper working out of all details.

05010.3.1.4 WELDING – General welding procedures are as follows (see also Subsections below):

- The Contractor shall notify the Engineer at least 24 hours before starting shop or field welding.
- A welding inspector may check the materials, the equipment, and the qualifications of the welders.
- The inspector may use gamma ray, magnetic particle, dye penetrant, trepanning, or any other aid to visual inspection which it may deem necessary to be assured of the adequacy of the welding.
- The costs of any tests and all re-tests on defective welds shall be borne by the Contractor. Cost in connection with qualifying welders shall also be borne by the Contractor.
- The cost of tests on sound welds will be borne by the Owner.
- Welders doing unsatisfactory work shall be removed or may be required to pass qualification tests again.

05010.3.1.5 MISCELLANEOUS METALWORK - Where anchors, connections, or other details of miscellaneous metalwork are not definitely shown or specified, its material, size, form, attachment, and location shall conform to best practice.

05010.3.1.6 HAZARDOUS PROJECTIONS - Sharp or hazardous projections shall be rounded off and ground smooth.

05010.3.1.7 CHIPS AND DEBRIS - All chips and other debris lodged between contacting surfaces shall be removed before assembly.

05010.3.2 ALUMINUM

05010.3.2.1 STRUCTURAL ALUMINUM

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

05010.3.2.2 LAYOUT ON ALUMINUM - Hole centers may be center punched and cutoff lines may be punched or scribed. Center punching and scribing shall not be used where such marks would remain visible on the surface of the fabricated material.

When critical dimensions exist, a temperature correction shall be applied in the layout as necessary. The coefficient of expansion shall be taken as 0.000013 per degree F.

05010.3.2.3 CUTTING AND DRILLING ALUMINUM – Aluminum may be cut and drilled as follows:

- Material 1/2 inch thick or less may be sheared, sawed, or cut with a router. Material more than 1/2 inch thick shall be sawed or routed.
- Cut edges shall be true, smooth, and free from excessive burrs or ragged breaks.
- Edges of plates carrying calculated stresses shall be planed to a depth of 1/4 inch. Sawn or routed edges will be acceptable when the finish is of equal quality to a planed edge.
- Re-entrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting.
- Rivet or bolt holes may be punched or drilled to finished size before assembly.
- The finished diameter of holes for unfinished bolts shall be not more than 1/16 inch larger than the nominal bolt diameter.
- All holes shall be cylindrical and perpendicular to the principal surface. Holes shall not be drifted in such a manner as to distort the metal.
- Flame cutting of aluminum alloys is not permitted.

05010.3.2.4 ALUMINUM FORMING AND ASSEMBLY - Structural aluminum material may not be heated except in forming operations where material may be heated to a temperature not exceeding 400 degrees F for a period not exceeding 30 minutes to facilitate bending. Such heating shall be done only when proper temperature controls and supervision are provided to insure that the limitations on temperature and time are carefully observed.

05010.3.2.5 WELDING ALUMINUM - This Specification shall apply to both field and shop welding operations. The general recommendations and regulations shown in the American Welding Society Specifications D1.1, "Structural Welding Code," apply to 6061-T6 structures. Detail requirements for welding aluminum alloy 6061-T6 are given as follows:

- Filler metal for welding shall be aluminum alloy welding rods conforming to the requirements of AWS A 5.10 and shall be AWS classification ER 4043, ER 5154, ER 5254, ER 5183, ER 5356, or ER 5556.
- The welding process and welding operators shall both meet a qualification tests. The method of qualification shall conform to the method described in the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications," Part B. Aluminum alloy 6061-T6 shall be used for the qualification test plates. Operators shall be qualified on the basis on bend tests and a fillet weld soundness test.
- Dirt, grease, forming or machining lubricants, or any organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing. Additional operations to remove the oxide coating just prior to welding are required when the inert gas tungsten arc welding method is used. This may be done by etching or by scratch brushing. The oxide coating may not need to be removed if the welding is done with the automatic or semi-automatic inert gas shielded metal arc.

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

- Any welding of aluminum shall be done using a nonconsumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG). No welding process that requires the use of a welding flux shall be used unless prior approval has been obtained from the Engineer. Preheating for welding is permissible provided the temperature does not exceed 400° F for a total time of 30 minutes.

- Welding of any structure which is to be anodized shall be done using filler alloy rods that will not discolor when anodized. ER 5154, ER 5254, ER 5183, ER 5356, or ER 5556 filler alloy rods shall be used.

05010.3.2.6 PROTECTION OF ALUMINUM SURFACES - Aluminum surfaces to be placed in contact with wood, concrete, masonry, or dissimilar metals other than stainless steel shall be protected as specified in the appropriate sections of Division 9 – Finishes.

05010.3.2.7 BOLTING - Where aluminum comes in contact with steel it shall be bolted with stainless steel bolts and separated or isolated from the steel with neoprene gaskets or washers or as specified in Division 9.

05010.3.3 STEEL

05010.3.3.1 STRUCTURAL STEEL – The following shall apply:

- The Contractor shall furnish and install all structural steel items in accordance with the plans and as specified herein.

- The Contractor also shall provide all supplementary parts necessary to complete each item even though such work may not be specifically covered by the Plans and Specifications.

- Wherever applicable, all fabrication and erection of steel items shall conform to AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" except as the same may be modified by applicable building codes, the General Conditions, and these Specifications.

05010.3.3.2 WELDING OF STEEL – Both the general recommendations and regulations shown in the American Welding Society Specifications D1.1, "Structural Welding Code," as well as the detail requirements in those specifications apply to welding of steel structures. Welding of steel shall adhere to the following:

- All welding of steel under this section shall be done by welders who have a current AWS certificate for the type of welding to be done by the welder.

- All welding of structural steel type ASTM A 36 shall be done using mild steel covered Arc Welding Electrodes conforming to ASTM A 233, Series E70, or shall be done using Electrodes and Fluxes for Submerged Arc Welding conforming to ASTM A 558, Classification F70-XXXXX, where XXXXX refers to any electrode referred to in ASTM A 558.

- Welding of stainless steels shall be done with electrodes and techniques as recommended in Welded Austenitic Chromium - Nickel Stainless Steels - Techniques and Properties as published by the International Nickel Company, Inc., New York, New York. All welds shall be full penetration welds, unless specified otherwise.

05010.3.3.3 PROTECTION OF STEELWORK - The Contractor shall paint steel and miscellaneous ferrous metal items as specified in the appropriate sections of Division 9-Finishes.

05010.3.4 DUCTWORK

05010.3.4.1 DESIGN AND FABRICATION - Ducts shall be fabricated of aluminum or galvanized steel sheets with gauges of sheet metal, joint types, reinforcing, bracing, supporting, fabricating, installing, and other requirements in accordance with Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems of the Sheet Metal and Air Conditioning Contractors National Association, Inc. Ducts shall be designed for the appropriate pressure type as shown in the above mentioned Duct Manual. Details on the Plans in some cases call for sheet metal thicknesses greater than called for in the Duct manual. Sheet metal shall conform to whichever requirement calls for the greater thickness. Aluminum ducting shall be not less than 0.063 inches thick.

05010.3.4.2 HANGERS - Ducts shall be supported on both sides at all changes in direction and at not greater than eight foot intervals by suitable hangers as specified herein or as detailed on the Plans. For galvanized ducting, hangers for ducts 12-inch by 24-inch or smaller shall be galvanized sheet metal straps not lighter than 18-gauge by one inch secured to the structure by one 5/16-inch bolt and to the duct by not less than two No. 10 sheet metal screws or 3/16-inch stove bolts. Hangers for ducts larger than 12-inch by 24-inch shall be galvanized steel straps or rods not less than 0.13 square inches in net cross section, secured to the structure by a Grinnell Figure 152, Size 2, concrete insert, or approved equal, and to a duct pocket or reinforcing angle by two 1/4-inch stove bolts. For aluminum ducting, supports shall be equivalent to supports for galvanized ducting except that all fasteners, fittings, and shafting shall be stainless steel.

05010.3.4.3 FLEXIBLE CONNECTIONS - Where blowers or equipment containing blowers or other machine elements, which may cause vibration, are connected to ducts or housing, such connections shall be by means of flexible connections. These flexible connections shall be airtight at the pressures encountered and be flame proof and water proof. The flexible material shall be equivalent to 14 ounce canvas.

05010.4 METHOD OF MEASUREMENT

Not used.

05010.5 BASIS OF PAYMENT

Not used.

05050.1 DESCRIPTION

This section covers a generic list of miscellaneous metals specifications.

05050.1.1 RELATED WORK

Not used.

05050.1.2 SUBMITTALS

Not used.

05050.1.3 DEFINITIONS

Not used.

05050.2 MATERIALS

05050.2.1 LADDERS AND METAL STAIRS

All ladders shall be safety ladders conforming to OSHA standards. All ladders and stairways supplied to the project shall be of one manufacturer. All stair and ladder wells shall be adequately guarded, and all stairs shall have handrails as specified or shown on the Plans.

Ladders shall be secured to the supporting surface by bent plate chips providing not less than 7 inches between the supporting surface and center of rungs. If exit from the ladder is forward, over the top rung, side rails shall be extended not less than 3-feet-3 inches above, and returned to the landing. If exit from the ladder is to the side, the ladder shall extend not less than 5-feet 6-inches above the landing and be rigidly secured at the top.

05050.2.2 ALUMINUM LADDERS

Aluminum ladders shall be made of 6063-T5-aluminum alloy, of welding construction. Rungs shall be not less than 1-inch square bar with 1/8-inch grooves in the top and redivided edges. Side rails shall be no lighter than 3 inches by 3/8 inches. Ladders shall be of the size, shape, location, and details indicated on the Plans. Ladders greater than 20 feet in height shall have standard ladder cages designed in accordance with State and OSHA requirements. All aluminum surfaces, which will be in contact with concrete, shall be coated as specified in Division 9.

05050.2.3 ALUMINUM STAIRWAYS

Aluminum stairways shall be fabricated and installed as shown on the Plans. Stairway stringers shall be fabricated of aluminum alloy 6061-T6. Treads shall be aluminum as specified below. Handrail shall be fabricated of aluminum pipe as specified under aluminum handrail.

Stair treads shall be aluminum of the sizes called for on the Plans, and shall be of the same type and make as called for under GATING. All fasteners shall be of Type 304 or 316 stainless steel.

Stair treads shall be furnished with cast abrasive type safety nosing.

05050.2.4 ARCHITECTURAL AND MISCELLANEOUS SHEET METAL

Sheet metal flashing and counterflashing shall be installed as indicated on the Plans. Galvanized steel or anodized aluminum flashing shall be used when indicated and specified on the Plans.

Unless otherwise indicated flashing shall be 0.025-inches thick. The aluminum flashing shall receive a 215-R1 anodic finish after fabrication as indicated on the Plans. Exposed edges shall be folded back 1/2-inch to provide stiffness. Except as otherwise indicated and specified on the Plans, counterflash shall be provided over all base flashings.

Unless specifically noted, galvanized steel flashing shall be used in contact with structural steel and anodized aluminum flashing shall be used in contact with structural aluminum. This shall be done to protect against dissimilar metal action.

Surfaces to which sheet metal is to be applied shall be even, smooth, round, thoroughly clean and dry, and free from all defects that might affect the application. All cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed under this section. All accessories or other items essential to the completeness of this sheet metal installation, though not specifically shown or specified, shall also be provided under this section. Nails, screws, and bolts shall be of the types best suited for the intended purpose and shall be of a composition that will not support galvanic action in the installation. Where sheet metal abuts into adjacent materials, the juncture shall be executed in a manner satisfactory to the Engineer.

Sheet metal items not covered elsewhere shall be as indicated on the Drawings and as required to provide a watertight installation. Formed sheet metal for metal covered work shall accurately reproduce the detail and design shown and profiles, bends, and intersections shall be sharp, even, and true.

05050.2.5 ALUMINUM SHEET METAL WORK

Except as otherwise specified or indicated on the Plans, sheet aluminum shall be alloy 5005-H14 conforming to the requirements of ASTM B 209 and shall be not less than 0.025 inch in thickness and extruded aluminum shall be 6063-T42.

05050.2.6 MISCELLANEOUS STRUCTURAL STEEL

Miscellaneous steel items not specified herein shall be as shown on the Plans or specified elsewhere and shall be fabricated and installed in accordance with the best practices of the trade.

05050.2.7 LINTELS

Lintels for masonry construction shall be structural steel beams or angles, fabricated as indicated on the Plans.

05050.2.8 SUBMERGED ASSEMBLY BOLTS

Assembly bolts for wood baffles, collectors, and other assemblies in areas where stainless steel anchor bolts would be required shall be stainless steel bolts Type 304 or 316.

05050.2.9 ANCHOR BOLTS AND INSERTS

Wherever feasible, anchor bolts shall be cast in place when concrete is placed.

All anchor bolts and concrete anchors embedded in concrete shall be accurately spaced with bolts truly normal to the surfaces from which they project. Type 304 or Type 316 stainless steel anchor bolts and nuts shall be used under these circumstances:

- Any time they are submerged in water.

- In the case of structures customarily containing water, placed in walls, ceilings, or overheads, even if above water level.
- In the dry side of water bearing walls.
- Where securing aluminum to steel or concrete.

Anchor bolts not required by above conditions to be of stainless steel, may be of carbon steel conforming to ASTM A 307 or ASTM A 36. Carbon steel anchor bolts in the following locations shall be hot-dip galvanized.

- Anchor bolts exposed to the weather.
- In electrical manholes or pull boxes.
- In tunnels, passageways, galleries, vaults, or rooms below grade or enclosed in part by water bearing walls.

In anchoring machinery bases subject to heavy vibration, two nuts shall be used, one serving as a locknut. In all cases where steel anchor bolts are used, a liberal coating of nonoxidizing wax shall be applied to the threads before screwing on nuts.

All bolts, when indicated for future use, shall be first coated thoroughly with nonoxidizing wax, followed by turning nuts down to the full depth of thread. Exposed thread shall then be neatly wrapped with a waterproof polyvinyl tape.

05050.2.10 INSTALLATION

Anchor bolts shall be embedded not less than 12 diameters. Where shown on the Plans, anchor bolts shall be set in metal sleeves having an inside diameter approximately 3 times the bolt diameter and not less than 12-bolt diameters in length. Sleeves shall be filled with grout when the machine or other equipment is grouted.

05050.2.11 CONCRETE ANCHORS

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

The material of each concrete anchor, including its integral anchor bolt, shall be the same material as would be required, under these Specifications, for anchor bolts in the same location that the concrete anchor is to be used.

Concrete anchors shall have the following minimum embedment lengths:

EMBEDMENT OF CONCRETE ANCHORS

Size	Embedment Length
3/8”	1-1/2”
½”	2-1/4”
5/8”	2-3/4”
¾”	3-1/4”

If Wej-It expansion anchors are used they shall have the following minimum embedment length:

WEJ-IT ANCHORS

Size	Embedment Length
¼”	1-1/2”
½”	5”
5/8”	5”
¾”	5”

Anchor bolts, of the same material and size as required for the specified concrete anchors, may be cast in the concrete in lieu of using concrete anchors. Embedment of bolts in concrete shall be not less than 12-bolt diameter plus a standard hook.

No cast iron, lead cinch, or slug-in anchors will be permitted for use.

05050.2.12 MISCELLANEOUS CAST IRON

All castings shall be tough, gray iron, free from cracks, holes, swells, and cold shuts, and be of workmanlike finish, and shall conform to the Standard Details and with the ASTM Specification Designation A 48, Class 40 B. The quality shall be such that a blow from a hammer will produce an indentation on a rectangular edge of the casting without flaking the metal. Before leaving the foundry, all castings shall be thoroughly cleaned and subjected to a hammer inspection, after which they shall receive a coating of coal-tar pitch varnish in such a manner as to form a firm, tenacious coating.

05050.2.13 MANHOLE FRAMES AND COVERS

Manhole frames and covers shall be made from a superior quality gray iron, conforming to the requirements of ASTM A 159, Class G3000, or ASTM A 48, Class 30-B. Frames and covers shall have horizontal and vertical bearing surfaces machined to fit neatly, and the cover shall bear firmly in the frame without rocking and shall be easily removable. Frames and covers shall be heavy-duty traffic type designed for H-20 loading and shall have a combined set weight of at least 265 pounds.

Frames shall have a clear inside opening of 24 inches diameter and shall be of the bottom flange type. Frame height shall be approximately 4½” and bottom flange outside diameter shall be approximately 32 inches.

Covers shall have a skid resistant grid pattern design as recommended ASTM publication STP326.

The elevations at which manhole frames and covers are to be set shall conform to the requirements set forth on the Plans, but in all cases shall be governed by the Engineer in the field. Where the cover is in existing pavement or in the traveled way of the existing road shoulder, it is to be placed flush with the existing surface. Where the structure is outside the limits of the traveled shoulder but not in the roadside ditch, it should be placed 1/10 foot or more above the existing ground surface. Where the manhole cover falls in the existing roadside ditch or right of way, it is to be placed approximately 1-1/2 feet above the existing ground surface or as directed by the Engineer. Manhole frames shall be set at the required grade and shall be securely attached to the top precast manhole shaft unit. After the frames are securely set in the place provided herein, covers shall be installed and all necessary cleaning and scraping of foreign materials from the frames and covers shall be accomplished to ensure a fine satisfactory fit. All costs of setting and securing manhole frame and cover sets in place as herein provided, including all necessary

concrete work shall be considered as included in applicable contract unit prices and no additional allowance will be made therefor.
Cast lettering on manhole covers shall be as shown on the Plans. Shop drawings of all manhole rings and covers shall be submitted to the Engineer.

05050.2.14 CAST IRON PRESSURE MANHOLE FRAME AND COVER

The Contractor shall furnish and install, ready for use as indicated on the Plans and as specified herein, rectangular pressure manholes and covers. Each pressure manhole shall have a clear opening of 18" X 30". The pressure plate shall be flat on top and shall not be less than 1/2 inch thick steel and fastened with 316 stainless steel studs and stainless steel nuts. A 1/8-inch thick neoprene gasket shall be supplied between the frame and pressure plate. Lifting shall be provided with a watertight pickhole. The frame shall be a seal-type with flanges at the base and at the top.

05050.2.15 MISCELLANEOUS ALUMINUM

Structural and other metal items fabricated from aluminum, not covered separately herein shall be fabricated in accordance with the best practices of the trade and shall be field assembled by riveting or bolting with no welding or flame cutting permitted except as approved by the Engineer.

05050.2.16 ALUMINUM STAIR NOSING

Stair nosings shall be installed on all treads of all concrete stairs including the top tread of the upper slab. Stair nosings shall be aluminum abrasive cast nosings with aluminum oxide granules integrally cast into the metal forming a permanent nonslip long wearing surface. The nosings shall be Type 101 Stair Tread by Wooster Products, Inc., Spruce Street, Wooster, Ohio 44691, Type A stair treads by American Abrasive Metals Company, or approved equal. The treads shall have integrally cast anchors. Stair nosings shall be cast in fresh concrete and shall be flush with the tread and riser faces. Stair nosing shall be coated with zinc chromate primer in accordance with the provisions of Division 9. Screws shall be 304 or 316 stainless steel.

05050.2.17 MANHOLE STEPS

Manhole steps shall consist of 3/4-inch diameter stainless steel or polyethylene rungs. Rungs shall extend 7-inches from the face of the wall to which they are anchored and shall have a minimum clear width of 16-inches. Rungs shall be designed such that the foot cannot slide off the end. Distance between rungs shall be 12-inches. Rungs shall be hook anchored into walls a minimum of 6-inches.

05050.3 CONSTRUCTION REQUIREMENTS

Not used.

05050.4 METHOD OF MEASUREMENT

Not used.

05050.5 BASIS OF PAYMENT

Not used

05100.1 DESCRIPTION

05100.1.1 Includes furnishing and installing galvanized steel, extruded aluminum, or fiberglass bar grating for commercial or industrial floors and walk ways as shown on the Drawings an in accordance with the requirements described herein.

05100.1.2 RELATED WORK

Not used.

05100.1.3 SUBMITTALS

The Contractor shall provide complete information, which includes shop drawings for fabrication and erection of all work, parts lists, fabrication details, loading tables, anchor details, and manufacturer's installation instructions and details in accordance with the requirements of Section 01300.

With regard to 05100.2.6 – Slip Resistant Surfaces, below, evidence of compliance with the requirements stated there shall be furnished from the grating manufacturer to the Engineer at the time of delivery of the gratings to the Project site.

05100.1.4 DEFINITIONS

Not used.

05100.2 MATERIALS

05100.2.1 GENERAL GRATING REQUIREMENTS

Grating shall be of such bar size and spacing that, as determined by the manufacturer, the grating will support a uniform loading of 180 pounds per square foot on the entire area of the grating, using an extreme fiber stress of not more than 10,000 pounds per square inch. The maximum deflection under this loading will not be more than 1/240 of the clear span of the grating. The spacing of the main grating bars shall not be more than 1-1/8 inches clear between bars. Crossbars shall be at right angles to the main bearing bars, and center to center spacing shall not exceed 4¼ inches. Ends of grating and cutouts shall be banded. Grating shall be of the thickness shown on Drawings or as required by these Specifications. All grating supplied to the project shall be by one manufacturer.

05100.2.2 STEEL BAR GRATING

Shall be machine-welded, galvanized carbon steel bearing bars and cross bars. Bearing bars for steel grating shall be not less than 1-1/2 inches in depth, unless directed otherwise by the Engineer. Spacing of bearing bars and cross bars shall not be less than those required in 05100.1.1.1 above. Span length of the bearing bars shall be in accordance with the information shown on the Drawings. The grating shall in all cases, meet the load and deflection requirements of 05100.1.1.1.

05100.2.3 ALUMINUM GRATING

Shall be I-bar or rectangular bar type grating with bearing bars and cross bars locked together by a swaging process. Bearing bars for aluminum grating shall be not less than 2 inches in depth, unless shown otherwise on the Drawings, or unless directed otherwise by the Engineer. Spacing of bearing bars and crossbars shall be as required in 05100.1.1.1 above. Span length of the

bearing bars shall be in accordance with the information shown on the Drawings. The grating shall in all cases, meet the load and deflection requirements of 05100.1.1.1.

Aluminum grating shall be supported on aluminum shelf angles cast in the concrete as indicated on the Drawings. Gratings, shelf angles, anchors, etc. shall be of 6061-T6 or 6063-T6 aluminum alloy, except that cross bars may be of 6063-T5 aluminum alloy. All surfaces of shelf angles, anchors, etc. to be in contract with concrete shall be coated as specified under Division 9.

05100.2.4 FIBERGLASS GRATING

Shall be constructed of fiberglass strands set in thermoset plastic in a one-piece mold. Glass content shall not exceed more than 35 per-cent by weight. The resin shall be an opaque, fire retardant polyester or vinyl material with a UL classification. The color and mesh pattern shall be indicted on the Drawings. Bearing bars for fiberglass grating shall be not less than 3 inches in depth, unless directed otherwise by the Engineer. Spacing of bearing bars and cross bars shall be the manufacturer's standards, but load capacity and deflection shall meet all requirements of 05100.1.1.1 above. Span length of the bearing bars shall be in accordance with the information shown on the Drawings.

05100.2.5 FLOOR PLATE

Shall be a commercial grade of hot-dipped, galvanized carbon steel or aluminum plating with a raised pattern of surface projections to resist slippage of foot traffic. The size, thickness, span length and pattern configuration shall be as shown on the Drawings but, in no case shall the thickness be less than ¼-inch.

05100.2.6 CAST IRON GRATING

Shall be cast gray iron meeting the requirements of ASTM 48-93, Class 35B of the type and configuration shown on the Drawings. Castings shall be of uniform quality and free from blow holes, smooth and cleaned by shot-blasting. The size, minimum weight, spacing and span length of the grating sections shall be in accordance with the requirements indicated on the Drawings. Gratings located in areas subject to vehicular traffic shall be capable of sustaining standard highway H-20 loads. Bearing surfaces between grating and supporting cast iron frames shall be machined to allow full contact between the grating and fence.

05100.2.7 SLIP RESISTANT SURFACES

When slip resistant surfaces are required by the Drawings or these Specifications, such surfaces shall conform to all applicable OSHA standards and to USDA/FDA requirements for the food and drug industry, when applicable.

05100.3 CONSTRUCTION REQUIREMENTS

05100.3.1 PREPARATION

The Contractor shall carefully prepare the supporting structure to provide a neat fit and unobstructed walking surface in accordance with the Drawings. A clearance of 1/4-inch shall be provided for grating sections to provide easy removal and minimal movement when tread on. Openings for piping or other obtrusions shall be reinforced to support bearing components of the grating.

05100.3.2 Gratings shall be furnished and installed with appropriate clips and/or fasteners as recommended by the grating manufacturer. Supporting frames for grating shall be fabricated from materials which will not contribute to the corrosion or deterioration of the grating and which will provide

uniform support to the grating sections. Grating frames shall be designed to be removable and/or replaceable unless shown otherwise on the Drawings.

05100.3.3 Grating located in areas subject to foot and vehicular traffic shall have opening spaces sufficiently small as to not allow entrapment of bicycle or wheelchair wheels.

05100.3.4 Support for grating sections shall be constructed in full compliance with the recommendations of the grating manufacturer. Openings for piping or other obtrusions shall be properly reinforced to provide support of the bearing components of the grating section.

Except as otherwise specified or shown on the plans, grating shall be supported on shelf angles cast in the concrete as indicated on the plans. All surfaces of shelf angles, rebates, anchors, etc. to be in contact with concrete shall be coated as specified under Division 9.

05100.3.5 The clear opening space for grating section shall provide sufficient space for easy removal of sections; however, it shall not be oversized to allow excessive movement of the sections. Unless otherwise indicated, this clearance space shall be ¼-inch between grating sections and supporting frames. The top surfaces of grating sections adjacent to each other shall be in the same plane.

05100.4 METHOD OF MEASUREMENT

Separate measurement of the floor will not be made when the material is installed as a component of a building or structure listed in the Bid Schedule.

05100.5 BASIS OF PAYMENT

Separate payment will not be made for floor grating included in the measurement of a building or structure in which it is installed.

05570.1 DESCRIPTION

This section covers furnishing and installing galvanized iron or welded steel pipe posts filled and set in concrete at designated locations shown on the Drawings and in accordance with the requirements described herein.

05570.1.1 RELATED WORK

Not used.

05570.1.2 SUBMITTALS

Not used.

05570.1.3 DEFINITIONS

Not used.

05570.2 MATERIALS

05570.2.1 POSTS

Posts shall consist of Schedule 40, galvanized pipe or welded carbon steel pipe with 3/16-inch (min.) wall thickness. Pipes shall extend 48-inches above the driving surface in which they are set and 36-inches below the driving surface. Diameter shall be as shown on the drawings.

05570.2.2 CONCRETE

Concrete installed in the post interior and surrounding the post shall be Class 2000 Portland cement concrete meeting the requirements of Section 03050 of these Specifications. Concrete shall be premixed before placing.

05570.3 CONSTRUCTION REQUIREMENTS

The Contractor shall carefully locate the position of the bumper post from information provided on the Drawings and excavate a hole of sufficient diameter and depth to provide at least 4-inches of coverage when filled with concrete.

The posts shall be set plumb and in a position that will not obstruct entry into any doorway to be protected by the post. Following the setting and filling of the post with concrete, a galvanized iron cap will be screwed on the galvanized pipe and/or a steel cap will be welded tightly to the welded steel post and the post will then be cleaned and painted in accordance with Section 09910 of these Specifications with red enamel.

05570.4 METHOD OF MEASUREMENT

Separate measurement of the bumper posts will not be made when they are installed as a component of a building or structure listed in the Bid Schedule. Measurement of the posts will be included with the building or structure which it serves.

05570.5 BASIS OF PAYMENT

Separate payment will not be made for bumper posts included in the measurement of a building or structure in which it is installed.

DIVISION 7

THERMAL AND MOISTURE PROTECTION

SUNRISE
ENGINEERING

07210.1 GENERAL

07210.1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

07210.1.2 SUMMARY

A. This Section includes the following:

1. Foundation wall insulation (supporting backfill).
2. Cavity wall insulation.
3. Concealed building insulation.
4. Metal building insulation system and vapor barrier exposed to plenum areas.
5. Perimeter fire-containment systems - fire safing
6. Vapor retarders.

B. Related Sections include the following:

1. Division 3 Section “Cast-in-Place Concrete.”
2. Division 4 Section “Unit Masonry Assemblies” for insulation installed in cavity walls.

07210.1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: Full-size units for each type of exposed insulation indicated.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for insulation products.

D. Research/Evaluation Reports: For foam-plastic insulation.

07210.1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Surface-Burning Characteristics: ASTM E 84.

2. Fire-Resistance Ratings: ASTM E 119.

3. Combustion Characteristics: ASTM E 136.

07210.1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.

3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

07210.2 PRODUCTS

07210.2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Extruded-Polystyrene Board Insulation:

a. DiversiFoam Products.
b. Dow Chemical Company.
c. Owens Coming.
d. Tenneco Building Products.
e. Engineer approved equal.

2. Glass-Fiber Insulation:

a. CertainTeed Corporation.
b. Johns Manville Corporation.
c. Knauf Fiber Glass.
d. Owens Coming.

3. Metal Building Roof and Sidewall Systems:

a. Thermal Design, Inc.
b. "Simple Saver Systems" 1-800-255-0776.
c. Engineer approved equal.

4. Perimeter Fire-Containment Systems:

a. United States Gypsum Co.
b. Architect approved equal.

07210.2.2 INSULATING MATERIALS

A. General: Provide insulating materials that comply with requirements and with referenced standards.

1. Preformed Units: Sizes to fit applications indicated; selected from manufacturer's standard thicknesses, widths, and lengths.

B. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indices of 75 and 450, respectively:

1. Type IV, 1.60 lb/cu. ft. (26 kg/cu. m), unless otherwise indicated.

C. Unfaced Mineral-Fiber Blanket Insulation (for concealed wall applications): ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

D. Unfaced Mineral-Fiber Blanket for application at metal purlin/roofing and sidewall girt systems: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from glass, slag wood or rock wool with maximum flame-spread and smoke-developed indices of 25 and 50 respectively, passing ASTM E 136 for combustion characteristics.

1. Nominal 3-1/2" batt for application directly under metal roofing and siding system.

2. Nominal 6" batt or thicker for application within the roof purlin spacing concealed by proprietary system vapor barrier.

3. Completed system R-value based on 4'-9" member and wall girt spacing of R-30.

07210.2.3 PERIMETER FIRE-CONTAINMENT SYSTEMS

Where indicated for gaps between the perimeter edge of fire-resistance-rated floor and roof/ceiling assemblies, provide a perimeter fire-containment system with the fire-test-response characteristics indicated, as determined by testing identical systems per UBC Standard 26-9 and UL 20709 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

1. Products: Subject to compliance with requirements provide

a. USG Thermafiber SAFB
b. Architect approved equal.

07210.2.4 VAPOR RETARDERS

A. Products: Subject to compliance with requirements, provide one of the following:

B. Polyethylene Vapor Retarder: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ngfPa x s x sq. m).

1. Application: concealed by gypsum wallboard

C. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

D. Heavy Duty Fire Retardent, Reinforced Polyethylene Vapor Retarder (nominal 8 mil thickness): 2 outer layers of colored polyethylene film laminated to a woven HDPE 900 denier Skrim and weighing not less than 31 lb./1000 sf (14.1 kg/i 00 sq m) with a maximum permeance rating of 0.02 US perms (11.44 ng/Pa x s x sq m), and a flame-spread and smoke developed indices of not more than 25 and 50 respectively.

1. Application: at interior side of all metal building roofs and sidewalls.

2. Custom sizes: match structural bay widths up to 5000 sf per piece.

3. Color: Super White

07210.2.5 AUXILIARY INSULATING MATERIALS

Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

07210.2.6 INSULATION FASTENERS

Products: Subject to compliance with requirements, provide one of the following:

1. Insulation-Retaining Strapping: Continuous painted steel strapping formed from 0.0 16-inch (0.41-mm) thick galvanized steel sheet, sized as required to hold metal building insulation and vapor retarded securely in place, but not less than 1 inch (25.3 mm) in width.

2. Strap Anchors: Metal roof insulation system manufacturer approved painted self-drilling steel fasteners.

07210.3 EXECUTION

07210.3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for
Sections in which substrates and related work are specified and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

07210.3.2 PREPARATION

A. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

B. Close off openings in cavities receiving poured-in-place insulation to prevent escape of insulation. Provide bronze or stainless-steel screens (inside) where openings must be maintained for drainage or ventilation.

07210.3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. At metal roof systems and sidewall systems apply multiple layers of insulation to provide complete fill of purlin/girt depth under slight compression.

E. At walls apply multiple layers of insulation to produce thickness indicated, and as required to make up total thickness.

07210.3.4 INSTALLATION OF PERIMETER INSULATION

A. On vertical surfaces, set units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.

1. If not indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line; 36 inches (915 mm) total piece size.

B. Protect below-grade insulation on vertical surfaces from damage during backfilling by applying protection board. Set in adhesive according to insulation manufacturer's written instructions.

C. Protect top surface of horizontal insulation from damage during concrete work by applying protection board.

07210.3.5 INSTALLATION OF CAVITY WALL INSULATION

On units of plastic insulation, install small pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face, as recommended by manufacturer. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 4 Section "Unit Masonry Assemblies."

2. At wall assemblies indicating metal zee framing, adhesive can be deleted.

07210.3.6 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed-cell (nonbreathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Install mineral-fiber blankets in cavities formed by framing members according to the following requirements:

1. Use blanket widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.

2. Place blankets in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically.

D. Place loose-fill insulation into spaces and onto surfaces as shown, either by pouring or by machine blowing to comply with ASTM C 1015. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.

1. For cellulosic loose-fill insulation, comply with the Cellulose Insulation Manufacturers Association's Special Report #3, "Standard Practice for Installing Cellulose Insulation."

E. Stuff glass-fiber, loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).

07210.3.7 INSTALLATION OF PERIMETER FIRE CONTAINMENT SYSTEMS

A. Install perimeter fire-containment blanket systems to completely fill voids in fire rated construction. Cut and piece material as required to comply with manufacturer's recommended installation procedures.

07210.3.8 INSTALLATION OF VAPOR RETARDERS

A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated and metal strap systems at roof purlins. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs or one roof purlin bay spacing. Fasten vapor retarders to framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches (406 mm) o.c.

C. Seal overlapping joints in vapor retarders with adhesives or vapor-retarder tape according to vapor-retarder manufacturer's instructions. Seal butt joints and fastener penetrations with vapor-retarder tape. Locate all joints over framing members or other solid substrates.

D. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor-retarder manufacturer.

E. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.

F. Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

07210.3.9 PROTECTION

Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

07210.4 METHOD OF MEASUREMENT

Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

07210.5 BASIS OF PAYMENT

Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work.

07500.1 DESCRIPTION

Includes furnishing and installing lightweight fiberglass or foam insulation in buildings or enclosures as shown on the Drawings an in accordance with the requirements described herein.

07500.1.1 RELATED WORK

Not used.

07500.1.2 SUBMITTALS

The Contractor shall provide complete information which includes complete product description and manufacturer's installation instructions in accordance with the requirements of Section 01300.

07500.1.3 DEFINITIONS

Not used.

07500.2 MATERIALS

07500.2.1 FOAM

Foam insulation materials shall be Styrofoam brand insulation board, or approved equal, with a thermal resistance rating (R-Value) per inch of five (5) and a capability of being submerged in water and not absorbing more than 0.1% water by volume.

07500.2.2 FIBER

Fiber insulation materials shall consist of long, resilient glass fibers bonded with a thermosetting resin in batts faced with foil and kraft paper facing which enables the product to carry a fire hazard classification rating of 25/50 or less per ASTM E 84. Unless called for otherwise, the thermal resistance and material shall be Corning, 6”, R-19.

07500.3 CONSTRUCTION REQUIREMENTS

The type, application and installation of either insulation material will be as shown on the Drawings.

07500.3.1 PREPARATION AND INSTALLATION

The Contractor shall carefully prepare the supporting structure to provide a neat fit for the insulation material in accordance with its manufacturer’s recommendations. Appropriate anchor devices or procedures shall be provided to retain the insulation in proper position as recommended by the manufacturer.

07500.3.2 DUCT INSTALLATION

New supply ductwork shall be insulated with 1-pound density, 1-inch thick, fiberglass blanket insulation having aluminum foil reinforced facing complete with vapor barrier. Insulation shall be secured to the sheet metal with clips and adhesive as recommended by the insulation manufacturer. Insulation shall be fitted to the duct surfaces with all joints tightly butted together and against standing seams. All joints and/or holes shall be vapor sealed using an adhesive compound as recommended by the insulation manufacturer.

07500.4 METHOD OF MEASUREMENT

Separate measurement of thermal insulation will not be made when the material is installed as a component of a building or structure listed in the Bid Schedule. Measurement will be included with the building or structure which it serves.

07500.5 BASIS OF PAYMENT

Separate payment will not be made for thermal insulation included in the measurement of a building or structure in which it is installed.

DIVISION 8

DOORS AND WINDOWS

SUNRISE
ENGINEERING

ACCESS HATCH — SECTION 08121SP

08121.1 DESCRIPTION

This section covers furnishing and installing access hatch(s) for entrances into structures as shown on the Drawings or into existing structures in accordance with the requirements described herein.

08121.1.1 RELATED WORK

11388 SP Recirculation Pump

08121.1.2 SUBMITTALS

The Contractor shall provide complete information, which includes cutaway drawings, parts lists, fabrication details, and manufacturer's installation instructions in accordance with the requirements of Section 01300.

08121.1.2.3 DEFINITIONS

Not used.

08121.2 MATERIALS

08121.2.1 QUALITY CONTROL

This specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if, in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

08121.2.2 ACCESS HATCH

08121.2.2.1 The access hatches shall be Series F1R, as manufactured by Halliday, or approved equal. The hatch for the wet well shall be of the size shown on the Drawings. The hatch shall have a fully enclosed curb and stainless steel hardware. The hatch shall be sealed through the use of a caulked neoprene gasket.

08121.2.2.2 The F1R (single leaf) series access frames and covers as manufactured by Halliday Products, Inc. of Orlando, Florida shall have a 1/4" (7mm) thick, mill finish, aluminum frame designed for surface mounting. Door panel shall be 1/4" (7mm) aluminum diamond plate, reinforced to withstand a 10 foot (3m) column of stationary water, or approximately 625 lbs. psf. (28kg. psm) load rating. The door shall incorporate a 90 degree return flange around the perimeter. Stainless steel pressure locks shall be provided to work in conjunction with a 1/4" (7mm) thick neoprene compression gasket, mounted to the under side of the door, to insure minimal water intrusion. Door shall open to 90 degrees and automatically lock with a T-316 stainless steel hold open arm with aluminum release handle. Hinges and all fastening hardware shall be T-316 stainless steel. The method of closure and closing hardware shall meet requirements of the Utah State Division of Drinking Water. Unit shall lock with pad lock lugs. Unit shall carry a lifetime guarantee against defects in material and/or workmanship.

08121.3 CONSTRUCTION REQUIREMENTS

The Contractor shall carefully prepare the opening in the structure to provide a neat fit and full clearance with the inside opening space of the hatch. The hatch shall then be installed in accordance with the manufacturer's recommendations and instructions provided on the Drawings.

The hatches shall be sealed through the use of a caulked neoprene gasket and shall be fastened to the opening by a minimum of eight 3/8" x 4" long stainless steel expansion anchors. Care shall be taken during installation to ensure that a weather-tight seal is achieved between the hatch curb flanges and the structure surface.

08121.4 METHOD OF MEASUREMENT

08121.4.1 NO MEASUREMENT

Measurement will not be made for access hatches that are installed as part of a structure or assembly identified as a separate line item in the Bid Schedule. In such cases, the hatches and their installation will be included in the lump sum quantity represented for that structure.

08121.4.2 SEPARATE MEASUREMENT

When hatches are identified as individual line items on the Bid Schedule, quantities shall be measured by counting the number of hatches in place and accepted. In such cases, measurement will include all necessary labor, equipment, and materials required to complete installation of the access hatch to provide a fully functional system in accordance with these Specifications, as shown on the plans, and as required by the applicable Regulatory Agencies.

08121.5 BASIS OF PAYMENT

08121.5.1 NO PAYMENT

Separate Payment will not be made for access hatches that are installed as part of a structure or assembly identified as a separate line item in the Bid Schedule.

08121.4.2 SEPARATE PAYMENT

When hatches are identified as individual line items on the Bid Schedule, the accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
Access Hatch	Each

08130.1 DESCRIPTION

Includes furnishing and installing exterior steel commercial duty, rolling service doors and hardware in buildings as shown on the Drawings and specified herein.

08130.1.1 RELATED WORK

Not used.

08130.1.2 SUBMITTALS

08130.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, model number, materials of fabrication, dimensions, description of closure unit, and installation instructions and requirements, shall be provided in accordance with Section 01300.

08130.1.2.2 MANUFACTURER'S INSTRUCTIONS - Manufacturer's instructions for operation and maintenance of the doors and hardware shall be furnished to the Owner prior to the time of final acceptance for payment.

08130.1.2.3 DEFINITIONS

Not used.

08130.2 MATERIALS

08130.2.1 DOOR CURTAINS

Shall consist of interlocking curved or flat slats which are roll-formed from hot-dipped galvanized steel. Slats shall be 20-gauge steel, unless shown otherwise on the Drawings, with a minimum overall depth of 3/4-inches. Lateral movement of slats shall be prevented with end-locks.

08130.2.2 DOORS

Shall be mounted with a "face-to-wall" installation with a side overlap to the opening of at least 3-inches on each side of the door opening. Bottom edges of doors shall have continuous flexible tubular vinyl weather-stripping installed as a manufacturer's standard.

08130.2.3 FINISH ON THE DOOR CURTAIN AND APPURTENANCES

The finish on the door curtain and appurtenances shall be bright galvanized unless required otherwise on the Drawings in these Specifications. When a paint finish is required, the door curtain shall be phosphate treated for paint adherence.

08130.2.4 GUIDES, WALL ANGLES AND BRACKETS

Shall be fabricated from structural steel angles with a minimum thickness of 3/16-inches to properly retain and support the door.

08130.2.5 BARREL

Shall be fabricated from structural steel pipe with a deflection of not more than 0.03-inches per foot of span. Sealed ball bearings shall be provided at rotating points of the barrel. Springs shall be oil-tempered, helical-wound, torsion springs, stress relieved after coiling. A galvanized or primer-painted sheet metal hood shall be provided to cover the door when in the open position.

08130.2.6 OPERATION OF THE DOORS

Shall be as shown on the Drawings and required by these Specifications. When not shown otherwise, only manual (push-up) operation will be provided on doors up to 80 square feet and 8-feet or less in height.

08130.2.7 INTERIOR SLIDE-BOLTS LOCKS

Interior slide-bolts locks suitable for padlocks shall be provided with manual operated doors. Motor operated doors shall be locked by magnetic brake.

08130.2.8 MOTORIZED OPERATOR

When called for on the Drawings or in these Specifications, the motorized operator shall be an integral enclosed assembly with a high starting torque motor, fully enclosed gear reducer operating in an oil bath, self locking gearing, geared limit switch, brake, emergency hand chain engaged from the floor with disconnect lever, electrical cutout switch to prevent motor operation during chain operation, internal reversing starter and standard push button station. Push button controls (open, close, and stop) shall be mounted on the interior side of the well adjacent to the door. Operator shall be designed to allow removal of motor without affecting chain operation or limit switch setting. The motor shall be a minimum of 1/3 horsepower, and shall be suitable for 120 VAC, 60 Hz, single-phase power, designed to raise the door at 8 to 10 inches per second. All necessary wiring shall be installed and shall conform to requirements in Section 16010.

08130.3 CONSTRUCTION REQUIREMENTS

Installation of the door shall be made in strict accordance with the door manufacturer's instructions.

08110.4 METHOD OF MEASUREMENT

No separate measurement will be made for overhead doors and their appurtenances which are components of a building indicated as an item in the Bid Schedule.

08110.5 BASIS OF PAYMENT

Payment for overhead doors shall be included in the contract unit price for the building on which the doors are installed and accepted and no separate payment will be provided.

08210.1 DESCRIPTION

Includes furnishing and installing metal framed windows on buildings or enclosures as shown on the Drawings and in accordance with the requirements described herein.

08210.1.1 RELATED WORK

Not used.

08210.1.2 SUBMITTALS

The Contractor shall provide complete information which includes complete material description and manufacturer's installation instructions in accordance with the requirements of Section 01300.

08210.1.3 DEFINITIONS

Not used.

08210.2 MATERIALS

08210.2.1 FRAMES AND SASHES

Frames shall be of heavy-duty, high quality aluminum with the finish shown on the Drawings or required in the Special Provisions. Frames shall be fabricated with the number of sliding sashes shown on the Drawings and fitted with latches to secure the window sashes in the closed position. Sliding sash openings shall be screened with standard bright aluminum screens which can be removed only from the inside. Window frames shall be specifically manufactured or fabricated for use with the materials forming the window opening (i.e. concrete, metal framing, wood framing, etc.). Window sashes for exterior windows shall be manufactured with double panes of glass to form an insulated window, and the window frames shall be fitted with non-metallic heat transmission barriers to minimize heat loss through the frame.

08210.2.2 GLAZING

Clear double strength glass shall be installed in the window sashes unless indicated otherwise on the Drawings. All exterior glazing shall be composed of 1 inch Thermopane with 3/16 inch tinted exterior glass, 5/8-inch air space, and 3/16-inch clear interior glass.

Any interior glass with sashes and frames shall be as shown on the Drawings or required in the Special Provisions of these Specifications.

08210.3 CONSTRUCTION REQUIREMENTS

08210.3.1 INSTALLATION - The Contractor shall install the windows in accordance with the manufacturer’s instructions. Frames shall be securely fastened and sealed with exterior paintable silicone caulking. Installation of the windows shall be made so that operation of the sliding sashes is easy and without any obstruction.

08210.3.2 FINISH - Unless indicated otherwise on the Drawings, windowsills, inside and out, shall be finished and caulked to form a tight seal around the frame. Exterior sills shall be formed with concrete masonry which matches other adjacent building windows or as shown on the Drawings.

08210.4 METHOD OF MEASUREMENT

Separate measurement for Metal Windows will not be made when they are installed as a component of a building or structure listed in the Bid Schedule.

08210.5 BASIS OF PAYMENT

Separate payment will not be made for window materials installed and accepted in a building or structure listed separately in the Bid Schedule.

DIVISION 9

FINISHES

SUNRISE
ENGINEERING

09205.1 GENERAL

The interior finish of the building shall be painted concrete and Fiberglass Reinforced Panels (FRP)

09205.1.1 RELATED WORK

Section 03100 – Concrete Forming, Finishing and Curing
Section 05100 – Floor Gratings
Section 06100 – Carpentry
Section 09910 – Painting
Section 10400 – Safety & Hand Railings
Section 10410 – Aluminum Hand Rails

09205.2 REQUIREMENTS

Concrete - All interior concrete surfaces shall be smooth finished. Formed surfaces shall be ground or grouted as necessary in accordance with Section 03100 of the specifications.

After a smooth finish is achieved, the concrete shall be prepped in accordance with the paint manufacture's recommendations and painted with a minimum of two coats. The paint requirements shall be that of Severe Service as defined in Section 09910 of the Standard Specifications

Walls – Walls shall be finished and insulated as shown in the typical wall detail in the plans. All walls shall be insulated and sheeted with ¾" OSB in accordance with Section 06100 of the Standard Specifications. After the OSB is installed, it shall be covered with vapor barrier and Fiberglass Reinforced Paneling (FRP) in accordance with the Drawings and the manufactures recommendations.

The base of all walls shall be grouted at a 45° angle as shown on the plans, grouted corners shall then be covered with a 14 gauge aluminum flashing to extend 4" minimum over the grouted corner and 6" minimum up the wall, under the FRP panel wall board. Flange shall be installed with non drying silicon, and all seams shall over lap a minimum of 3 inches. Self-adhered air & vapor barrier membrane between FRP & 3/4" OSB, membrane shall be 36 mills minimum of self-adhering SBS rubberized asphalt laminated to a 4 mil minimum cross- laminated high density polyethylene film w/ a silicon release liner. All OSB seams shall be continuously sealed with a non-drying sealant. A 1" rigid foam insulation treated for buried use shall extend from 3" above slab to 24" below grade, the gap between foam insulation and ¾" OSB shall be filled with a foam sealant. The gap between interior and exterior walls shall be filled with blown in R25 fiberglass insulation.

A ¼" thick foam thermal break shall be installed continuously along all structural metal members that are in contact w/ outside metal siding. A foam sealant shall be injected under metal siding as shown on the plans above a corrugated metal foam insert mounted in place with water-proof caulking at the base of the metal siding. A flashing and drip edge shall be installed at the base of the metal siding as well.

2" rigid foam insulation treated for buried use shall be installed for 24" around the entire perimeter of the building underneath the concrete floor slab.

09205.3 METHOD OF MEASUREMENT

The method of measurement for the interior building finishes shall be "lump sum" and shall include but not limited to all labor and materials required to provide the building with a clean finish including FRP paneling, insulation, grouting, OSB, flashing, foam, membranes, sealants, barriers, etc., as specified herein or shown on the drawings. This measurement shall also include all grating, grating supports, handrails, ships ladders, and appurtenances. In summary this item shall include all labor and material as shown in the plans or described in the specifications, or required to make a fully functional treatment operation and provide for a clean finish, in relation to the interior of the building which are not included in other bid items.

09205.4 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
Building Interior Finish	Lump Sum

09210.1 DESCRIPTION

It shall be the responsibility of the Contractor to coordinate with the Owner and/or the Engineer on the color of paint to be used on the referenced materials.

09210.2 MATERIALS

09210.2.1 CONCRETE AND MASONRY

A. The project building(s) shall be constructed as shown on the plans. Concrete work shall conform to the requirements of Division 3, and shall be Class A concrete. All work shall be neat and workmanlike. The surface of the entire structure, both interior and exterior, shall have any irregularities ground smooth. After being smoothed, the exterior surface of the structure shall be brushed with a mixture of 1/3 water, 1/3 cement, and 1/3 sand. The thickness of the brushed on mixture shall not exceed 1/8 inch.

B. Exposed Concrete or masonry interior walls shall be sealed with a high quality concrete sealer and painted with one coat of white, high gloss enamel paint or other color as may be specified.

C. Unless a different color is specified, the interior floor of the building shall be sealed with a gray industrial cement floor sealer.

09210.2.2 P-TRAPS

Drain piping shall be drain waste and vent (DWV) schedule 40 PVC pipe and fittings sized to fit the floor drain in accordance with the Drawings.

09210.2.3 OTHER SURFACES

A. All plywood and other wood surfaces shall be painted with two coats of wood seal primer and one coat of white, high gloss enamel paint unless other colors are specified.

B. All doors shall be painted with two coats of high gloss epoxy paint.

C. All exposed pipe shall be painted with two coats of high gloss epoxy paint. Where required, the paint shall be color coded to indicate the nature of the material being transported in the pipe.

D. All factory painted items should be approved by the Owner prior to delivery to coordinate color combinations.

09210.3 METHOD OF MEASUREMENT

09210.3.1 This work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

09210.4 BASIS OF PAYMENT

09210.4.1 Complete compensation for the accepted work outlined in this Section shall be included in other bid items.

09910.1 DESCRIPTION

The Contractor shall furnish all labor, materials and equipment necessary to paint all designated components of buildings, piping and equipment in accordance with these Specifications.

09910.1.1 RELATED WORK

Not used.

09910.1.2 SUBMITTALS

09910.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature identifying manufacturer, type, content, application recommendations, and color samples, shall be provided in accordance with Section 01300 of these Specifications.

09910.1.2.2 DATA FOR PAINT APPROVAL - Complete data on each type and kind of paint and primer shall be submitted to the Engineer for approval. Approval shall be received from the Engineer before the paint is delivered to the jobsite. This procedure must be followed whether or not the paint that the Contractor proposes to use is named in the Specifications. Approval data shall show where and for what uses each paint product is proposed. Information submitted on each proposed type and kind of paint shall include data to show that the paint meets the detailed requirements of these Specifications.

09910.1.2.3 SAMPLES - The Contractor shall prepare and submit sample colors for all items which require color selection by the Engineer. No color selection will be made until all samples of all paints have been submitted. After all samples of all paints have been submitted, the Engineer will prepare a color scheme using the submitted colors. Colors will not necessarily be standard colors with all suppliers. The manufacturer shall mix colors, to secure the desired color when it is not one of his standard colors.

09910.1.2.4 SAND BLAST PANELS - The Contractor, at the beginning of the Project, shall furnish one square foot steel panels sandblasted in accordance with the sandblasting specifications and coated with non-yellowing shellac or clear non-yellowing plastic coating. Panels shall be used as the standards for preparation of steel surfaces for the duration of the project.

09910.1.2.5 PAINT REMNANT - At the end of the project, the Contractor shall turn over to the Engineer a gallon can of each type and color of paint, primer, thinner, or other coating used in the field painting. If the manufacturer packages the material concerned in gallon cans, then it shall be delivered in unopened labeled cans as it comes from the factory. If the manufacturer does not package the material in gallon cans, and in the case of special colors, the materials shall be delivered in new gallon containers, properly closed with typed labels indicating brand, type, color, etc. The manufacturers' literature describing the materials and giving directions for their use shall be furnished in three bound copies. A typewritten inventory list shall be furnished at the time of delivery.

09910.1.3 DEFINITIONS

Submerged Surfaces - In general, items shall be treated as submerged if they are to be at any time under water or are in structures that normally contain water. Unless specified otherwise, anything below the tops of the walls of such structures shall be considered as submerged.

09910.2 MATERIALS

09910.2.1 QUALITY CONTROL

This Specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

09910.2.2 COLOR

The Engineer will make color selection from color samples provided by the Contractor.

09910.2.3 PAINT SELECTION

All paint and coating systems shall include high quality materials, resistant to temperatures up to 130°F, and sunlight exposure. Paints selected shall meet the manufacturer's recommendations and suitability standards for the specific application where it will be used.

09910.2.3.1 MINIMUM REQUIREMENTS - Minimum requirements for paint materials and their application shall be as shown in the tables below:

EXTERIOR PAINT APPLICATION TABLE

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Wood Siding, Trim, Doors	1	A-100 Exterior Alkyd Wood Primer	2.3
	2	A-100 Exterior Latex Flat House & Trim by Sherwin Williams - OR -	1.3
	1	SUPRIME 8 Exterior	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert- OR -	1.3
		System 2H-4 Alkyd by Tnemec	
	1	Tnemec Series 10-99W Undercoater	2.5
	2	2H-Color Hi-Build Tnemec Gloss	2.5
Porous Masonry (Block)		Series 156 Modified Epoxy Sand Texture Finish by Tnemec	
	2	Series 156, 25 BR	4-8
Concrete Walls, Above Grade	1	Loxon Ext. Masonry Acrylic Primer	3.1
	2	A-100 Exterior Latex Satin House & Trim by Sherwin Williams -OR -	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	2	Series 1029 Acrylic Latex Low Sheen by Tnemec	2.5
Metal (Aluminum)	2	A-100 Exterior Latex Satin House & Trim by Sherwin Williams - OR -	1.3
	1	SUPRIME 3 Latex Metal Primer	1.3
Metal (Aluminum) Continued	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	1	DEFLEX 4020 Primer	3
	1	DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	1.5
Metal, New Steel, (Mild Service)	1	Kem Kromik Universal Metal Primer	2.5
	2	Direct to Metal Enamel by Sherwin	3.0

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
		Williams - OR -	
	1	SUPRIME 3 Latex Metal Primer	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	1	Devguard 4160 Primer followed by	2
	1	Devguard 4308 Alkyd Enamel or	2
	2	DEFLEX 4218 DTM Enamel by DeVoe	2
Metal, New Steel, (Severe Service)	1	Series 27 WB Typoxy by Tnemec	4
	1	73-Color Endura-Shield	2
Metal, Galvanized Steel, (Mild Service)	1	Galvite HS	2.0
	2	A-100 Exterior Latex Satin House & Trim by Sherwin Williams -OR -	1.3
	1	SUPRIME 2 Latex Metal Primer	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	1	Devguard 4020 Primer	3
	2	DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	1.5
Metal, Galvanized Steel, (Severe Service)	1	Series 27 WB Typoxy by Tnemec	4
	1	Series 10 Primer by Tnemec	2
PVC Pipe		System 66-23 Epoxy Polyamide by Tnemec	
	1	66-Color Hi-Build Epoxoline	4

INTERIOR PAINT APPLICATION TABLE

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Woodwork	1	ProMar 200 Alkyd Enamel	1.9
	2	Undercoater ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams-OR	1.7
	1	SUPRIME 11 Int Alkyd Wood Primer	1.5
	2	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.5
Woodwork Continued		System 2H-4 Alkyd by Tnemec	
	1	Series 10-99W Tnemec Primers	2.5
	2	2H-Color Hi-Build Tnemec Gloss	2
Drywall	1	ProMar 200 Latex Wall Primer	2.5
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.8
	1	SUPRIME 1 100% Acrylic MP Primer	1.1
	2	Pro-Hyde Plus Latex Satin by Pratt & Lambert – OR –	1.5
		System 6-1 Acrylic Latex Low Sheen by Tnemec	
	2	Series 1029 Enduratone	2

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Metal (Aluminum)	1 2 1 1	SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR – DEFLEX 4020 Primer DEFLEX 4206 Semi-Gloss Waterborne Acrylic Enamel	1.1 1.5 3 1.5
Metal, New Steel, (Mild Service)	1 2 1 2 1 1 2	Kem Kromik Universal Metal Primer ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR - SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR – Devguard 4160 Primer followed by Devguard 4308 Alkyd Enamel or DEFLEX 4218 DTM Enamel by DeVoe	2.5 1.7 1.1 1.5 2 2.5 2
Metal, New Steel, (Severe Service)	 1 1	System 66-2 Epoxy Polyamide by Tnemec 66-1211 Epoxoline Primer 66-Color Hi-Build Epoxoline	 3.5 4
Metal, Galvanized Steel, (Mild Service)	1 2 1 2 1 2	Galvite Paint ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR - SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR – Devguard 4020 Primer DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	2.0 1.8 1.1 1.5 3 1.5
Metal, Galvanized Steel, (Severe Service)	 1 1	System 66-2 Epoxy Polyamide by Tnemec 66-1211 Epoxoline Primer 66-Color Hi-Build Epoxoline	 3.5 4
Ductile Iron (DI) Pipe and fittings	1 2 1 1 2	SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR – Devguard 4160 Primer followed by Devguard 4308 Alkyd Enamel or DEFLEX 4218 DTM Enamel by DeVoe	1.1 1.5 2 2.5 2
PVC Pipe (Mild Service, Interior Only)	 2	System 6-1 Acrylic Latex Low Sheen by Tnemec Series 1029 Enduratone	 2
PVC Pipe (Severe Service)	 1	System 66-23 Epoxy Polyamide by Tnemec 66-Color Hi-Build Epoxoline	 4
Concrete Walls and Ceilings (Mild Service)	1 2 1	ProMar 200 Latex Wall Primer ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR - SUPRIME 4 Latex Wall Primer	1.1 1.3 1.2

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
	2	Pro-Hyde Plus Latex Satin by Pratt & Lambert	1.5
Concrete Walls and Ceilings (Severe Service)	 2	System 66-4 Epoxy Polyamide by Tnemec Series 27 WB Typoxy by Tnemec	 4
Porous Masonry Walls (Mild Service)	 1 2 1 2	Pre-Prime 167 by Devoe ProMar 200 Latex Wall Primer ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR - SUPRIME 4 Latex Wall Primer Pro-Hyde Plus Latex Satin by Pratt & Lambert	1.5 1.1 1.3 1.2 1.5
Porous Masonry Walls (Severe Service)	 1 2	System 66-15 Epoxy Polyamide by Tnemec 54-660 Masonry Filler Series 27 WB Typoxy by Tnemec	 75-100 4
Concrete Floors (Mild Service)	1 1 2 2 2	Pre-Prime 167 by Devoe Concrete and Terrazzo Sealer (ANCO Cure and Hard by Intermountain Concrete Specialties. Industrial Enamel by Sherwin Williams - OR - With STAND Alkyd Floor Enamel by Pratt & Lambert – OR – Devguard 4328 Alkyd Enamel by DeVoe	1.5 None 2 1 2
Concrete Floors (Severe or Mild Service)	 2	System 67-1 Epoxy Polyamide Semi-Gloss by Tnemec 67-Color Tneme Tread	 2.5

*Brand names of materials have been used to indicate the types and quantities of materials required. Approved equals will be accepted.

09910.2.3.2 PAINT FOR WASTEWATER SYSTEMS - All paint for concrete and metal surfaces in wastewater systems shall be especially adapted for such use.

- Fume Resistance. All paint for final coats shall be fume resistant, compounded with pigments suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide. Pigments shall be materials, which do not tend to darken, discolor, or fade due to the action of sewage gases. If a paint manufacturer proposes use of paint which is not designated "fume resistant" in its literature, it shall furnish full information concerning the pigments used in this paint.

- Lead Paint. No lead paints shall be used.

09910.2.3.3 PAINT FOR POTABLE WATER SYSTEMS - All paint systems to be used in potable water service shall meet NSF requirements. See also Subsection 09910.2.3.5 below.

09910.2.3.4 PAINT FOR SUBMERGED SURFACES

- Coal Tar Epoxy. Coal tar epoxy shall meet and conform with Government Specification Mil P-23236 with further qualification that the coal tar epoxy manufacturer and product must be listed on the current U.S. Navy Qualified Products List. Coal tar epoxy shall be subject to the Engineer's approval.

- Alternate Systems. Alternate coating systems for submerged service, such as Epoxy Polyamide Epoxoline by Tnemec, Epoxy Bar Rust 233H, by DeVoe, or equal, may be required for some applications, or may be approved in lieu of coal tar by the Engineer, upon request. Some colors of Epoxy Polyamide Epoxoline, or equal may be acceptable for use in potable water systems, however the manufacturer must be consulted for verification of acceptability prior to use in potable water applications.

09910.2.3.5 HIGH TEMPERATURE SURFACE TO 400°F - Paint for high temperature surfaces shall be DeVoe Hi-Heat Aluminum HT-4, Glidden 592 Metallite Aluminum, or Sherwin-Williams Silver-Brite Heat resisting aluminum paint B59 S1, or approved equal.

09910.2.4 CLEANING MATERIALS

Cleaning materials shall be best quality solvents, chemicals or detergents, which are commercially prepared for preparing painted surfaces and delivered to the site in sealed containers bearing an identifying label and the manufacturer's name.

09910.3 APPLICATION REQUIREMENTS

ALL paint and coating systems shall be applied in strict accordance with the manufacturer's published instructions for use.

09910.3.1 SURFACE PREPARATION

09910.3.1.1 CLEANING - All surfaces to be painted shall be clean and dry except that in some cases the paint manufacturer's directions may require wetting the surface before painting. Grease and oil shall be removed by wiping with mineral spirits or naphtha per Specification SP-1. Rust, scale, welding slag, and spatter shall be removed and the surface prepared by hand tool cleaning, power tool cleaning, or blast cleaning in accordance with the appropriate Specification SP-2 through SP-10.

09910.3.1.2 METAL SURFACES - Except as otherwise provided, all preparation of metal surfaces shall be in accordance with Specifications SP-1 through SP-10 of the Steel Structures Painting Council (SSPC). Sandblasting procedures shall be as follows:

- No surface, which is to be sandblasted, shall be given a coat of primer or paint in the shop or in the field before sandblasting.

- Unless otherwise specified, all iron or steel surfaces which are to be painted as <u>submerged</u> metal shall be dry sandblasted on the site in accordance with Specification SP-10, near white blast cleaning.

- Except as otherwise specified, all metal surfaces, which are to be painted as <u>non-submerged</u> metal, shall be commercial blast cleaned per Specification SP-6. This sandblasting shall be done not more than 12 hours ahead of the painting, subject to humidity and weather conditions between the time of sandblasting and painting operations. If any rusting of sandblasted surfaces occurs before painting, such rusting shall be removed by additional sandblasting.

- Threaded portions of valve and gate stems, machined surfaces intended for sliding contact, surfaces to be assembled against gaskets, surfaces of shafts for sprockets or to fit into bearings, machined surfaces of bronze trim on slide gates, and similar surfaces shall be masked off to protect them from the sandblasting of adjacent surfaces.

- Cadmium-plated or galvanized items shall not be sandblasted except that cadmium plated, zinc-plated, or sheradized fasteners used in assembly of equipment to be sandblasted shall be sandblasted in the same manner as the other metal.

- Surfaces which cannot be sandblasted, or cannot be sandblasted and then painted after the assembly of which they are a part has been completed and placed in final position, shall be sandblasted, or sandblasted and painted, before the items are put into final position. In some cases, while the painting could be done after the items concerned were in place, the limitation on time between sandblasting and painting may make it necessary to paint the surfaces before installation of those items.

- Sand or other media residue from sandblasting operations shall be thoroughly removed, using any method necessary and consistent with the requirements of the painting system, including vacuum cleaners or other means.

09910.3.1.3 GALVANIZED SURFACES - Galvanized surfaces which are to be painted shall first be treated with Koppers No. 40 Metal Conditioner; Amercoat No. 59 as manufactured by Amercoat Corporation, Brea, California; Galvaprep No. 5 as manufactured by Amchem Products, Fremont, California; or approved equal.

09910.3.1.4 CONCRETE SURFACES - Concrete and masonry surfaces shall be free of dust, mortar droppings and spatter, fins, loose concrete particles, form release materials, oil, grease, and other deleterious materials. If required by the coating manufacturer, such surfaces shall be etched as specified below or brush off blast cleaned per Specification SP-7.

Concrete surfaces specified to be acid etched shall be etched with a 15 to 20 percent solution of muriatic or sulfamic acid until the surface has the texture of find sandpaper. The surface shall then be thoroughly scrubbed with clean water, rinsed, and allowed to dry.

09910.3.1.5 WOOD SURFACES - Wood shall be cleaned and dusted immediately prior to painting. Final dusting shall be accomplished using tack cloth. Shelves, drawers, benches, and associated woodwork shall be sanded before painting and lightly sanded between coats. Prior to application of each coat, the surfaces shall be again dusted with tack cloth to remove all dust.

09910.3.1.6 BITUMINOUS PAINTED SURFACES - Surfaces, which are to be painted with other than bituminous paint, and which have a bituminous coating (such as coal tar varnished pipe), shall be sealed with not less than 2 coats of Inertol Tar Stop; Sherwin-Williams Metalatex B42W100; Glidden Insulcap as manufactured by the Glidden Company; or approved equal. This seal coating shall be applied in sufficient quantity to permanently prevent bleeding of the bituminous coating.

09910.3.1.7 HIGH TEMPERATURE SURFACES - In general, high temperature paint shall be applied to exposed (un-insulated) steam line valves and traps, heat exchangers, and miscellaneous metal piping and equipment in piping and mechanical systems exposed to high temperatures. The Contractor shall paint these surfaces with two coats of high temperature paint as specified herein or as otherwise shown or directed. No painting shall be done on surfaces with a temperature in excess of 125 degrees F at the time of application. Immediately before application of the first coat of paint, the surface shall be sandblasted according to SSPC-SP-5 (Blast Cleaning to “white” metal). See also Subsection 09910.3.1.2 above.

09910.3.1.8 THINNING - No thinning of paint other than as directed by the manufacturer's published directions shall be done without the approval of the Engineer. No painting shall be done under conditions, which, in the opinion of the Engineer, will jeopardize the appearance of quality of the painting in any way.

09910.3.1.9 TINTING OF FIRST COAT - When two coats of the same material are specified, the first coat applied shall be tinted with aluminum powder, lampblack, or other suitable pigment to distinguish it from the top coat.

09910.3.1.10 BETWEEN-COATS TREATMENT - All painted surfaces shall be dusted between coats, and high gloss finish shall be lightly sanded and dusted between coats unless otherwise directed by the manufacturer.

09910.3.2 PAINT APPLICATION

09910.3.2.1 PAINTER QUALIFICATIONS - Contractor or subcontractor personnel applying the coating system shall have had past experience in application of the type or types of coatings and under similar conditions that it will be required to meet in this contract. The qualifications of personnel applying the coating system, whether Contractor or subcontractor shall be verified by the Contractor prior to allowing application to proceed. The Contractor shall not subcontract paint application to a subcontractor that is not qualified to apply the coating system.

09910.3.2.2 WEATHER CONDITONS - No painting shall be done under dusty conditions, during or immediately after a rain, during rainy weather, or when the temperature is less than 50°F.

09910.3.2.3 GENERAL REQUIREMENTS FOR APPLICATION OF PAINT – These requirements shall be as follows:

- All work shall be done in a workmanlike manner, leaving the finished surfaces free from drops, ridges, waves, holidays, laps, or brush marks.
- Where possible, prime coats shall be applied by brush and well worked into the surface, unless directed otherwise by the paint manufacturer.
- Other paints may be applied by brush, roller, trowel, or spray, unless manufacturer's recommendations or these Specifications require a particular method of application.
- Primer and intermediate coats of paint shall be un-scarred and completely integral at the time of application of each succeeding coat.
- Each coat shall be subject to the inspection and approval of the Engineer before the next succeeding coat is applied, and defective work of any kind shall be deemed sufficient cause for re-coating the entire surface involved.
- Where spray application is used, each coat of paint shall be applied to a thickness equivalent to a brush coat application at a coverage rate not greater than that specified by the manufacturer for a brush coat application. All spray painting shall be done with airless type spray units.
- The time interval between paint coats shall meet the recommendations of the paint manufacturer, and these Specifications. The Contractor shall not allow excessive time or exposure between coats, where such excessive time or exposure will impair the bond between the coats.

- The number of coats specified in these Specifications is the minimum to be applied. Suction spots between coats shall be touched up, and additional coats shall be provided if required to produce a finished surface with a solid, even color free from defects.

- The total thickness of the coating shall be as specified. Additional coats of paint shall be added if necessary to bring the total thickness up to not less than that specified. For control, the Contractor shall determine the dry film thickness of the coatings on metal surfaces with a correctly calibrated thickness meter. The Contractor also shall check for holidays with a low voltage holiday detector. The Engineer may use the Contractor's meter and detector for additional inspection and checking deemed necessary.

- Particular care shall be used to assure that the specified coverage is secured on the edges and corners of all surfaces. Additional brush coats shall be applied if necessary to ensure coverage of the edges and corners.

- Damaged paint or scratched painted surfaces shall be sanded smooth before repainting. Sanding and repainting shall be done to such a degree and in such a manner that all evidence of the scratches or damages is obscured.

09910.3.2.4 COAL TAR EPOXY – Application of coal tar epoxy shall be as follows:

- Where called for in the Painting Schedule, shown on the Drawings, or required in these Specifications, concrete and some other submerged surfaces shall be coated with not less than two coats of coal tar epoxy.

- Only components from new, previously unopened containers shall be used to mix coal tar epoxy coatings. Coal tar epoxy shall be mixed and applied in accordance with the manufacturer's recommendations. All coating components shall be mixed with power mixers. The time during pouring or stirring will not be allowed as mixing time. The minimum mixing time as recommended by the manufacturer shall be met. Only unit quantities shall be mixed.

- Coal tar epoxy shall be applied to a total dry film thickness of not less than 16 mils.

- Some metal surfaces may require sandblasting prior to application of the coating system. See Subsection 09910.3.1.2 above.

- In some cases it may also be necessary to apply coatings to parts or subassembly surfaces before they are actually installed at their final Project or system location. All support brackets, stem guides, pipe clips, fasteners, etc. that are bolted to concrete shall be painted on all sides.

- Application of coal tar epoxy shall be performed only at the job site unless specific approval is granted for offsite application. Offsite application will not be allowed unless by an applicator with acceptable proven and documented experience in the application of coal tar epoxy systems.

- Each succeeding coat shall be applied over the previous coat as soon as possible in accordance with the manufacturer's instructions, without causing sagging. Succeeding coats shall not be delayed longer than allowed by the manufacturer's instructions. In no case shall the application of subsequent coats be made after the previous coat has set or oxidized. All coats, and the full thickness on all parts, shall be applied before the previous coat has cured. The Contractor shall check the film thickness after application, and before the coating has

cured, to ensure that sufficient coating thickness has been applied. If additional coating is necessary, it shall be applied the same day. Checking and control of thickness at this stage shall be the Contractor's obligation and responsibility and not the Engineer's.

- If the surface coating has been applied for a longer period of time than the limits in the Table below, and if it is found that bituminous paint has not been applied to the specified thickness, the areas that are too thin shall be sandblasted to remove the surface film from the coating. These sandblasted areas shall then be washed and cleaned with the solvent recommended by the manufacturer and shall be re-coated within the time limits specified for coating over fresh bituminous paint. Washing or cleaning the surface of the paint with solvents or other solutions will not be a satisfactory substitute for the specified sandblasting if the painted surface is older than the time limits indicated in the table. This applies even if the paint manufacturer approves the solvent method as adequate for preparing the old surface.

TEMPERATURES AND COATING TIMES

Average Temperature	Maximum Time Between Coats
50 - 60° F	36 hours
60 - 70° F	24 hours
70 - 80° F	12 hours
80 - 120° F	4 hours

Coal tar epoxy shall not be applied when the ambient temperature is less than 50 degrees.

09910.3.2.5 EDGES AND CORNERS - The Contractor is hereby CAUTIONED that the edges and corners of members are difficult places upon which to build the required thickness of paint. The required thickness must be applied to all surfaces, including the corners and edges, by applying as many spray coats as necessary or by additional brush coats on the corners and edges, if necessary, in order to build up the required thickness.

09910.3.3 FINISH SCHEDULE

The Contractor shall finish all work as follows unless indicated otherwise on the Drawings or within these Specifications:

TABLE OF FINISH SCHEDULES

NO FINISH	FACTORY FINISH	SITE FINISH
Stainless Steel Surfaces	Heating Units	Interior Concrete Building Floors and Walls
Polished Aluminum Surfaces	Electric Control Panel Cabinets	Interior Building Walls & Ceiling
Chain Link or Stock Fencing	Cranes & Hoists	All Interior and Exterior Exposed Piping Valves & Pipe Supports
Name Plates	Gauges and Meters	Exposed Electrical Conduit & Junction Boxes
Exterior Concrete	Instruments	Entry Doors and Frames
Exterior Masonry Surfaces	Light Fixtures and Cover Plates	Wood Moldings and Trim
Exposed Plastic Pipe & Fittings	Electrical Wiring & Transformers	Other Exterior Surfaces Indicated on drawings
Warning Labels	Ventilating Fans	
Operating Instructions	Dampers	
Gratings	Air Conditioning Units	
Buried or Encased Pipe	Metal Soffit & Fascia Covering	
	Roofing and Siding	
	Roll-Up Overhead Doors	
	Motors, Pumps, Equipment	

09910.3.4 CLEANUP

Upon completion of painting, the Contractor shall remove all masking and protective covers and properly dispose of all rubbish, debris and unused paint materials. The Contractor shall remove and cleanup all paint overspray, drips, spatters and etc. from any and all surfaces where it does not belong.

09910.4 METHOD OF MEASUREMENT

09910.4.1 NO MEASUREMENT

Separate measurement for Painting will not be made when painting is included as part of an item, building or structure listed in the Bid Schedule.

09910.4.2 SEPARATE MEASUREMENT

Separate measurement for Painting will be made as a Lump Sum when painting is listed as a separate item in the Bid Schedule.

09910.5 BASIS OF PAYMENT

When Painting is included as part of the measurement of another item, structure or building listed in the Bid Schedule, separate payment will not be made.

When Painting is required for a specific item, the accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
Paint (*Item Description)*	Lump Sum

The following section shall be added to section 9910.2.3:

09910.2.3.6 ALUMINUM IN CONTACT WITH CONCRETE– All aluminum which is to be anchored into or which will be in contact with concrete surfaces shall be coated with a coal tar epoxy bituminous compound as specified in section 09910.3.2.4.

DIVISION 10

BUILDING SPECIALTIES

SUNRISE
ENGINEERING

ALUMINUM HANDRAIL (NON-WELDED PIPE) SECTION 10410

10410.1 DESCRIPTION

The Contractor shall furnish and install aluminum handrails as shown on the Drawings and required by these Specifications. One manufacturer shall supply all aluminum railings used on the project.

10410.1.1 RELATED WORK

Not used.

10410.1.2 SUBMITTALS

10410.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, load capacity, and materials of fabrication for all items furnished under this section shall be provided by the Contractor in accordance with Section 01300 of these Specifications.

10410.1.2.2 CERTIFICATION OF COMPLIANCE - Certification of compliance to the standards and Specifications contained herein shall be obtained from the manufacturer and provided by the Contractor at the time of delivery of these materials to the project site.

10410.1.3 DEFINITIONS

Not used.

10410.2 MATERIALS

10410.2.1 QUALITY CONTROL

This specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

10410.2.2 FEDERAL SAFETY STANDARDS

The handrail system shall comply with minimum Federal safety standards

10410.2.3 HANDRAIL SYSTEMS

10401.2.3.1 MANUFACTURE - Handrail systems shall be the ReynoRail Aluminum Railing System, Connectorail Aluminum Railing system, or approved equal. All fastenings and fasteners shall be as recommended or furnished by the manufacturer.

10410.2.3.2 COMPOSITION - All rails, posts, and fitting-assembly spacers shall be formed from 6063-T5 or T6 extruded aluminum pipe of 1.9-inch OD and 0.145-inch wall thickness. Kick plates shall be fabricated of aluminum alloy 6061-T6. All other aluminum parts shall be 6063 extruded aluminum or F514.0 aluminum castings. Unexposed parts shall be Type 300 series stainless steel. All components shall be completely fabricated and assembled without welding. Plug screws or blind rivets shall be Type 305 stainless steel.

10410.2.3.3 FINISH - Aluminum railing components shall be given a Class I architectural anodized finish on all exposed surfaces after cutting, 4 mils on castings, and 0.7 mils on pipe. Aluminum shall be pretreated before anodizing for cleaning and removing all markings. Anodizing finish shall be clear.

10410.2.3.4 TOE BOARDS - The handrail system shall include toe boards where indicated on the Drawings and on all open sides of walkways or platforms where a person can pass beneath the walkway or platform, where there is moving machinery or where there is equipment with which falling material could create a hazard.

Toe boards shall be 4-inches nominal in vertical height from top edge to level of the floor or walkway. They shall be securely fastened in place with not more than 1/4-inch clearance above floor level.

10410.2.4 GATE MATERIALS

Aluminum gate materials, quality, design and workmanship shall be similar to the aluminum railing, and shall be designed as part of the railing system. Hinges shall be installed so that each gate can swing 180 degrees from the closed position to the fully open position. Gates shall swing to the walkway side of the handrail only. Gate stops shall be installed on the stationary railing posts to prohibit gates from swinging the wrong direction. Latch assemblies shall be of a durable self-locking type. Construction and installation of each gate frame, hinges, gate stops and latch shall conform to OSHA minimum strength requirements. Gate closing springs shall be stainless steel.

10410.3 CONSTRUCTION REQUIREMENTS

The Contractor install handrails where shown on the Drawings in accordance with the manufacturer's recommendations.

10410.3.1 WORKMANSHIP AND PROTECTION OF FINISH

The Contractor shall be responsible for the workmanship, rigidity, and protection of the system finish. He shall use all precautions necessary to protect the finish from scratches, nicks, gouges, dents, etc. during assembly and installation.

10410.3.2 ASSEMBLY AND INSTALLATION

10410.3.2.1 HANDRAIL SYSTEMS – Procedure shall be as follows:

- All pipe cuts shall be square and accurate for minimum joint-gap. Cuts shall be clean and straight, free of burrs and nicks. All holes shall be drilled and countersunk the proper size, as required for a tight, flush fit of assembly screws and all other component parts.

- All fastenings and fasteners shall be as recommended or furnished by the manufacturer, except that pipe rails shall be fastened to fittings with series 300 stainless steel pop rivets or flush set screws.

- Rail shall be erected straight, level, plumb, and true to the positions as indicated on the Drawings. Any deviation from the true line or grade, which is visible to the eye, shall be corrected.

- Posts shall be installed as single un-spliced pipe lengths. Post spacing shall not exceed 6 feet on center. All other attachment brackets shall be spaced as specified on the manufacturer's installation Drawings.
- Top rails shall be continuous whenever possible. Single, un-spliced lengths shall be attached to a minimum of 3 posts in all cases. Lower rails shall be single, un-spliced lengths between posts.

- Where protection is applied for prevention of dissimilar materials electrolysis, care shall be taken that none of the protective material is visible when assembly is completed.

- Fasteners shall be appropriately installed and drawn up tight with a hand wrench or screw driver so that completed railing is rigid and completely free of play at all joints and attachments. All hook bolts shall be tightened to torque recommended by the manufacturer.

10410.3.2.2 ALUMINUM GATES - Aluminum gates shall be installed at openings in the handrails where shown on the Drawings. Each gate shall consist of a gate frame, hinges, gate stops, and a latch. Each gate, in the closed position, shall be in a vertical plane with the handrail.

10410.4 METHOD OF MEASUREMENT

10410.4.1 NO MEASUREMENT

Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

10410.4.2 SEPARATE MEASUREMENT

Where items to be furnished and installed under this section are listed separately in the Bid Schedule, quantities shall be established by using a tape measure or other accurate measuring device to determine the total number of lineal feet of handrail system installed and accepted. This measurement shall include all gates, components, and fittings.

10410.5 BASIS OF PAYMENT

Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work.

When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Aluminum Handrail System	Lineal Foot

DIVISION 11

PROCESS & MECHANICAL EQUIPMENT

SUNRISE
ENGINEERING

11010.1 DESCRIPTION

This section is included for guidance in the selection and installation of mechanical equipment. The requirements contained herein apply to all items of mechanical equipment the same as if these provisions were contained in the individual part of the Specifications for the equipment.

11010.1.1 RELATED WORK

Not used.

11010.1.2 SUBMITTALS

11010.1.2.1 SHOP DRAWINGS – Shop drawings shall be submitted as follows:

- The Contractor shall submit Shop Drawings to the Engineer for approval on all mechanical equipment to be furnished under this Contract in accordance with Section 01300. The number of copies submitted shall be four, PLUS the number of copies the Contractor wishes to have returned.

- Prior to submitting the drawings, the Contractor shall review the information for completeness. Only complete information will be reviewed by the Engineer, and only after the Contractor has signified his approval of the information. Shop drawings will not be approved until cut-away or assembly drawings, with part and material specification lists, have been submitted.

- Shop drawings shall consist of a cover sheet which indicates intended use and data summary, outline drawings, cut-away drawings, parts lists, material specification lists, and all information required to substantiate that the proposed equipment meets the Specifications. In some special cases reproducible transparencies of Shop Drawings shall be furnished to the Engineer in addition to the above mentioned number of copies.

- Shop drawings for motors shall include published dimension sheets and shall include a motor data sheet which shows all the motor characteristics, i.e., horsepower, voltage, code letter, design letter, service factor, enclosure, insulation, etc. All characteristics of the motor shall be shown on the data sheet, which shall be approved by the Engineer prior to delivery of the motor.

- Shop drawings for pumps shall include make, style, speed, size, type, head-capacity, efficiency, materials used, design features, weights, etc. All characteristics of the pump shall be shown on the data sheet, which shall be approved by the Engineer prior to delivery.

- The Contractor shall assume the responsibility to ensure that approved guards for all drive units, pulleys, or rotating shafting are detailed on Shop Drawings and submitted with them to the Engineer for approval.

11010.1.2.2 PARTS CALCULATIONS AND DETAILS - The Contractor shall provide calculations and details on all parts individually and collectively to show that the equipment offered satisfies the performance, strength, vibration, and other requirements of these Specifications.

11010.1.2.3 GEAR REDUCTION UNITS - The Contractor shall submit complete engineering information, catalog data, design features, load capacities, and mechanical efficiency ratings for each gear reduction unit incorporated in the work. This information shall also be included in the equipment Operation and Maintenance Manuals, as described herein.

11010.1.2.4 OPERATION AND MAINTENANCE MANUALS - The Contractor shall furnish to the Owner four (4) copies of Operation and Maintenance (O & M) Manuals for each system or item in accordance with Section 01300 of these Specifications and as follows:

- O & M manuals shall be broken down into sections. The sections shall include Mechanical Equipment, Automatic and Special Valves, Control Systems, Electrical, and other additional sections as necessary. All sections shall be labeled and each item shall be sub-labeled. Each section shall include a description of the operation and maintenance of each item or component included in that section.
- There shall be included in the front of each manual an index laminated with plastic on both sides for protection against rough use.
- Each manual shall be bound in hard cover
- The manuals shall be delivered to the Owner prior to installation of any operating equipment.
- No acceptance of any equipment will be made until the complete manuals have been submitted, evaluated and approved.
- One copy of the complete manual shall be at the jobsite available for use by the Contractor's field personnel, the Owner, and the Engineer during installation, start-up and testing of the equipment.

11010.1.3 DEFINITIONS

Not used.

11010.2 EQUIPMENT

11010.2.1 QUALITY CONTROL

All equipment shall be the product of a manufacturer experienced in the design, construction, and operation of equipment for the purpose required. The manufacturer shall have furnished such equipment long enough to be able to show a record of successful operation for a period of not less than two years. When two or more units of equipment for the same purpose are required, they shall be products of the same manufacturer.

11010.2.2 MANUFACTURER'S GUARANTEE

Manufacturers or suppliers of all equipment furnished under this contract shall guarantee said equipment for a period of 1 full year from the date of Substantial Completion or Final Acceptance of the work in accordance with Section 00700.29 of these Specifications. Equipment shall be made up of parts which are designed to act as a unit; and the manufacturer shall guarantee that when the component parts are assembled into the final unit, these parts will fit and operate satisfactorily.

11010.2.3 ACCOMMODATION TO SEA LEVEL

The elevation of this project above sea level is shown on Drawings. Design and performance of all mechanical equipment shall conform thereto.

11010.2.4 GENERAL REQUIREMENTS

11010.2.4.1 HEAVY DUTY RATING - The manufacturer shall rate all mechanical items heavy duty. All parts of equipment shall be amply proportioned for all stresses, which may occur during operation and for any additional stresses, which may occur during fabrication and erection. Unless specified otherwise, all bearings shall be sized as a minimum for 100,000-hour service at maximum loading under AFMBA B-10 conditions.

11010.2.4.2 STEEL AND IRON - Structural steel shall conform to ASTM A 36. Iron castings shall be tough close-grained gray iron castings in accordance with ASTM A 48.

11010.2.4.3 FASTENERS - All fasteners for aluminum shall be stainless steel. All steel other than stainless steel shall be isolated from aluminum with stainless steel, neoprene, or other approved material.

11010.2.4.4 MODIFICATIONS TO PRODUCTION LINE EQUIPMENT - Modifications shall be made in manufacturer's equipment to make it conform to the specific requirements of the Drawings and Specifications, if the standard product does not fulfill all requirements.

11010.2.4.5 PRODUCTION LINE IMPROVEMENTS - All equipment shall include all production line improvements made prior to the contract or delivery date.

11010.2.5 MOTORS

11010.2.5.1 GENERAL - The purpose of this subsection is to identify and define premium quality electric motors having high electrical and mechanical integrity and energy efficient operation under adverse operating conditions to give maximum life and minimum life cycle costs.

11010.2.5.2 COMPLIANCE – Standards for motors are as follows:

- Motors shall be totally enclosed, either fan-cooled or non-ventilated, squirrel-cage induction motors, NEMA frame size 182T through 449T, as indicated on the Drawings or prescribed in the Special Provisions. Motors shall be Reliance XE or approved equal.

- All motors covered by this specification shall conform to the latest applicable requirements of NEMA, IEEE, ANSI, and NEC standards, including IEEE Std. 841.

- Motors shall be designed for continuous duty for 3-phase, 60 HZ, 200, 230, 230/460 or 575 volt operation, NEMA design B.

- Ratings shall be based on a 40°C ambient temperature and on operation at the given project altitude. Ratings shall provide for a maximum resistance temperature rise of 80°C at a service factor of 1.0, and a 90°C rise at a service factor of 1.15, through 150HP.

- Motors shall be furnished with Class F insulation, 1.15 service factor but shall be selected for operation within their full load rating without applying the service factor.

- Motors shall be of a premium efficient design and shall be different from the manufacturer's standard efficient product.

- Motors shall be evaluated on conformance to this specification and total costs including initial cost and operating life-cycle cost. Life-cycle cost to be based on motor efficiency evaluation at a stated dollar penalty per kilowatt of motor losses based on specific operating conditions.

11010.2.5.3 CONSTRUCTION - Motor rotor construction shall be die cast aluminum or fabricated copper or their respective alloys. Rotors on frames 213T and above shall be keyed to shaft and rotating assembly dynamically balanced to and .0005 inches peak to peak 182T-326T frames, and .00075 inches peak to peak 364T-449T frames. Balance weights, if required, shall be secured to the rotor resistance ring or fan blades by rivets. Machine screws and nuts are prohibited. The entire rotating assembly between bearing inner caps shall be coated with a corrosion-resistant epoxy.

11010.2.5.4 MECHANICAL – Mechanical requirements shall be as follows:

- Bearings shall be ball, open, single row deep groove, Conrad type, and shall have a Class 3 internal fit conforming to AFBMA Std. 20. For belted duty applications, drive end bearing may be cylindrical roller type.

- Bearings shall be selected to provide L10 rating life of 17,500 hours minimum for belted applications, 100,000 hours minimum for flexible direct coupled applications. Calculations shall be based on external loads using NEMA belted applications limits per MG1-14.07 and typical sheave weights and internal loads defined by the manufacturer including magnetic pull and rotating assembly weight.

- Bearing temperature rise at rated load shall not exceed 60°C 3600 RPM or 50°C 1800 RPM and slower. Temperature rise is to be measured by RTD or thermocouple at bearing outer race.

- Bearing AFBMA identification number shall be stamped on motor nameplate.

- Motor lubrication system shall consist of a grease inlet on motor bracket with capped grease fitting on inlet, grease relief plug 180 degree from inlet, grease reservoir in bracket and grease reservoir in cast inner cap.

- Motor to be greased by manufacturer with a premium moisture resistant polyurea thickened grease containing rust inhibitors and suitable for operation over temperature from -25°C to 120°C.

- Bearings shall be protected by INPRO/SEAL bearing isolators on both ends of the motor unless otherwise approved by the Engineer.

11010.2.5.5 ENCLOSURE – Motor enclosure including frame with integrally cast feet, end brackets, locking bearing inner caps, fan guards, and conduit box and cover shall be cast iron, ASTM Type A-48, Class 25 or better.

11010.2.5.6 CONDUIT BOX - Motor conduit box shall be cast iron construction; rotatable in 90-degree increments, diagonally split with tapped NPT threaded conduit entrance hole. Neoprene conduit box cover gasket and neoprene lead seal gasket between box and motor frame shall be furnished. The conduit box shall incorporate a mounted, clamp-type ground lug.

11010.2.5.7 COOLING FAN – The external cooling fan shall be corrosion-resistant, non-sparking, bi-directional, keyed, clamped and shouldered on the motor shaft.

11010.2.5.8 BREATHER DRAINS - Stainless steel automatic breather drains shall be provided in the lowest part of both front and back end brackets to allow drainage of condensation.

11010.2.5.9 MOUNTING HARDWARE - All mounting hardware shall be hex head, high strength, SAE Grade 5, plated for corrosion protection. Screwdriver slot fasteners are prohibited. A forged, steel, shouldered eyebolt shall be provided on all frames. Eyebolt receptacle shall be threaded and designed to prevent moisture or foreign material from entering motor when eyebolt is removed.

11010.2.5.10 NAMEPLATE - Corrosion resistant stainless steel nameplate shall be affixed to motor frame with stainless steel or brass drive pins. Nameplate(s) shall include all required NEMA data and AFBMA bearing numbers, and connection diagram for dual voltage motors.

11010.2.5.11 SHAFT SLINGER - An external V-ring shaft slinger shall be provided on both shaft extensions 254T and larger and on the drive end shaft only 182T-215T to minimize entrance of moisture or foreign material into bearing cavity.

11010.2.5.12 CORROSION PROTECTION - Frame to end bracket assembly of machined parts shall be protected and sealed by application of thick corrosion-resistant material to the machine surfaces prior to assembly.

11010.2.5.13 ELECTRICAL – Electrical requirements shall be as follows:

- All motors shall successfully operate under power supply variations per NEMA MG1-14.30.
- All motors shall be NEMA Design B with torque and starting currents in accordance with NEMA MG1-12.35 and 12.38 except in special applications requiring higher starting torques where NEMA Design C is permitted.
- Motors shall have copper windings.
- Motor insulation system shall be Class F minimum, utilizing materials and insulation systems evaluated in accordance with IEEE 117 classification tests.
- Motor leads shall be nonwicking type, Class F temperature rating or better and permanently numbered for identification.
- The entire wound and insulated stator shall receive an additional coating of epoxy paint on all air gap surfaces, to protect against moisture and corrosion.

11010.2.5.14 FACTORY TESTING - Each completed and assembled motor shall receive a routine factory test per NEMA standards.

11010.2.5.15 NOISE - The no-load sound pressure level, based on the A-weighted scale at 3 feet when measured in accordance with IEEE Std. 85 should not exceed 85 DBA.

11010.2.5.16 EFFICIENCY - All motors shall be of an energy-efficient design, different from manufacturer's standard product through the use of premium materials, design and improved manufacturing process, that reduces motor losses approximately 40% from standard efficient designs, and whose minimum efficiencies exceed NEMA Table MG1-12.6C. Motor efficiency shall be determined in accordance with NEMA Standard MG1-12.54 and full load efficiency labeled on motor nameplate in accordance with NEMA Standard MG1-12.55.

11010.2.5.17 FINISH - All motor parts including frame, brackets, fan cover, and terminal box shall receive a minimum of two coats of high grade USDA accepted epoxy paint. Motor assembly must satisfactorily withstand salt spray tests for corrosion per ASTM B-117 for 96 hours.

11010.2.6 PUMPS

11010.2.6.1 GENERAL - The Contractor shall furnish, install, and test all pumps. Pumps shall be of heavy-duty construction for heavy-duty continuous service or for intermittent service, whichever imposes the most severe service on the pump. Pumps of inferior design or make will not be accepted.

11010.2.6.2 MECHANICAL DEFECTS - Mechanical defects shall include excessive vibration, improper balancing of any rotating parts, improper tolerances, binding, excessive motor heating, defective materials, improper fitting of parts, and any other defect which will in time damage the pump or pumps or unreasonably impair the efficiency of the pumps.

11010.2.6.3 CAUSE FOR REJECTION – Rejection of pumps for cause will be as follows:

- Pumps that have mechanical defects or do not meet the range of head-capacity characteristics, efficiency, and vibration requirements will be rejected and shall be replaced at the Contractor's full expense for furnishing, installing, removal, and replacement.

- If it is found upon delivery that the pump materials do not agree with the requirements of the Specifications as to size, type, quality, or metallurgy, they will be rejected as unfit for use on this project. Bronze or brass parts of any pump in contact with the pumped liquid shall contain no aluminum nor greater than six percent zinc.

11010.2.6.4 FRICTION LOSSES - Pump friction losses, including entrance, column, shaft, and discharge losses shall be added to the total dynamic heads that are specified under each pump in order to get the head that the impeller must pump against. Pump head-capacity curves shall indicate that these losses have been included.

11010.2.6.5 PRESSURE GAUGES - Pumps shall be tapped at the suction and discharge for pressure gauges. In general, all pumps that can be tested by pressure gauges shall be provided with suitable taps on both suction and discharge. Taps may be in pumps or in adjacent pipes within three inches of the pump flange.

11010.2.6.6 TESTING - Each and every pump, with its motor, drive, gearing, etc., shall be checked run, and tested at the place of manufacture. In addition, all pumps shall be volumetrically tested as to head-capacity requirements and for the purpose of cross checking the calibration of meters as required by the Engineer, after installation. Four certified laboratory performance curves for each pump shall be submitted to the Engineer for approval before shipment of the pump.

11010.2.7 MECHANICAL POWER TRANSMISSION EQUIPMENT

All mechanical power transmission equipment including V-belts, sheaves, chains, sprockets, mechanical variable speed drives, gear reducers, open and enclosed gearing, clutches, brakes shall be rated for 24-hour a day service and sized with a minimum service factor of 1.5. The 1.5 service factor shall be related to the nameplated HP and torque of the prime source of power and not the equipment actual loading. Should the manufacturer recommend a service factor larger than 50%, the manufacturer's recommendation shall take precedence.

11010.2.8 GEAR REDUCTION UNITS

11010.2.8.1 CONSTRUCTION - Unless otherwise specified, all gear reduction units shall be helical or herringbone type. No planetary gear units shall be used for any purpose, and worm gear type units may be used only where specified. Gears of gear reduction units shall be made of highest quality alloys treated for hardness and severe service. The complete reduction unit shall be fully enclosed

in a heavy cast iron housing with gears running in oil. All bearings shall be of the anti-friction type.

11010.2.8.2 CLASS OF SERVICE - Gear reduction units shall be selected for the class of service specified. The class of service must be determined by the manufacturer of the gear reduction units after being informed by the Contractor as to what equipment the units are to be used for and to what type of duty the equipment will be subjected. Where no class of service is specified, gear reduction unit class of service shall be Class II or heavier, as required, as classified by the American Gear Manufacturers Association.

11010.2.8.3 CAPACITY AND PERFORMANCE - The actual and rated horsepower capacity, torque, overhung capacity, and bearing capacity of each reduction unit shall be not less than the horsepower rating of the drive motor nor less than that which will be encountered under full load and under the most severe operating conditions which the equipment will be called upon to operate. The Engineer may reject any gear reduction unit that does not meet the above requirements. Only gear reduction units of long established manufacture and reputation may be used.

11010.2.9 SPECIAL TOOLS

All special tools that are required to assemble, disassemble, repair, and maintain any item of mechanical equipment shall be furnished with the equipment. Special tools shall include any type of tool that has been specifically made for use on an item of equipment for assembly, disassembly, repair, and maintenance. When special tools are provided, they shall be marked or tagged, and a list of such tools shall be included with the maintenance and operation instructions describing the use of each marked tool.

11010.2.10 LUBRICATION FITTINGS

All lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housing, or guards. Fittings shall be accessible from safe, permanent walk or walk areas without ladders, scaffolds, etc. Fittings shall be Lincoln “Bullneck” Hydraulic Surface Check Fittings (Lincoln Engineering Co., St. Louis, Missouri), or approved equivalent. Lubrication fittings shall be mounted together wherever possible. They shall not be individual fittings field mounted together, but use shall be made of factory-mounted multiple fitting assemblies located in convenient area. Connection from multiple fitting assemblies to point of use shall be minimum 3/16” stainless steel tubing, securely mounted parallel with equipment lines and protected where exposed to damage.

11010.2.11 MACHINERY AND EQUIPMENT GUARDS

11010.2.11.1 CONSTRUCTION AND INSTALLATION - All machinery drive units, pulleys, or rotating shafting shall be furnished with approved guards, shields, or barriers. Such guards, shields, or barriers shall be neatly and substantially constructed, adequately supported from adjacent framing,. Guards shall be constructed of 6061-T6 aluminum unless otherwise indicated. The frame shall be covered with expanded aluminum for heat dissipation. All guards shall be isolated so no dissimilar metals come into contact.

All guards shall be sized to allow installation of pulleys up to and including 15 percent over size. The width of the guard shall be such as to allow one additional belt to be added in the future.

11010.2.11.2 COMPLIANCE - Guards shall be provided in all cases where required by state or OSHA or local codes. While all such guards may not be shown in detail on the Drawings, the Contractor is

expected to be familiar with the requirements of local, state, and federal regulations regarding machinery guards and safety devices.

11010.2.12 PAINTING

All equipment furnished for the project shall be painted in accordance with the requirements of Division 9 of these Specifications.

11010.3 EQUIPMENT CONSTRUCTION, INSTALLATION, AND TESTING

11010.3.1 GENERAL

The furnishing and installation of equipment shall include testing, painting, checking levels and alignment, furnishing and placing of lubricants of whatever type, and furnishing of factory-trained service mechanics or engineers where called for. All equipment when finally installed shall be complete and ready for operation without binding or overloading of critical components or motors. The Contractor shall furnish at no extra cost to the Owner all appurtenances, piping, valves, fittings, wiring, supports, hangers, etc., as are required to place the equipment in first-class operating condition and in a near and workmanlike manner.

11010.3.2 INSTALLATION

11010.3.2.1 GENERAL - Equipment shall be installed complete and ready to operate by skilled craftsmen. Each craftsman employed to install a specific type of equipment shall be thoroughly trained in the particular trade required to install that equipment.

All moving parts of equipment and machinery shall be carefully installed, tested for operation, and adjusted so that all parts move freely and function to secure satisfactory operation.

11010.3.2.2 WELDING - Qualified welders in accordance with applicable welding codes and procedures shall perform all welding. Welding shall be by electric arc, unless otherwise shown on the Drawings or required by these Specifications.

11010.3.2.3 ANCHOR BOLTS - Anchor bolts for heavy equipment shall be encased in metal tubing having an inside diameter not less than two times that of the bolt, unless otherwise detailed on the Drawings. Foundations for pumps, motors and other equipment shall be left one inch below the grade of machine base unless otherwise required on the Drawings. After the proper setting of machine for alignment and grade, the recess below the equipment base, together with recess between the anchor bolt and the metal tube, shall be grouted and carefully finished with non shrink grout.

11010.3.2.4 PIPING - All piping required for proper operation of equipment shall be installed. Piping layouts may require modification from that shown on the Drawings depending on equipment furnished. All costs for piping or piping modifications required to suit the particular equipment furnished shall be borne by the Contractor.

11010.3.2.5 ELECTRICAL - Unless otherwise specified herein all electrical work, materials and equipment shall conform to the provisions of Division 16, Electrical of these Specifications. It shall be the responsibility of the Contractor to provide complete electrical systems sized to suit the equipment furnished and installed.

11010.3.2.6 ALIGNMENT OF MOTORS AND EQUIPMENT – Alignment of motors and equipment shall be as follows:

- In general, checking and correcting the alignment shall follow the procedures established in Section B (1X) of the Standards of the Hydraulic Institute, Instructions for Installation, Operation, and Maintenance of Centrifugal Pumps, as applicable.

- In all cases, the equipment shall be properly leveled and brought into angular and parallel alignment.

- Equipment bases shall not be grouted nor foundation bolts finally tightened until all piping connections are complete and in satisfactory alignment, such that no strain is transmitted to the equipment.

- In every case where a drive unit is connected to a driven piece of equipment by a flexible coupling, the coupling halves shall be disconnected and the alignment between the motor and the equipment checked and corrected after the complete unit has been leveled on its foundation. The alignment shall then be checked and corrected again after the grout has cured and the foundation bolts have been tightened.

11010.3.2.7 GROUTING – Grouting shall be performed as follows:

- Machinery shall first be perfectly aligned and leveled by means of steel wedges and shims near the anchor bolts. Anchor bolts shall be tightened against the shims on wedges before placing grout.

- Before grout placement, equipment foundations shall be prepared by chipping, hammering or sand blasting the entire concrete surface which will be grouted to remove any dirt or grease and to expose the concrete aggregate, unless approved otherwise by the Engineer.

- The equipment shall again be checked for level and alignment.

- The roughened foundation shall then be thoroughly cleaned, and the grout shall be thoroughly packed into place, filling all voids under the base of equipment.

- Special non-shrink grout shall be used in the placement of all heavy equipment and equipment bases. Non-shrink grout shall be as specified in Division 3 of these Specifications.

- Grout around all machinery bases shall be neatly pointed. All sandblast residue, grease, and debris shall be removed before any grout placement is started.

11010.3.3 TESTING

11010.3.3.1 GENERAL - Before testing, all equipment and mechanisms shall be filled by the Contractor with the proper amounts and types of oil and grease as recommended by the equipment manufacturer. The Contractor shall furnish all personnel, chemicals, and other necessary items as are required for the initial testing of equipment.

11010.3.3.2 DURATION OF TEST - Generally each piece of equipment, which in its normal use will operate for prolonged periods, shall be operated by the Contractor for at least 24 hours after installation, unless the Engineer is satisfied that a shorter test period is adequate. Satisfactory completion of this test does not relieve the Contractor of his responsibility in the event of binding, overloading, over-heating, or other equipment failure or malfunction after initial testing is performed.

11010.3.3.3 VIBRATION - The prime supplier shall make field tests for acceptable vibration in the on all pumps or other equipment with rotating shafts and/or a drive unit. Units shall be field tested for vibration after installation using the following process:

- All vibration testing shall be performed in the presence of and be witnessed by the Engineer. Testing shall be as required by the Engineer at various speeds between maximum and minimum. The Engineer shall be furnished a complete copy of vibration test data for each test performed.
- Each unit shall be tested separately with no other unit running.
- Drive systems, complete with motors, in place at the jobsite shall not vibrate more than 0.012 amplitude inch. Amplitude as used in this Section shall mean total peak-to-peak displacement, and it shall be measured by an IRD Vibration Meter, Model 306, or approved equal.
- All field tests shall be running tests with the drive unit driving the equipment.
- The equipment shall be free of static unbalance; shall be free of dynamic unbalance up to the maximum speed of the drive system; shall have the torsional critical speed 20 percent above the maximum speed of the pump and drive system.
- Vibration that occurs at the rotational critical speed shall not be greater than 0.012 amplitude inch; and shall be free of apparent unbalance caused by defective bearings, by close-fitting parts which may rub on the rotating parts intermittently, by loose discs or rotor parts, unbalanced loads, or by oil whip.
- Unless directed otherwise by the Engineer, vibration shall be measured at the top of the motor.

11010.3.3.4 NOISE LEVELS – Noise levels for the equipment and motors shall be measured in the field in accordance with AGMA 295.03. The combination equipment and motor, shall be designed to emit not more than 85 dBA when the measurements of the "C" network of the sound level meter are converted to "A" network readings or read directly on "A" network, unless otherwise specified. The manufacturer shall guarantee the sound levels specified. Enclosures built over the units are not acceptable as a means to meet specified sound levels. Each piece of equipment and its driver shall be tested through the range of possible operating speeds.

11010.4 METHOD OF MEASUREMENT

Not used.

11010.5 BASIS OF PAYMENT

Not used.

Ultraviolet Disinfection Equipment	SECTION 11250SP

11250.1 GENERAL

11250.1.1 DESCRIPTION

11250.1.1.1 Scope:

This Section covers the requirements for supplying all labor, materials, equipment and services necessary to furnish and install an open channel, gravity flow ultraviolet (UV) disinfection system as it is specified herein and shown on the Contract Drawings.

The contractor shall furnish and install a fully functioning Ultraviolet Disinfection system as shown on the drawings and described in these specifications. The system is to be installed by the Contractor and tested and commissioned by the Manufacturer of the UV System Representatives as specified herein.

11250.1.1.2 RELATED WORK AND REFERENCED SECTIONS

1. Section 1300: Submittals
2. Division 3: Concrete
3. Division 16: Electrical & Instrumentation
4. Division 17: Instrumentation and Controls

11250.1.2 QUALITY ASSURANCE

11250.1.2.1 Pre-qualification Requirements: Any alternate UV System Supplier that is not listed as approved equal must submit the following 15 days prior to the bid date to be considered for approval:

1. Evidence of qualification and at least ten (10) years of experience in manufacturing and delivering open channel UV disinfection systems using low pressure high output amalgam lamps.

2. The proposed UV System Supplier must be able to demonstrate a minimum of fifty (50) permanent installations of this equipment type in similar applications.

3. Submittal including UV system details, control panel, lamp and ballast descriptions, and engineering reports stating headloss. Calculation or validation of the delivered dose will also be submitted for consideration.

4. The UV system must utilize an active control based on the following dose parameters: Lamp output intensity, quartz sleeve transmittance, flow rate. Based on these parameters, the system shall automatically vary the UV lamp power within a range of 50% to 100% proportionally to the dose requirement.

5. The UV system must be equipped with a pneumatically powered automatic wiping system and shall use Teflon/Viton sandwich wipers to clean the quartz sleeves. Other cleaning systems will be considered on a case by case basis. However, all cleaning systems must not contain any chemical which may harm fish.

6. A statement by the UV System Supplier listing any deviations or exceptions taken to these specifications will be submitted. State specification reference and proposed alternative with reason for exception.

7. Description of UV System Supplier's service capabilities including local support offered for technical service and spare part availability.

8. Manufacturer shall provide a complete copy of the full NWRI validation report including all algorithms and shall confirm that the system has been sized based upon that validation report with support calculations.

11250.1.2.2 Design Approach (NWRI):

The UV system shall be tested in accordance with the NWRI guidelines by an accredited 3rd party engineer using full bioassay results on an independent test site.

11250.1.2.3 Design Criteria:

11250.1.2.3.1 Provide UV equipment, which shall disinfect aquaculture, feed water with following characteristics:

Peak Design Flow	3.87	MGD
Max Total Suspended Solids (TSS)	15	mg/l
Max Particle Size	<10	Microns
Max Turbidity	<2	NTU
Max Iron	< 0.3	mg/l
Max Manganese	< 0.05	mg/l
Max Hardness	<100	mg/l
UV Transmittance @ 253.7 nm	75	%
Water Temperature	41 deg. F to 86 deg. F	
Ambient Air Temperature	41 deg. F to 86 deg. F	

11250.1.2.3.2 The provided UV equipment shall be configured as follows:

Number of channels	1	
Number of banks per channel	3 (2 duty, 1 standby)	
Number of UV modules per bank	3	
Number of lamps per UV module	10	
Total number of lamps in the UV system	90**	
Max head loss per channel at peak design flow	<18	inches
Max power consumption of the UV system (lamps and ballasts only)	32.4	kW
Max power consumption of the UV system (including fan-cooling)*	36.9	kW
Power Supply	480 volts, 3 phase, 60 her	

*Maximum power consumption shall be measured at the point where the power is coming into the electrical enclosure.
**Minimum number of lamps for systems using 330 watts or greater per lamp. System with lower powered lamps shall increase their number of lamps proportional to the difference in power per lamp. Or the system must provide independent data demonstrating that UV intensity is equivalent to this number of lamps specified, and are capable of producing the minimum UV dose at end of lamp life with fouled sleeves.

11250.1.2.3.3 The UV channel dimensions shall be as follows:

Channel width	28.0	inches
Channel width at level control	28.0	
Channel total depth	39.0	
Channel water depth	23.2	
Channel length	420	

11250.1.2.4 Performance Requirements:

The UV disinfection system shall deliver the Minimum UV Dose at Peak Design Flow capacity, minimum operating water temperature, and the minimum design UVT, with lamp output adjusted to account for the combined lamp degradation and fouling factors to simulate the end of lamp life condition.

The end of lamp life output is based on a Lamp Aging Factor determined from independent testing in accordance to the NWRI Guidelines and is guaranteed by the UV System Supplier. The minimum end of lamp life output is calculated from the nominal lamp output, which is defined as the full power lamp output after 100 hours of lamp operation.

If no independent third party testing has been conducted, the default factors as described in the NWRI Guidelines must be used: Aging Factor = 0.50, Fouling Factor = 0.80 The use of a higher lamp aging or quartz sleeve fouling factor will be considered only upon review and **approval** of independently verified data that has been collected and analyzed in accordance with protocols described in NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (May 2003). However, the lamp aging factor shall not exceed 0.90.

Based on the Design Criteria, the effluent shall be in compliance with the performance requirements as follows:

Min UV Dose (NWRI)	50 mJ/cm² @ end of lamp lifetime with fouled sleeves
Lamp Aging Factor	0.87
Fouling Factor	0.90

The basis for evaluating the UV dose delivered by the UV system will be the independent third party bioassay, without exception. Bioassay validation methodology to follow protocols described in NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (May 2003).

11250.1.2.5 Spot Check

The Owner, at their expense, may at any time elect to perform a full bioassay spot check in accordance with NWRI guidelines.

11250.1.3 SUBMITTALS

The following documents shall be submitted for review:

A. Technical description in sufficient detail to permit an item comparison with the specification.
B. General arrangement drawing of the UV vessel, including details necessary for installation.
C. Electrical drawings
D. Dose Calculation or Validation Report documenting the UV dose delivered by the system
E. 5 Copies of the Operation and Maintenance Manuals.

11250.1.4 WARRANTY

A. The equipment furnished by the UV System Supplier (excluding all consumables such as UV lamps and wiper rings) shall be warranted to be free of defects in material and workmanship for a period of one (1) year from start-up or 18 months after shipment, whichever occurs first. In the event a component fails to perform as specified, or is proven defective in service during the warranty period, the manufacturer shall promptly replace the defective part at no cost to the Owner.

A. The UV lamps shall be warranted for a minimum of 12,000 hours operating time under the conditions specified herein and include max 4 on/off cycles per 24 operating hours.

B. In case of premature UV lamp failure, the UV System Supplier shall offer the following:
   1. Lamp failure before 9,000 hours - send a replacement lamp free of charge
   2. Lamp failure after 9,000 hours - issue a credit proportional to the hours not used

11250.2 PRODUCTS

11250.2.1 MANUFACTURER

A. The physical layout of the system as shown on the Engineering Drawings and the equipment specified herein are based upon the WEDECO TAK 55 Series as manufactured by ITT Water & Wastewater, or approved equal.

B. Other UV manufactures will not be eliminated based strictly on the layout and design of their system, in as much as those differences do not decrease functionality, quality or ease of operation and maintenance, nor compromise the intent of the specification. Each UV system will be considered on a case by case basis in regards to if the intent of the specification is met. One such system that would be considered as a possible acceptable alternative is the Trojan UV3000Plus system, if it is able to meet the intent of this specification. Any changes to the layout of the facility resulting from using a manufacturer other than that which the system was designed around will be the responsibility of the contractor with no additional cost to the owner.

C. If other equipment is proposed, the Contractor will demonstrate to the Engineer and the Owner that all requirements of materials, performance, and workmanship have been met or exceeded by the equipment proposed. Contractors proposing alternate manufacturers will be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical and civil aspects of the installation.

D. To be acceptable, the UV system must operate in an open channel and use low pressure high output amalgam UV lamps. The UV lamps shall be oriented horizontally and parallel to the flow.

11250.2.2 GENERAL REQUIREMENTS

A. Provide a UV system complete with UV modules, electrical enclosure(s), automatic wiping system, UV intensity monitoring system(s), and water level controller(s) as herein specified.

B. All material exposed to UV light shall be Type 316 stainless steel, Type 214 quartz, Teflon or other suitable UV resistant material.

C. If a different design for the UV system is proposed, the Contractor shall be responsible for any changes in layout or design of equipment. For UV systems with ballasts located within or directly above lamp modules, additional overflow channels with overflow pipes for flow diversion may be necessary, and if necessary shall be included to protect the ballasts from possible flooding in case of inadvertent water level rises within the channel. The UV manufacturer shall submit proposed conceptual design as part of bid package. The UV manufacturer and CONTRACTOR will be responsible for detailed design submittal including provision to get diverted flow back to the head-works.

11250.2.3 LAMP ARRAY CONFIGURATION

A. The lamp array configuration shall be uniform with all lamps parallel to each other and to the flow. The lamps shall be spaced per the manufacturer's standard design. Lamp array perpendicular to the flow shall not be acceptable.

B. The single array pattern shall be continuous and symmetrical throughout each UV bank.

C. The system shall be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the effluent. Both lamp electrodes shall operate at the same temperature and be cooled by the effluent.

D. Systems designed whereby the lamps are inserted through a metallic bulkhead or which otherwise prevent continuous cooling of the lamp electrodes by the effluent shall not be permitted.

11250.2.4 UV LAMPS

A. The UV lamps shall be low pressure, high output amalgam lamps such as WEDECO Spektrotherm© lamps, or approved equal.

B. The low pressure high output amalgam UV lamps shall have an arc length of 56.3 inches (143 cm) and use lamp bases made of metal and ceramic construction, resistant to UV and ozone.

C. Medium pressure or other UV lamp types with a polychromatic UV output which require a higher connected electrical load than specified to deliver the specified total UV-C (253.7 nm) output wattage shall not be acceptable.

D. The minimum UV lamp output after a 100 hour burn-in period shall be 150 watts of UV-C energy at a wavelength of 253.7 nm. Low pressure amalgam UV lamps with less than 150 watts UV-C output at 253.7 nm shall not be acceptable.

E. In case of a power failure, the UV lamps shall not require more than 10 minutes cool down period prior to re-start.

F. The UV lamp output shall not fluctuate more than 5% due to water temperature variations between 41 to 86 deg. F (5 to 30 deg. C)

G. The operating skin temperature of the UV lamp shall not exceed 266 deg. F (130 deg. C) in order to minimize the possibility of quartz fouling.

H. The UV lamp filaments shall be the rugged clamp design to withstand shock and vibration. Each lamp base shall incorporate a dielectric barrier or pin isolator. The pin isolator shall

consist of a non-conductive divider placed between the lamp pins to prevent direct arcing across the pins in moist conditions. The barrier shall be dielectrically tested for 2500 volts.

11250.2.5 UV LAMP ASSEMBLIES

A. Each UV lamp assembly shall consist of a UV lamp, enclosed in an individual quartz sleeve, and with the one end appropriately sealed using an O-ring sealed quartz end plug.

B. UV lamps shall be removable with the quartz sleeve and wiper system remaining in place.

C. The UV lamp sleeve shall be a single piece of clear fused quartz circular tubing, open at one end. It shall be rated for a minimum UV transmittance of 92%, which shall not be subject to degradation over the life of the system.

D. All electrical connections to the lamp assembly shall be made at one end through a four pin, watertight plug connector.

E. The electrical connection end of the quartz sleeve shall be sealed by means of a protective retainer plug designed with dual o-rings to seal and hold the sleeves in parallel alignment. The retainers shall remain in place to protect the quartz sleeve ends against accidental damage, without impeding the removal and replacement of the UV lamp.

F. The lamp socket shall be centered against the inside of the quartz sleeve and shall be retained by a cap nut with a ribbed exterior surface providing a positive handgrip for tightening / loosening without the need for any tools. This connection shall include a self-contained o-ring, sealing the lamp and socket assembly (independent from the quartz sleeve).

11250.2.6 UV MODULE

A. Each UV module shall consist of a dual (side-by-side) row configuration of UV lamp assemblies, with 5 pairs of lamp assemblies in the vertical direction, giving a total of 10 lamp assemblies per module.

B. The module frame shall be constructed of stainless steel with stainless steel spring tension clips for holding the lamp assemblies in place. The top of the frame shall also serve as a UV reflector shield to prevent UV light from the exiting the UV bank area.

C. The end of the lamp sleeve shall not protrude beyond the stainless steel frame of the UV module.

D. The UV module shall be connected to NEMA 4 rated modular, quick disconnect plugs and sockets on the junction box, for ease of removal, by means of separate sets of multi conductor cables, each covered by a flexible stainless steel conduit. The plugs shall connect the power cables to the lamps in the module, interlock and sensor cables, and wiping system airlines.

E. The UV modules shall be designed such that operating personnel at the plant can change the lamps and quartz sleeves without requiring special tools.

F. Each UV module shall be equipped with an interlock switch, which will automatically disconnect power to its associated UV bank if a module is raised from the UV channel or a quick disconnect plug is removed.

G. The UV modules shall be designed for submergence above the top of the UV lamps only without causing failures or damage to the system or components. Damage to the limit switches, wiper lifted switches, intensity sensor and wiper cylinder can occur if water rises to or above the module top plate.

H. The UV module support shall be a 304 stainless steel bar mounted in a position above the effluent level in the channel allowing precise adjustment of the module position within the channel during installation. Once correctly positioned, the frame will allow for permanent fixing to prevent any movement during the life of the installation.

I. All wetted stainless steel parts need to be fabricated out of 316 stainless steel.

11250.2.7 AUTOMATIC WIPING SYSTEM

A. Each UV module shall be equipped with an automatic wiping system with selectable wiping frequency and number of strokes per wiping cycle. The wiping system shall be PLC controlled and provide a fully automatic, unattended operation.

B. Systems without automatic mechanical wiping or systems requiring chemicals which may harm fish or removal of the module from the channel as the only means of cleaning will not be acceptable. Wiping systems that require the excessive maintenance of an integral chemical reservoir in order to function are not acceptable.

C. The automatic wiping system shall be pneumatically powered and shall use Teflon/Viton sandwich wipers to clean the quartz sleeves. The actuator for the wiping system shall be a pneumatic cylinder mounted to the underside of the module top plate. Wiping systems operating hydraulically or electrically will be considered on a case by case basis. All fluids which are used in the UV system must be “fish friendly”.

D. The useful life of the wiper brush or cleaning device in contact with the quartz sleeve shall be in excess of two years based on factory stroke and interval settings.

E. The wiper blade brush or other cleaning device in contact with the quartz sleeve shall be non-metallic and shall not damage or scratch the quartz sleeve or sensor in any way.

F. The wiped length of the quartz sleeve shall be no less than 56 inches or the complete lamp arc length, whichever is greater.

G. The wiping system airlines shall be quick connect type and shall not require the separate connection or disconnect of compression type fittings for installation or removal of the module from service. Each airline connector in the quick disconnect plug and socket shall have an integrated check valve so that upon removal of a module from service, system pressure is maintained.

H. A compressor with suitable sized receiver tank and all installation and control equipment shall be furnished for the automatic wiping system.

11250.2.8 UV MONITORING SYSTEM

A. One (1) UV intensity sensor shall continuously monitor the UV intensity in <u>each</u> bank of UV modules.

B. The physical construction of the sensor shall be high quality and have a third party calibration certificate.

C. The UV intensity sensor shall measure only the germicidal portion of the light emitted by the UV lamps as measured at 253.7 nm. It shall have sensitivity at 253.7 nm of greater than 95%. Sensors whose sensitivity to other wavelengths amounts to more than 5% of the total sensitivity shall not be allowed.

D. The UV intensity sensor system shall be factory calibrated. Calibration shall be valid for a minimum of one (1) year unless otherwise specified.

E. The measured intensity shall be displayed on the operator interface as an absolute value in mW/cm^2.

F. The UV sensor shall be automatically cleaned at the same frequency as the lamp sleeves to prevent fouling of the sensor and hence spurious false alarms for low intensity. Systems without automatic cleaning of the intensity sensor shall not be acceptable.

11250.2.9 WATER LEVEL CONTROLLER (DOWNWARD OPENING GATE WEIR)

A. Control of water level shall be provided with one (1) electric motor actuated downward opening gate weir per channel. Gate weirs not utilizing actuators shall not be acceptable.

B. The dimensions of the weir shall be designed in accordance with the channel geometry and the peak hydraulic flow. Taking a maximum headloss restriction of 14 inches into account (including 4 inches of freefall).

C. Weir frame shall be suitable for end of channel or in channel mounting and incorporate resilient seals. Any tensioning adjustment units shall be mounted on the downstream side of the gate to enable adjustments without draining the channel.

D. Single or duplex stainless steel rising screw stems shall terminate in the drive sleeve of a modulating actuator or pair of gearbox units with drive shaft to modulating actuator. The modulating actuator shall be mounted on a stainless steel stool fixed directly to the frame.

E. Control of the weir position by PLC shall maintain a constant water level under all flow conditions in the channel to ensure optimum disinfection conditions are maintained. An ultrasonic level sensor mounted onto a fixed structure above the channel shall measure the channel level continuously. The channel level shall be used by the PLC to provide modulating control of the downward opening gate utilizing a PID control algorithm. The PID parameters and actuator run / dwell time setting shall be adjusted at commissioning of the system to suit the hydraulic characteristics of the works and minimize system hunting.

   In the event of system failure such as two banks failing or if the UV dosing drops below a critical level for more than one bank of UV modules the weir gate shall automatically rise to full height, preventing untreated water from discharging.

11250.2.11 ELECTRICAL & CONTROL SYSTEM

A. General

   1. The electrical system shall be designed to provide:
      a. Maximum reliability of the UV disinfection system

b. Segregation of plant services and supplies into sensible groups to allow for safe and simple maintenance or servicing while maintaining the required level of disinfection
c. Plug and socket quick disconnect facilities enabling non-technical personnel to carry out lamp replacement without the need for any tools or special isolation procedures
d. Full redundancy, so that in the event of any one UV bank failing for any reason the other ones will continue to operate correctly.
e. UPS backup sufficient for five minutes minimum runtime of the full UV system shall be available in the event of a power outage.
f. In the event that the UPS backup decreases in power below an acceptable level to operate, or the generator fails to start within an acceptable time range a signal, in the form of a dry contact, will be supplied to the UV system. When the UV system receives this signal the weir gate shall automatically raise to prevent untreated water from discharging through the UV channel. The weir gate will also close/raise in the event that the UV system is not able to supply the necessary treatment level.
g. The Contractor shall be responsible to supply the UPS system, whether or not it is included with the UV system or by a separate provider. The Contractor shall coordinate the installation of the UPS system with the UPS supplier and the UV system supplier to insure that the control

2. All heat sensitive components shall be adequately cooled with dry air utilizing forced or natural ventilation.

3. Harmonic distortion correction equipment shall be provided by the UV System Supplier as required to meet IEEE519-1992 of The Institute of Electrical and Electronic Engineers.

4. The Electrical Enclosure(s) shall be UL/NEMA Type 12 painted sheet steel to be installed inside a climate-controlled building. Although the temperature should not exceed 86 ^{0}F it is possible that the ambient temperature within the building may exceed 86 °F for short periods of time, the equipment must not be damaged by short periods in excess of 86 ^{0}F, and must be able to continue to operate at this temperature for a short time.

5. The major components of the UV electrical system shall be:

   a. System Electrical Enclosure(s) (i.e. ICA/Ballast Dist / Ballast 72(s)) there shall be seven (7) enclosures. Three (one per bank) will be provided for ballast distribution; three (one per bank) will be provided for ballasts, and one will contain the PLC. Each enclosure will have a separate feed with incoming fused disconnect for isolation, this ensures that any single fuse or component failure will not lose more than one bank of lamps.
   b. Three (3) Transformer(s), <u>if required</u>
   c. Three (3) Junction Box(es)

B. Instrumentation Control Automation (ICA)

1. The ICA shall be a separate enclosure to house the system control unit, operator interface, control and instrumentation equipment and plant interface termination points.

2. Electrical power supply to the ICA shall be 120 volts, 1 phase, 60 Hertz.

3. The ICA shall have an internal single point of isolation and house any power distribution circuits, transformers or power supplies for the UV system requirements.

C. Ballast Distribution Enclosure (BDE)

1. Electrical power supply to each of the BDE(s) shall be 480 volts, 60 Hz, 3 phase, 4 wire connection with transformer(s) if necessary inside or outside the BDE

2. The BDE shall provide a single point of isolation for a complete bank.

3. The BDE shall provide the individual power supplies, with appropriate circuit protection levels, required for the operation of a single bank including, each bank EBE and auxiliary electrical plant.

D. Transformer if required.

The UV system for which this specification is based on does not require a transformer as 480 volt 4 wire power is supplied to the system. However, if the UV system manufacture requires a transformer the following shall apply.

1. Electrical power supply to each transformer(s) shall be 480 volts, 60 Hz, 3 phase, 4 wire connection.
2. The location of the transformer(s) shall be in their own NEMA 3R enclosure.

E. Electronic Ballast Enclosure (EBE)

1. The EBE shall be a single or single multi door enclosure, which shall house all the control gear, and electronic ballasts etc. associated with a bank of UV lamps.

2. The EBE shall have a door interlocked isolator, which shall be the single point of isolation for the full bank of lamps, enabling simple isolation for safe working on the lamps etc. The door-interlocked isolator shall provide the facility with a means to lock the system off with padlock.

3. Each EBE shall be equipped with a temperature control device, which will shut off this part of the UV system should the critical limit of 122 deg. F be exceeded. UV systems, which do not have a temperature control device to protect the ballast life and prevent premature aging and failure, shall not be acceptable.

4. Each EBE shall be equipped with a cabinet heater to prevent the formation of moisture due to humidity. UV systems, which do not provide the protection of ballasts from moisture with heater, shall not be acceptable – even if the ballasts are theoretically completely sealed from the environment

F. Junction Box (JB)

1. The JB shall be a 304 stainless steel unit, which spans over the channel and provides all service connections for the associated bank of lamps, sensor, position and safety switches, wiper system operation etc. via quick disconnect plug and socket arrangements.

2. The JB shall provide individual termination points for all field cabling and airlines entering the unit.

3. The quick disconnect plug and socket arrangement will be on one side or two sides of the JB.

4. Access to the field terminations inside the JB shall be via a bolted door with weatherproof seal.

5. The construction of the JB shall provide mechanical protection for all cabling and airlines entering the JB.

G. Electronic Ballasts

1. The ballasts shall be electronic microprocessor controlled designed as slot cards fitting into a rack system with a plug connector for ease of maintenance.

2. Each ballast shall drive a pair of lamps with independent control and monitoring circuits.

3. The ballast shall produce an earth free lamp power supply operating at above supply frequency and optimized to preserve lamp life.

4. The ballast shall incorporate a galvanic separation of the two circuits. In case of the secondary circuit operating in abnormal conditions regarding voltage and/or amperage, the ballast shall shut off the lamp concerned.

5. The ballast shall incorporate a filament pre-heat circuit to minimize lamp failure on start up.

6. The operating power factor for the ballasts shall be 0.98 or higher.

7. The ballast shall be capable of varying the lamp power between 50-100% proportional to 4-20 mA or digital control signal.

8. The configuration of ballast cooling shall include a minimum of two independent forced ventilation systems, to reduce risk of ballast overheating in the event of a single ventilation failure. Ballast systems, which rely on natural ventilation, or a single forced ventilation system shall not be permitted.

H. Instrumentation and Controls

1. Local monitoring and control shall be configured to each power/control module with a local control selector (manual-off-auto), power on display, status of each lamp, low UV intensity alarm and lamp hours run counter.

2. Remote monitoring and control shall be configured to each power/control panel to accept the indicated inputs when remote control selected and to provide the indicated outputs at all times with an external, supervisory control system.

   a. Inputs: On/Off for unit power

   b. Discrete Outputs (isolated contact): Power on display, chamber/cabinet, temperature alarm, UV intensity/ lamp failure alarm.

   c. Analog Output (4-20 mA): UV intensity signal

I. Control unit (PLC)

1. The control device shall be governed by an Allen Bradley Compact Logix PLC. The PLC shall be continuously monitoring and controlling the UV system's functions. Custom electronics and the UV sensor shall provide the control panel with the necessary indications of the system parameters.

2. Complete control and monitoring of the UV system shall be accomplished through the operator interface. The operator interface shall be an Allen Bradley Panel View Plus 700.

3. The measured intensity shall be displayed on the operator interface as an absolute value in W/m^2.

4. The PLC shall be menu driven and shall display the following system information when prompted: vessel status, individual lamp status, lamp operating hours, UV intensity, ON/OFF frequency, alarms, alarm history.

5. The PLC program shall control the On/Off cycling and lamp power of the UV vessel based upon a Dose pacing philosophy.

6. The PLC shall utilize a UV intensity sensor located within the UV vessel to accurately sense any change in lamp power, effluent transmittance and compensate for any reduction in the UV-C output due to lamp aging and quartz fouling.

7. The PLC shall receive inputs from the UV sensor and flow meter and shall automatically adjust the received UV Dose to maintain the required levels under all operation conditions.

8. A PLC that actively monitors only flow and uses independent transmittance for theoretical Dose paced control is not acceptable.

9. If the system is designed in accordance to the NWRI guidelines, the PLC shall be programmed to have a Dose equation that has been formulated after validation of the vessel(s).

J. Safety Alarms

1. General alarms are as follows:
   a. Lamp Failure Alarm
   b. Multiple Lamp Failure Alarm
   c. UV Dose is Approaching Minimum Design Dose Warning
   d. UV Dose Below Minimum Design Dose Alarm

2. The PLC shall utilize a UV sensor located within each UV bank to accurately sense any change in lamp power, effluent transmittance and compensate for any reduction in the UV-C output due to lamp aging. The PLC shall receive inputs from the UV sensor and flow meter (provided by general contractor) and shall automatically adjust the received UV Dose to maintain the required levels under all operation conditions. In the event that a UV Dose below Minimum Design Dose Alarm is triggered the UV system controls will cause the Weir gate to raise to its maximum Height, so as to prevent untreated water from discharging from the UV.

3. Should there be any abnormalities or failure to the UV sensor, the following will occur:

a. UV Sensor Failure
b. Low UV Intensity

11250.2.12 REQUIRED SPARE PARTS AND SAFETY EQUIPMENT

The following spare parts and safety equipment shall be supplied:

A. 5% of UV lamps
B. 5% ballasts
C. Two (2) face shields that block UV light wavelengths between 200 and 400 nm.

11250.3 EXECUTION & SERVICES

11250.3.1 GENERAL

All components of the UV system shall be handled with care during transportation, storage and installation. In case of doubt the Contractor shall follow the manufacturer Guidelines for Storage & Handling (which shall be provided to the contractor upon request).

11250.3.2 INSTALLATION

B. All installation of the UV equipment shall be performed by the Contractor. All required installation hardware (such as, but not limited to, support braces and saddles, bolts, washers, nuts, and jam nuts) shall be furnished by the Contractor.

C. The UV System Supplier shall provide four (4) hard copies of operation and maintenance manuals per section 01300. One (1) additional electronic copy shall also be provided.

D. All equipment must be installed in accordance with manufacturer instructions and approved drawings.

E. All components shall be fully tested and verified for service by the UV System Supplier or an authorized representative.

F. All electrical work required for the Ultraviolet Disinfection System shall be provided in accordance with Section 16010 of these Specifications and the Drawings.

11250.3.3 START-UP AND FIELD SERVICES

A. A field service technician or start-up engineer of the UV System Supplier shall commission the UV equipment.

B. Local manufacturer's representatives are not acceptable to perform these tasks unless authorized by the UV System Supplier.

C. The field service technician shall certify that all equipment is properly installed and that the plant operators have been trained on proper operation and maintenance procedures

D. The minimum man-days / trips for installation inspection, system commissioning, and operator training shall be as follows:

1. Inspection of installation: a minimum of three (3) man-days for the UV banks.

2. Start-up/system commissioning: a minimum of three (3) man-days per UV system.

3. Operators training: a minimum of one (1) man-day.

E. Any additional trips required to provide a fully functioning UV system will be provided at the Contractor's expense. Except when necessity for the increased time is caused by the owner, or otherwise specified by the owner.

11250.4 METHOD OF MEASUREMENT

Measurement for UV equipment will be made as a "lump sum" as shown in the Bid Schedule, and shall include all equipment, piping, wiring, controls, installation and startup and field services for a fully functional UV system as described in these Specifications and as shown in the Drawings.

11250.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
Ultraviolet Disinfection Equipment	Lump Sum

11260.1 GENERAL

11260.1.1 DESCRIPTION

This Section covers the requirements for supplying all labor, materials, equipment and services necessary to furnish and install rotary microscreen drum filters as it is specified herein and shown on the Contract Drawings.

The contractor shall furnish and install a fully functioning Drum Filter system as shown on the drawings and described in these specifications. The system is to be installed by the Contractor and tested and commissioned by the Manufacturer of the Drum Filter System Representatives as specified herein.

The Contractor shall furnish and install a rotary microscreen drum filters with associated equipment. Each microscreen filter shall consist of a drum assembly with a 304 stainless steel support frame with an integral removable lid. Each microscreen filter shall have an electric drive motor and reduction gear, screen panels, solids trough, support bearings, liquid level control, high-pressure backwash spray assembly and backwash pump, solenoid and all associated anchor bolts, attachment bolts, and piping connections for microscreen filter installation to comprise a complete and operable system.

11260.1.2 RELATED WORK AND REFERENCED SECTIONS

1. Section 1300 – Submittals
2. Section 01019 – Measurement and Payment
3. Section 11010 – Mechanical Equipment General Requirements
4. Section 16010 – Electrical General Requirements
5. Section 16050 – Basic Material and Methods
6. Section 16150 – Electrical Control Devices
7. Section 16400 – Service and Distribution Systems
8. Section 17000 – Process Control and Instrumentation General Requirements
9. Section 17051SP – Control Strategies

11260.1.3 REFERENCE STANDARDS

A. Commercial Standards:

ASTM	American Society for Testing and Materials
AWS	American Welding Society
AISI	American Iron and Steel Institute
CSA	Canadian Standards Association
UL	Underwriter's Laboratory
NEMA	National Electrical Manufacturer's Association
NEC	National Electrical Code

B. Definitions: The following are industry abbreviations:

TEFC: Totally Enclosed Fan Cooled

HP: Horsepower

gpm: Gallons per Minute

Lpm: Litres per Minute

11260.1.3 SYSTEM DESCRIPTION

11260.1.3.1 Description of Operation:

Standard operation of the rotary microscreen drum filter is as follows:

11260.1.3.1.1 Influent Flow

Influent flow shall be gravity fed to the microscreen filter(s). Influent piping shall allow for equal distribution of the flow to each filter. Upon entering the drum, the flow disperses radially as it moves through the woven polyester screen panels mounted to the periphery of the drum frame.

11260.1.3.1.2 Operating Liquid Levels

The influent hydrostatic head shall be sufficient to overcome headloss within the microscreen filter and ensure gravity flow through the microscreen filter. Influent flow shall enter the inside of the drum where the water level shall vary between the minimum allowable water level and a maximum of 10 inches above the minimum allowable water level. The fluctuating water level inside the drum is caused by the increased headloss as particles to be filtered collect on the screen panels. A constant water level shall be maintained within the filter sump with an overflow weir to keep the drum partially submerged. The microscreen filter shall be operated at 40 percent submergence of its filtering surface area.

11260.1.3.1.3 Backwash Cycle:

When the differential water level between the inside of the drum and the filter sump reaches a pre-set limit, a level switch shall initiate the backwash cycle. After the switch is activated, the drum drive shall rotate the drum 2 – 2½ rotations, which is controlled by a timer in the control panel. As the drum rotates, the backwash pump shall operate to convey high-pressure filtered process water to the spray bar and spray nozzles located above the drum screens. To withdraw filtered water, the inlet of the backwash pump shall be piped to the filter sump. As backwash water passes through the screens, it is collected in a solids trough located directly under the spray bar inside the drum. The collected solids water is conveyed out of the drum by the inclined trough to discharge by gravity to a pipe to the treatment bypass line.

11260.1.3.2 General Operating Conditions:

a. Fluid	–	Untreated Stream Water
b. Service	–	Aquaculture Influent
c. Fluid temperature (degrees C)	–	1 to 25 (33.8 to 77°F)
d. Operation	–	Continuous screening, intermittent backwash

11260.1.3.2 Performance Requirements: The rotary microscreen drum filter shall be capable of meeting the following performance requirements.

a. Design flow capacity	–	6 CFS Total Flow With 1 Unit Offline

b.	Flow capacity	– 2100 gpm each
c.	Design influent TSS	– 15 mg/L
d.	Maximum effluent TSS	– 15 mg/L
e.	Maximum Particle Size Allowed to Pass through System	– 15 mg/L

11260.1.4 SUBMITTALS

11260.1.4.1 Submit product data, shop drawings, and installation instructions for approval in accordance with Section 01300 Submittals. Product data and drawings must certify that the filter unit meets the required specifications.

11260.1.4.2 Product Data: Provide product data for each item in PART 2 – PRODUCTS. Product data shall include the following:

1. Name of Manufacturer, model number, and clear indication of screen size.
2. Performance characteristics and capacities.
3. Construction materials.
4. Installation and maintenance instructions for each type of product or component indicated.
5. Electrical characteristics.

11260.1.4.3 Shop Drawings: Shop drawings shall include:

1. Detailed piping and equipment assemblies. Indicated dimensions, weights, loads, required clearances, components, and location and size of each field connection.
2. Wiring diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
3. Location, mounting details, and connection requirements of control panel, backwash pump, and all other field assembled components.

11260.1.4.4 Upon completion of the work, submit the following before final acceptance and payment:

1. Operation and Maintenance Manuals in accordance with SECTION 01300 – Submittals. Provide five (5) copies of Operation & Maintenance Manuals.
2. Certification: Written certification by the MANUFACTURER, addressed to the OWNER and ENGINEER, stating that the equipment has been correctly installed and is operating properly.

11260.1.5 QUALITY ASSURANCE

11260.1.5.1 The CONTRACTOR is responsible for determining any changes to the mechanical, civil and electrical design as necessitated by the use of other manufacturer or suppliers. Any design changes are the CONTRACTOR's responsibility, and both design and construction costs associated with any design changes necessitated shall be borne by the CONTRACTOR. All changes shall be subject to review and approval by the ENGINEER.

11260.1.5.2 Manufacturer Qualifications: The rotary microscreen drum filter supplier must have not less than two (2) operational installations at different locations, which are currently screening a similar flow or greater, and which have been in use for not less than two (2) years. Provide names and telephone numbers for the installation's design engineer and principal operating personnel.

11260.1.6 DELIVERY, STORAGE, AND HANDLING

The ENGINEER reserves the right to reject delivery of the equipment, if found upon inspection, to have any cracks, foreign matter, surface porosity, or sharp discontinuity or if it does not meet these specifications.

11260.1.7 WARRANTY

Manufacturer shall warrant all equipment furnished to be free from defects in materials and workmanship under normal use and service for a period of twelve (12) months after the date first placed in service, or eighteen (18) months after delivery, whichever occurs first.

11260.2 PRODUCTS

11260.2.1 MANUFACTURERS

Approved Manufacturer(s):

The system is designed around the Rotofilter™ Model RF 6096 as supplied by PR Aqua Supplies Ltd. However, other systems which meet the intent of the specification, and meet all quality and functionality requirements of the specified system, will be considered. One such system which may also be considered is the Hydrotech HDF1605-2H by Water Management Technologies if it meets the intent of the specification. Any changes to system layout or design shall be the responsibility of the contractor.

- PR Aqua Supplies Ltd.,
  1631 Harold Rd.
  Nanaimo, BC Canada
  Phone: 866-714-0141

- Water Management Technologies
  PO Box 6625
  Baton Rouge, LA
  USA 70896
  Phone: 225-755-0026
  Fax: 225-755-0995

- ENGINEER-approved equal.

11260.2.2 MATERIALS

11260.2.2.1 Install no materials containing cadmium, brass, bronze, copper, zinc, or their alloys that may come in contact with contact with fish rearing water, as these heavy metal materials are proven to be toxic to fish.

11260.2.2.2 The rotary microscreen filter must be constructed such that no portion requiring grease lubrication can come in contact with the water flow. All portions of the microscreen filter, which require grease lubrication, shall be clearly identified in the submittal drawings.

11260.2.2.3 All wetted fabricated metal shall be AISI 304 stainless steel. All welding shall conform to the latest standards of the American Welding Society. Non-wetted fabricated metal parts may be marine grade aluminum.

11260.2.3 EQUIPMENT

11260.2.3.1 General:

Verify drum filter size and access requirements and obtain approval from the Contracting Officer. If the size is larger or access requirements are greater than that shown on the drawings, the CONRACTOR is responsible for any required design modifications to the affected structures, piping systems, space arrangement, and layout of the affected structures. Any design modifications by the Contractor must be approved by the Engineer prior to final acceptance and procurement of the equipment.

11260.2.3.2 Design: Rotary microscreen drum filter design criteria are as follows:

a.	Screen pore size	–	21 µm
b.	Filter surface area (per unit)	–	101.2 ft^2
c.	Maximum drum submergence	–	40% of filtering surface area
d.	Maximum screen hydraulic head loss	–	12 in
e.	Filter rotational speed	–	Manufacturers Standard
f.	Filter rotational direction	–	Manufacturers Standard
g.	Drive motor	–	1 HP, TEFC, 480 volt, 3 phase, 60 Hz
h.	Drive assembly	–	Helical worm gear with chain drive
i.	Backwash pump (1 per unit)	–	2 HP, TEFC, 480 volt, 3 phase, 60 Hz
j.	Backwash flow rate	–	Minimum of 24 nozzles at 0.8 gpm each nozzle
k.	Backwash pressure	–	100 psi
l.	Inlet	–	20” Flanged
m.	Outlet	–	20” Flanged
n.	Solids outlet	–	4” Flanged
o.	Backwash system connections	–	1.25” NPT

11260.2.4 COMPONENTS

11260.2.4.1 Support Frame:

11260.2.4.1.1 Each microscreen drum filter shall have a structural welded 304 stainless steel frame that provides support for the rotating drum assembly and all mechanical components.

11260.2.4.1.2 The filter shall be furnished with a cover constructed of marine grade aluminum and consisting of a support frame and sectional, removable access panels. When the panels are in place, the cover shall prevent misting from the spray wash assembly from escaping. When a panel is removed, it shall provide access for inspection or maintenance. The support frame shall also be removable to facilitate maintenance.

11260.2.4.2 Drive Train Assembly:

11260.2.4.2.1 The drive mechanism is to consist of a sealed mechanical gear reducer mounted to the shaft of the drive axle, located on the closed end of the drum. The reducer shall be coupled with lubricated chain and sprockets to a high efficiency, TEFC electric motor. Both motor and gear shall have a corrosion resistant epoxy coating and corrosion resistant hardware.

11260.2.4.2.2 Both motor and gear are to be located external to the filter enclosure. Ensure that there is no risk of lubricants or grease directly contacting the process water or dripping into the process water.

11260.2.4.2.3 The drive axle shall be constructed of 316 stainless steel and shall have a keyed shaft. The axle shall be coupled to a stainless steel plate (32 series) forming the closed end of the drum assembly.

11260.2.4.3 Screen Media:

11260.2.4.3.1 Screen media is to be woven polyester fabric with a nominal screen size of 21microns contained within and supported by a molded injected polypropylene grid. Screen media shall be furnished in complete pre-formed panels that can be individually installed, repaired or replaced. Individual cells of the media panel grid must be designed to allow the use of patching plug(s), as furnished by the manufacturer, for repair of minor damage to filter plates.

11260.2.4.3.2 Screen panels, when mounted on the drum filter, shall be capable of withstanding a maximum continuous headloss of twelve (12) inches of water.

11260.2.4.3.3 Each screen panel shall be sealed continuously on all edges with a closed cell neoprene gasket, attached to the drum frame with 316 stainless steel anchoring assemblies.

11260.2.4.3.4 Replacement of the filter media must be possible from outside the filter tank. Individual panel removal shall be achievable without removal or disengagement of additional panels.

11260.2.4.4 Rotating Drum:

The rotating drum shall be fabricated from structural welded, 304 stainless steel and shall be open at one end to allow the influent to enter. The drum assembly shall be sealed sufficiently to prevent bypassing of influent flow into the filtered water tank except in an overflow condition.

11260.2.4.5 Drum Seal:

The drum seal is to consist of a synthetic elastomer seal wear ring integrally assembled to the front face of the drum filter support frame. The seal shall be formed to maintain continuous contact with the surface of the open end of the rotating drum assembly. The elastomer wear ring shall use hydraulic differential to seat the seal.

11260.2.4.6 Backwash System:

11260.2.4.6.1 Each filter shall be supplied with a backwash system comprised of a backwash spray bar assembly, a backwash collection trough, and a backwash pump. The backwash system must operate automatically based on high differential water level between the inside of the drum and the filter sump, and timer in the manufacturers control panel, which will cause a backwash to occur at regular intervals in the event that the backwash level is not reached within a given period of time.

11260.2.4.6.1 The backwash collection trough must be located to allow the rotating drum to achieve a bypass condition without influent overflowing into the waste trough. The trough shall discharge by gravity.

11260.2.4.6.1 Backwash spray bar assembly is to consist of a stationary spray header, oriented along the length of the drum assembly, on which are mounted a series of spray nozzles. The spray nozzles shall be sufficient in quantity and shall be spaced appropriately to ensure full spray coverage of the drum length. Spray nozzles shall be of quick-disconnect design to allow for cleaning without turning the spray bar off. The spray nozzle shall consist of a nozzle tip made of 304 stainless steel, mounting cap for quick removal, nozzle body and seals. The replacement or cleaning of nozzles must be possible from outside of the filter enclosure.

11260.2.4.6.2 The backwash pump shall be of the horizontal multi-stage design with the motor mounted directly to the pump, Goulds GB Booster Pump series or approved equivalent. The pump shall be capable of supplying the required backwash flow, as specified by the Manufacturer, at a pressure of 100 psi. The pump suction and discharge fittings shall be 1" NPT. The discharge head and suction housing shall be constructed of cast iron. The pump shaft and outer discharge sleeve shall be constructed of stainless steel. The impellers and diffusers shall be constructed of an engineered composite. The impellers shall be secured directly to the pump shaft by means of a hex shaft arrangement. Pump shall be equipped with a John Crane type 6 mechanical seal assembly with Carbon/Ceramic seal faces and BUNA rubber O-rings mounted in stainless steel components. The motor shall be NEMA J frame design, Totally Enclosed Fan Cooled (TEFC) with a minimum service factor of 1.15.

11260.2.4.6.3 Filtered effluent shall be used as the backwash water source. Filtered water shall be drawn downstream of the filter from the sump. The backwash pump shall be able to draw water from the sump as shown on the drawings without being manually primed. A ball valve and pressure gauge assembly shall be installed on the backwash spray header piping downstream of the pump in order to regulate to the desired nozzle pressure. The backwash system shall be plumbed as shown on the plans.

11260.2.4.6.4 Spare Parts: The Manufacturer shall supply replacement spare parts consisting of two (2) spare screen panels, twenty (20) screen patching plugs, and one (1) elastomeric drum seal.

11260.2.5 Accessories:

11260.2.5.1 Control Panel:

1. Each microscreen filter shall have a local control panel which shall house the automatic level control circuit and motor controls. The panel will have a lockable NEMA-4X enclosure. The circuit shall be UL approved. The circuit shall be capable of closing and opening the motor contacts for the drive motor, and the backwash pump motor. The circuitry for the level switch shall be operated at low voltage. The control panels for each unit shall be interconnected so that when a backwash cycle is initiated for one unit it is initiated for all units. A timer shall also be supplied with the controls which shall initiate a backwash at a given time interval in the event that a backwash cycle is not initiated by the level system.

2. The control panel shall activate the motors for operation when the backwash cycle is initiated. Each of the motors shall have a hand-off-auto (HOA) selector switch and run indication pilot lights on the panel door.

    a. "Hand" Operation – When the HOA selector switch is in "hand" or "manual" mode, the drum drive and backwash pump shall operate continuously without any interlocking logic.

    b. "Auto" Operation – When the HOA selector switch is in "auto" or "automatic" mode, the level switch and timer shall control the operation of the drum drive and backwash pump.

3. The control panel shall include soft start circuitry to ensure the smooth, controlled starting of the filter motor on initiation of the backwash cycle, preventing damaging the filter or electrical components due to high initial torque and current draw.

4. The control panels shall include as a minimum the following:

a. Local through-the-door disconnect
b. Drum Motor Overload protection
c. Backwash pump Overload Protection
d. HOA switch for Drum motor (see item 2 above)
e. HOA switch for Backwash pump (see item 2 above)
f. Backwash length timer
g. Power on light
h. Drum filter motor running light
i. Backwash system running light
j. Drum motor overload light
k. Backwash pump overload light
l. B/W level switch connection
m. Solenoid control output signal
n. High Level switch input (to operate at 12V or 24V, not 120V)
o. High level signal light
p. Dry contact for high level switch output to central monitoring (for connection to central alarm at whatever voltage they want to supply)
q. Dry contact for drum motor trouble
r. A Dry contact for backwash pump motor
s. Relays so that three drum filter control panels can be ganged together
t. Terminal Blocks for all electrical connections to and from the enclosure
u. Timer so that drum filter will backwash even if there are insufficient solids to trigger the backwash
v. Soft start on drum motor

11260.3 EXECUTON

11260.3.1 GENERAL

11260.3.1.1 The rotary microscreen drum filters and related equipment must be fabricated, assembled, and installed in full conformity with the Contract Documents and Manufacturer's instructions and recommendations as approved by the ENGINEER.

11260.3.1.2 All parts of the mechanism are to be amply proportioned to endure stresses that may occur during fabrication, shipment, erection and intermittent or continuous operation. Workmanship must be of industrial high grade in all respects and of the latest design.

11260.3.1.3 Upon completion of the installation, each piece of equipment and each system must be tested for satisfactory operation without any leaking, excessive noise, vibration, overheating, or other operative malfunction by factory approved personnel. All equipment is to be adjusted and checked for alignment, clearances, supports, and adherence to safety standards until found satisfactory.

11260.4 FIELD SERVICES

11260.4.1 The Contractor is responsible to coordinate field services by the. The Manufacturer shall furnish the services of a factory-trained field representative to the project site. The services of the field representative shall include a minimum of one (1) day, exclusive of travel time, and one (1) travel trip.

11260.4.2 Prior to system start up, the Manufacturer's representative shall inspect the installation to verify system installation is satisfactory for operation. The Owner shall be advised in writing of any

corrections or adjustments that are required for the equipment installation. After the installation has been completed to the Manufacturer's satisfaction, a letter of certification shall be furnished stating that all equipment is installed in accordance with its instructions and that the equipment is ready for operation.

11260.4.3 The Manufacturer's representative will observe the start-up of equipment, verify all functions of the equipment, and make adjustments as needed to meet the performance goals of this section. Complete testing of the equipment functionality shall be performed in the presence of the Contracting Officer before final acceptance of the system is given.

11260.5 METHOD OF MEASUREMENT

Measurement for Drum Filter equipment will be made as a "lump sum" as shown in the Bid Schedule, and shall include all filter drums, motors, backwash pumps, controls, wiring, appurtenances and installation for a fully functional Drum Filter system as described in these Specifications and as shown in the Drawings.

11260.6 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
Drum Filter System	Lump Sum

SPECIAL PROVISION

RECIRCULATION PUMP	SECTION 11388SP

11388.1 DESCRIPTION

The contractor shall provide all equipment labor and materials to furnish and install the 480 Volt, 3 Phase, 60 Hz solids-handling, electric submersible pumps to be supplied with integral electric motor, discharge elbow, guide bar brackets and installation accessories as shown on the drawings and required by these specifications.

Additionally, The Contractor shall furnish all labor, equipment, and materials necessary to construct and erect a concrete wet well as shown on the Drawings, consisting of a concrete roof, concrete floor and a cast-in-place concrete wall. The wet well shall conform to the dimensions and be equipped with the appurtenances, valves and piping as shown on the Drawings and in accordance with these specifications.

11388.1.1 RELATED WORK

Section 01019 – Measurement and Payment
Section 02105 – Earthwork Materials
Section 02200 – Trench Excavation and Backfill
Section 02201 – Earthwork for Structures
Section 02222 – Water Pipe Installation
Section 03050 – Portland Cement Concrete
Section 03100 – Concrete Forming, Finishing and Curing
Section 03200 – Concrete Reinforcement
Section 03300 – Concrete Structures and Slabwork
Section 03310 – Concrete Joints for Slabwork
Section 08121SP – Access Hatch
Section 11010 – Mechanical Equipment General Requirements
Section 13320SP – Concrete Wet Well
Section 15110 – Pipe and Piping Systems
Section 16010 – Electrical General Requirements
Section 16050 – Basic Material and Methods
Section 16150 – Electrical Control Devices
Section 16400 – Service and Distribution Systems
Section 17000 – Process Control and Instrumentation General Requirements
Section 17051SP – Control Strategies

11388.2 RECIRCULATION PUMP

11388.2.1 MANUFACTURER

11388.2.1.1 The specifications and project drawings depict ITT Flygt Pump. The contractor shall prepare his bid based on the specified equipment for purposes of determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials, except as allowed below.

11388.2.1.2 After execution of the contract, the contractor may offer substitutions to the specified equipment for consideration; equipment must be pre-approved by engineer, such substitution shall be equal to or superior in construction and efficiency to that specified in the contract, and equal or higher quality must be demonstrated by service in a similar installation. Any equipment not pre-approved will not be considered.

11388.2.1.3 In event the contractor obtains Engineer's approval for equipment substitution, the contractor shall, at his own expense, make all resulting changes to the enclosures, buildings, piping or

electrical systems as required to accommodate the proposed equipment. Revised detail drawings illustrating the substituted equipment shall be submitted to the engineer prior to acceptance.

11388.2.1.4 In the event the contractor obtains engineer's approval of equipment other than that for which the station was originally laid out, the contractor shall, at his own expense, make any changes in the structures, buildings or piping necessary to accommodate the equipment, and shall provide as-built drawings to the engineer. It will be assumed that the cost to the contractor of the equipment proposed to be substituted is less than that of the equipment specified in the contract and if substitution is approved, the contract price shall be reduced by an amount equal to 50% the savings.

11388.2.1.5 A manufacturer's being named in this specification notwithstanding, all equipment approved for this project shall meet or exceed all performance, service, and warranty requirements of this specification. Submittal data shall include, but not be necessarily limited to: typical motor, as well as pump, performance curves; compliance documentation for all performance values described in Section 11388.2.4; compliance documentation for all construction details described in, and calculations required by, Section 11388.2.5; and service and warranty compliance documentation required by Section 11388.2.6 of this specification.

11388.2.1.6 Conditional approval by the Engineer under this section is based on a general review only of the specified pump and in no way constitutes final approval of equipment, nor waives any requirement of these specifications, nor relieves the Contractor or Manufacturer of any degree of responsibility for compliance with specific requirements of other portions of these specifications.

11388.2.2 QUALITY ASSURANCE

11388.2.2.1 GENERAL

The pumps shall be suitable for pumping fish hatchery effluent and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 40 degrees to 115 degrees F.

11388.2.2.2 STADARDS

The test code of the American Hydraulic Institute for testing pumps and sound engineering practice shall be used. All pump performance documentation, including flow/head curves, shall adhere to the Hydraulic Institute Standards and shall allow no negative tolerance on flow, head, hydraulic efficiency or any other criteria deemed by the Engineer to be necessary to evaluate pumping system performance.

11388.2.2.3 ENVIRONMENTAL CONDITIONS

11388.2.2.4 SUBMITTALS

In addition to all data required under Sec. 11388.2.1.2 Manufacturer of this specification, complete assembly, foundation support, and installation drawings, together with detailed specifications and data covering pumps, motors, material used, parts, devices and other accessories forming a part of the equipment furnished shall be submitted for approval in accordance with the procedure set forth in the General Conditions.

Data and specifications for the equipment shall include, but shall not be limited to the following:

A. Setting plans. Setting plans shall include:

1. Anchor bolt layout
2. Anchor bolt dimensions.
3. Outline dimensions and weights of pumps, bases, motors, and control enclosures.

B. Pumps. Data and drawings shall include:

1. Manufacturer, type and model number.
2. Assembly drawing, nomenclature and material list, five (5) copies of the O & M manual, and parts list.
3. Type, manufacturer, model numbers, location and spacing of bearings.
4. Impeller type, diameter, thru-let dimensions, sphere size, number of vanes and identification number.
5. Complete motor performance data including: rating, voltage/phase/frequency; design type; service factor; insulation class; motor pole number; actual rotation speed when combined with the specified pumps; current, power factor and active input power (KW) as a continuous function of shaft power from no load to at least 115 percent load; start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to synchronous speed.
6. Complete performance test curve(s) showing full range (shutoff to run-out) head vs. capacity, NPSHR, hydraulic efficiency, motor active (KW) input power, motor total (KVA) input power (based on measured current and voltage), and shaft power (BHP). See Sec. 11388.2.3.1 Shop Tests.
7. Location and description of Service Centers and spare parts stock.
8. Warranty for the proposed equipment.

The manufacturer shall indicate, by arrows to points on the Q/H curves, limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible, and shall be based on actual hydraulic and mechanical characteristics of the units and shall meet the hydraulic performance requirements of the proposed system.

11388.2.3 TESTING

General – Equipment shall be shop tested and field tested as specified hereinafter. All costs for the tests shall be borne by the Contractor. The Contractor shall submit the complete shop test procedures to the Engineer for approval at least 30 days prior to the shop test. In the event any equipment fails to meet the performance values set forth in this specification, the equipment shall be modified and re-tested or replaced with equipment that performs in accordance with this specification.

11388.2.3.1 SHOP TEST

11388.2.3.1.1 Pumps and Motors.

Each pump and motor shall be performance tested as specified hereinafter; all pumps shall be tested with motor cables to be supplied with the pumps. Three copies of certified test reports, including actual test records, shall be submitted and approved by the Engineer prior to shipment of the equipment.

The Contractor shall submit the complete pump test procedure, a diagram of the test setup showing location of instruments, a sample of the test stand log sheet, and calibration data of all instruments and measuring devices to be used by the manufacturer to the Engineer, for approval, prior to the pump tests.

Each pump shall be tested for performance at the factory to determine the head vs. capacity, motor total electrical power draw (KVA), and motor active electrical power draw (KW) for the full speed at which the pumps are specified and shown on a performance test curve, certified by a registered professional engineer, as continuous functions throughout the pump's performance range. Tests of models, prototypes or similar units will not be acceptable.

All tests shall be run in accordance with the test code for centrifugal pumps of the Standards of Hydraulic Institute, latest edition. The motor and cable on each pump shall be tested for moisture content or insulation defects. After the test, the pump cable end shall be fitted with a shrink-fit rubber boot to protect it from moisture or water.

11388.2.3.2 FIELD TEST

Equipment shall be field tested as specified hereinafter. Field testing shall be composed of preliminary tests and acceptance tests. The Contractor shall provide the services of authorized equipment supplier's representatives to conduct all field tests.

11388.2.3.3 PRELIMINARY TESTS

Preliminary tests shall be run on all pumps, motors, and control systems to demonstrate that they are in proper working order.

11388.2.3.4 ACCEPTANCE TESTS

Acceptance tests shall be run to demonstrate that the pumping units, motors and control system meet the following requirements:

A. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.
B. All automatic and manual controls function in accordance with the specified requirements.
C. All drive equipment operates without being overloaded.

11388.2.4 PERFORMANCE

Submersible pumps shall meet the following performance requirements:

11388.2.4.1 VALUE

ITEM (UNITS) **VALUE** *[purpose]*

Primary Duty Point (CFS/ft.) **6.5 / 20.1** *[sets specific "design" Q/H requirement]*
Secondary Duty Point (CFS/ft.) **7.8 / 14.6** *[establishes min. pump curve slope and operating pressure reserve]*
Minimum Shutoff Head (ft.) **40.0** *[establishes min. peak pump pressure reserve]*
Maximum Active Motor **Input Power**
at primary duty point (HP) **22.8** *sets a minimum primary "overall" efficiency]*
Maximum Active Motor **Input Power**
at secondary duty point (HP) **22.0** *[sets a minimum secondary "overall" efficiency]*
Maximum Pump Speed (RPM) **1160** *[higher pump speed increases NPSHR]*
Maximum NPSHR at primary duty point (ft.) **17.6** *[sets a maximum pump cavitation proclivity]*
Maximum NPSHR at secondary duty point (ft.) 18.5 *[sets a maximum pump cavitation proclivity]*

Minimum Motor Rating (HP) at 40 degrees C. **25** *[ensures minimum continuous shaft power availability]*
Voltage/Cycle/Phase **460/60/3**
Motor Design Type **B**

Motor Service Factor **1.15** *[specifies ratio of motor rated power to peak available power]* Greater than 1.10
Motor Insulation **Class H** *[sets minimum temperature that insulation system will withstand]*
Maximum Motor Pole Number **6** *[higher pole numbers mean lower power factor and higher current draw]*
Maximum Rated (FL) Current (A) **32** *[sets maximum "rated" load on power grid]*
Minimum Rated (FL) Power Factor (%) **85** *sets maximum "rated" load on power grid]*
Maximum LR Current (A) ***177*** *[sets maximum "load" on power grid during "pump start"]*
Maximum NEC Code Letter **H** *[limits electrical "start" power requirement]*
Minimum Pump Discharge Size (inches) **10** *[limits flow velocity and velocity head requirement]*

11388.2.4.2 PROJECT SCOPE

Furnish and install **1** submersible non-clog wastewater pump(s). Each pump shall be equipped with an **25** HP submersible electric motor, connected for operation on 460 volts, **3** phase, 60 hertz, **3** wire service, with an estimated **25** feet (length to be field verified and shall have no splices from the pump to the nearest junction box, or transfer switch or control panel) of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and also meet with P-MSHA Approval. The pump shall be supplied with a mating cast iron **10** inch discharge connection and be capable of delivering **6.5** CFS at **20.1** TDH. An additional point on the same curve shall be **7.8** CFS at **14.6** feet total head. Shut off head shall be **40.0** feet (minimum). Each unit shall be fitted with **30** Ft (20 ft. minimum) of Flygt **Grip Eye System** for use with portable cable hoist with adequate strength to permit raising and lowering the pump.

11388.2.4.3 PUMP DESIGN

The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. **Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable**. No portion of the pump shall bear directly on the sump floor.

11388.2.4.4 PUMP CONSTRUCTION

Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate **metal-to-metal contact** between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

11388.2.4.5 COOLING SYSTEM

(Cooling Jacket Equipped)

Each unit shall be provided with an integral motor cooling system. A motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid trough the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F. (40°C.). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

11388.2.4.6 CABLE ENTRY SEAL

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. **The cable entry junction chamber and motor shall be separated by a terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.**

11388.2.4.7 MOTOR

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180oC (356oF). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.

The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The motor service factor (combined effect of voltage, frequency and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of +/- 10%. The motor shall be designed for

continuous operation in up to a 40°C. ambient and shall have a NEMA Class B maximum operating temperature rise of 80° C. A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.

Motor horsepower shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out.
The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

11388.2.4.8 BEARINGS

The integral pump/motor shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a single ball type bearing to handle radial loads. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum L_{10} bearing life shall be 50,000 hours at any usable portion of the pump curve.

11388.2.4.9 MECHANICAL SEAL

Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion resistant **tungsten-carbide** ring. The upper secondary seal, located between the seal chamber and the seal inspection chamber, shall contain one stationary and one positively driven rotating corrosion resistant **tungsten-carbide** seal ring All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.

The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float type switch that will signal if the chamber should reach 50% capacity.
Seal lubricant shall be FDA Approved, nontoxic.

11388.2.4.10 PUMP SHAFT

Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The shaft shall be AISI type 431 stainless steel. Shaft sleeves will not be acceptable.

If a shaft material of lower quality than 431 stainless steel is used, a shaft sleeve of 431 stainless steel is used to protect the shaft material. However, shaft sleeves only protect the shaft around the lower mechanical seal. No protection is provided in the oil housing and above. Therefore, the use of stainless steel sleeves will not be considered equal to stainless steel shafts.

11388.2.4.11 IMPELLER

The impeller shall be of gray cast iron, ASTM A-48 Class 35B, dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The screw-shaped leading edges of the impeller shall be hardened to Rc 45 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impellers shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

11388.2.4.12 VOLUTE / SUCTION COVER

The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have integral spiral-shaped, sharp-edged groove(s) that is cast into the suction cover. The spiral groove(s) shall provide the sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The internal volute bottom shall provide effective sealing between the multi-vane semi-open impeller and the volute.

11388.2.4.13 PROTECTION

Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.

The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump control panel.

11388.2.4.14 SITE TESTS

The pump shall be tested at start-up. Voltage, current, and other significant parameters shall be recorded. The Manufacturer shall provide a formal test procedure and forms for recording data.

11388.2.4.15 PUMP TEST

The pump manufacturer shall perform the following inspections and tests on each pump before shipment from the factory:

1. Impeller, motor rating and electrical connections shall be checked for compliance to the customer's purchase order.
2. A motor and cable insulation test for moisture content or insulation defects shall be made.
3. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
4. The pump shall be run submerged a minimum of six (6) ft. under water.
5. After operational test No. 4, the insulation test (No. 2) is to be performed again.

A written report stating the foregoing steps have been done may be supplied with each pump at the time of shipment (upon request).

11388.2.4.16 PERFORMANCE CURVES

In no case shall the required horsepower at any point on the performance curve exceed the horsepower of the motor when using any of the impellers available for use with the proposed pump. All centrifugal pumps shall have a continuously rising curve.

11388.2.4.17 LOCAL PUMP SERVICE FACILITY

At the time of bidding, there shall be a fully accredited service facility within 100 miles of the project site having factory trained technicians and a full stock of repair parts for a complete overhaul of the proposed pumps.

11388.2.4.18 ADDITIONAL PUMP MOTOR CHARACTERISTICS

For economy of sizing and operating auxiliary generator standby power, the pump motor shall have electrical power in-rush characteristics of NEC Code Letter G . NEC Code Letters H and greater will not be acceptable.

11388.2.4.19 PUMP WARRANTY

The pump manufacturer shall warrant the units being supplied to the owner against defects in workmanship and material for a period of five (5) years or 10,000 hours under the Municipal Wastewater-Permanent Installation Warranty Policy under normal use, operation and service. The warranty shall be in printed form and apply to all similar units.

11388.2.4.20 DOCUMENTATION

The manufacturer, if requested, will supply a minimum of five (5) sets of standard Submittal Drawings, Operating and Maintenance Instruction Manuals and Parts Lists. Additional sets of Drawings, Parts Lists, Manual etc. or modification to the manufacturer's standard submittal will be at an additional charge. Aperture Cards, photo or microfilming sets, if required, will be at an additional charge per set.

Standard submittals will consist of:

a). Pump Outline Drawing
b). Control Data
c). Access Frame
d). Typical Installation Guides
e). Technical Manuals

f). Parts List

11388.2.4.21 EXPERIENCE CLAUSE

The pump manufacturer shall have a minimum of 1,000 units of similar type pumps, installed and operating for no less than five (5) years in the United States.

11388.2.4.22 ACCES FRAME AND COVER

See 08121 SP

11388.2.4.23 GUIDE RAILS

Furnish and install upper guide holder, lower guide holder and level sensor(s) cable holder. Lower guide bar holders shall be integral with the pump discharge connection. Guide bars shall be of at least schedule 40 Stainless Steel type 304 pipe of the size indicated on drawings minimum 2 inch diameter. The guide bars shall not support any portion of the weight of the pump. Power cable shall be suspended by stainless steel kelum grip type strain relief attached to the cable holder.

11388.2.4.24 CONTROLS

Furnish and install one (1) Simplex Flygt automatic pump control center in 33"X21"X12" NEMA **_4X_** **Stainless Steel** gasketed enclosure with three-point latch for **___480__** volts, **__3__** phase, 60 hertz **___3___** wire power supply. For the pump motor, there shall be included: a combination circuit breaker/overload with manual reset for protection against current overloads, short-circuit protection, and disconnect for all phases; Soft-Start solid state stator; hand/off/automatic (H-O-A) pump operations selector switch; and low level alarm function. In the event of a fault/failure of the Feed Pumps, a normally closed contact in Feed Pump panel will indicate failure and initiate start of the recirculation pump when the H-O-A selector switch is in the Auto position.

The following additional options shall be included with the panel:

1. NEMA 4X Stainless Steel enclosure with 3 point latch.
2. Anti-Condensation heater & Thermostat.
3. Running time meter(s).
4. Pump run light(s).
5. Secondary Lightening arrestor.
6. 3 Phase Power Monitor Phase protection.
7. Aluminum inner dead front door
8. Incoming Power Terminals with Neutral and Ground Terminations
9. Heavy Duty Square D FAL Frame Circuit Breakers
10. NEMA Rated Square D Motor Starter w/ Overloads for each pump
11. Auxiliary Contact on Motor Starter indicating pump running.
12. Additional Contact Block on the H-O-A selector switch indicating the switch is in the "Auto" position.
13. Control Circuit Breaker
14. Control Voltage Transformer if 460 V or 230 V three phase panel
15. MiniCAS relay for seal failure and pump high temp alarms.
16. Multitrode MTRA relay for low level alarm.
17. Multitrode Relay Level Control System w/ 8" Multitrode Probe.

11388.2.4.25 LIQUID LEVEL SENSOR

Furnish and install **8 Inch** Flygt Multitrode Probe with 30 Ft of Cable, and cable holder.

11388.2.4.26 BALL CHECK VALVE SPECIFICATION

Ball check valves shall be designed to be non-clog, fully automatic, maintenance free and specifically suited for operation in sewage and storm water where solids, fibers, grit or highly viscous materials are encountered.

Ball check valves will have one moving part, the ball, which automatically rolls out of the path of flow, thus providing an unobstructed and "full flow" equal to nominal size. Upon discontinuation of flow the ball automatically rolls back to the closed position, thus providing a positive seal against back pressure or backflow.

The ball shall have an exterior coating of vulcanized nitrile rubber resistant to grease, petroleum products, animal and vegetable fats, dilute concentrations of acids and alkalis, tearing and abrasion. The body and cover shall be nodular cast iron type GGG 40/ASTM 65-45-12/SAE 4512.Ball check valves are designed to be maintenance-free and suited for installation in the horizontal or vertical position. The valve shall be so constructed that by unbolting and lifting off the cover, the ball may be removed and replaced without removing the valve from the line.

Ball check valves will be available with either a floating or sinking ball.

The valve(s) shall be equal in all respects to model **10 Inch** 5087 as manufactured by the ITT Flygt Corporation.

11388.3 WET WELL AND APPURTENANCES

11388.3.1 SUBMITTALS

11388.3.1.1 Descriptive literature, which identifies the manufacturer and materials used for fabrication for all piping, valves, fittings, control valves, water stops, liners and appurtenances, shall be provided by the Contractor in accordance with Section 01300 of these Specifications.

11388.3.1.2 The Contractor shall submit a 2-foot minimum length of each type of closed cell neoprene pad for the Wet Well lid joint and of the water stop material for inspection and acceptance testing, to ensure compliance with the requirements of these Specifications.

11388.3.1.3 The Contractor shall submit concrete mix design information along with certified strength test documentation for that design for approval by the Engineer at least two weeks prior to planned concrete placement.

11388.3.2 MATERIALS

11388.3.2. MISCELLANEOUS COMPONENTS AND APPURTENANCES

11388.3.2.1 The wet well access roof hatch shall be by Halliday, or approved equal, with a fully enclosed curb and stainless steel hardware, of the type and size specified on the Drawings. It shall be sealed through the use of a caulked neoprene gasket and shall be fastened to the wet well by means of eight 3/8" x 4" long stainless steel expansion anchors. The method of closure and closing hardware shall meet requirements of the Utah State Department of Public Drinking Water. See Section 08121SP of these Specifications.

11388.3.2.2 The air vents shall consist of a 4 inch diameter hot dip galvanized steel pipe fabricated as shown on the Drawings. The vent shall be provided with a ring seal embedded in the wet well roof slab and a # 14 (1.4 mm) stainless steel screen installed as shown on the drawing details.

11388.3.2.3 STEPS - Plastic or fiberglass steps reinforced with steel, which conform to ASTM C487 or ASTM C478 standards, shall be installed in all sections of the wet well as shown on the Drawings.

11388.3.2.4 Brackets and bands, which support and stabilize the interior piping, shall be fabricated from stainless steel as shown on the Drawings, and all bolts and fasteners shall be stainless steel.

11388.3.3 CONSTRUCTION

11388.3.3.2 WATER STOPS

11388.3.3.2.1 Water stops shall be ribbed, having a hollow center bulb cross-section and they shall uniform in dimensions and as detailed on the Drawings. Water stops shall be free of porosity and shall be made of a dense, homogeneous, virgin PVC compound. No reclaimed PVC shall be used in the compound. Water stops shall be by Vinylex Corporation, 2636 Byington-Solway Road, Knoxville, TN 37921 (ph. 615-690-2211), Greenstreak Plastic Products, Box 7139, St. Louis, MO 63177 (ph. 314-225-9400), or approved equal. Water stops shall meet the minimum material requirements of the table below.

WATER STOP MATERIAL SPECIFICATIONS		
Tensile Strength	2,000 PSI	(ASTM D-412)
Ultimate Elongation	350%	(ASTM D-412)
Shore Hardness	75 + 5	(ASTM D-2240)
Specific Gravity	1.3	(ASTM D-792)
Stiffness in Flexure	600 PSI	(ASTM D-747)
Cold Brittleness	-35°F	(ASTM D-746)
Water Absorption: 48 Hours	0.320% (Max.)	(ASTM D-570)
Tear Resistance	290 pounds/inch	(ASTM D-624)

11388.3.3.2.2 Water stops shall be installed in the joints designated on the Drawings, with precautions taken to ensure proper location, support, and protection of the water stop during concrete placement.

Water stops shall be correctly positioned and held in place within the forms by using split forms, or other approved method that will positively hold the water stop in the correct position and alignment, so that the center of the water stop is centered on the joint. Horizontal water stops shall be bent up during concrete placement, until the concrete has been brought to the level of the water stop; additional concrete shall then be placed over the water stop, after which the concrete shall be thoroughly vibrated.

11388.3.3.2.3 All water stops shall be tied off in two directions every 12 inches in such a manner that bending over one way or another is prevented. In cases where preformed expansion joint material is used in conjunction with the water stop, allowance shall be made for equal water stop embedment on each side in the concrete. A hog ring or a nail may be driven through both outside ends of the water stop (within ½" of the outside edge) to facilitate placement and/or tying of water stops to reinforcing steel, forms, or form-ties.

11388.3.3.2.4 All water stops shall be properly spliced and joints shall be checked for strength and pinholes after splicing. Splices shall be strong enough to develop a pulling force of 75 percent of the strength of the water stop, and shall be watertight. The Contractor shall connect the ends of the radial water stop in the wall-footing joints to the circumferential water stop in the wall to wall-footing joint and to the circumferential water stops in the floor to wall-footing joints if they should exist.

11388.3.3.3 CONCRETE

11388.3.3.3.1 Concrete work shall conform to the provisions of Division 03000 of the Standard Specifications as supplemented and modified by this Section. Concrete forms, reinforcement, concrete and wet well appurtenances shall be located and placed as shown on the Drawings, and in accordance with Division 03000 of the Standard Specifications, unless noted otherwise herein.

11388.3.3.3.2 The proposed concrete mix design shall be submitted to the Engineer for review a minimum of two weeks in advance of the first planned concrete placement along with certified compression test results for that mix design. No concrete for the wet well may be placed until the Engineer has approved the mix design.

11388.4 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all labor, equipment, and materials required to furnish and install the fully functional Feed Pump System as shown on the Drawings and as required by these Specifications. The Contractor shall complete all work and install all equipment and components at the locations required in accordance with the equipment manufacturer's recommendations and the requirements of these specifications. The pump system supplier shall provide up to 8 hours of onsite training on his equipment and up to 8 hours of startup and calibration of the pump system at no additional cost to the Owner. It is the Contractor's responsibility to insure a fully functioning pump system, therefore, any additional startup and calibration time necessary to provide a fully functioning pump system shall be completed at no additional cost to the owner.

11388.5 METHOD OF MEASUREMENT

11388.5.1 Measurement shall be lump sum, and shall include furnishing and installing of the recirculation pump and accessories, as well as the recirculation pump wet well, all necessary piping within 5 feet of the wet well, all valves, controls, guide rails, and wiring. In short all labor and equipment necessary to provide a fully functioning recirculation pump system as shown on the plans and described in the specifications.

See note on Drawing C1 to determine items included in schedule A and B.

11388.6 BASIS OF PAYMENT

11388.6.1 Complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNITS
Recirculation Pump System	L.S.

SPECIAL PROVISION

DIVERSION STRUCTURE	SECTION 11389SP

11389.1 DESCRIPTION

The contractor shall provide all labor, equipment, and materials necessary to construct and erect the diversion structure as shown on the Drawings, consisting of a concrete roof, concrete floor and cast-in-place concrete walls. The diversion structure shall conform to the dimensions and be equipped with the appurtenances, valves, gates, railings, ships ladders, and piping as shown on the Drawings and in accordance with these specifications.

The structure will need to be constructed over the existing 48" PE pipe. The pipe will have to remain live during the construction with minimal downtime.

11389.1.1 RELATED WORK

Section 01019 – Measurement and Payment
Section 02105 – Earthwork Materials
Section 02200 – Trench Excavation and Backfill
Section 02201 – Earthwork for Structures
Section 02222 – Water Pipe Installation
Section 03050 – Portland Cement Concrete
Section 03100 – Concrete Forming, Finishing and Curing
Section 03200 – Concrete Reinforcement
Section 03300 – Concrete Structures and Slabwork
Section 03310 – Concrete Joints for Slabwork
Section 11010 – Mechanical Equipment General Requirements
Section 13320SP – Concrete Wet Well
Section 15110 – Pipe and Piping Systems
Section 15515SP – Aluminum Hydraulic Control Gates

11389.3.2 SUBMITTALS

11389.3.2.1 Descriptive literature, which identifies the manufacturer and materials used for fabrication for all piping, valves, fittings, control valves, water stops, liners and appurtenances, shall be provided by the Contractor in accordance with Section 01300 of these Specifications.

11389.3.2.2 The Contractor shall submit a 2-foot minimum length of each type of the water stop material for inspection and acceptance testing, to ensure compliance with the requirements of these Specifications.

11389.3.2.3 The Contractor shall submit concrete mix design information along with certified strength test documentation for that design for approval by the Engineer at least two weeks prior to planned concrete placement.

11389.3 MATERIALS

11389.3.1 MISCELLANEOUS COMPONENTS AND APPURTENANCES

11389.3.1.1 ALUMINUM HYDRAULIC CONTROL GATES.

Aluminum Hydraulic Control Gates shall be sized to properly fit the opening shown on the plans, and shall be supplied and installed according to the requirements of section 15515SP.

11389.3.1.2 STEPS - Plastic or fiberglass steps reinforced with steel, which conform to ASTM C487 or ASTM C478 standards, shall be installed in all sections of the wet well as shown on the Drawings.

11389.3.2 CONSTRUCTION

11389.3.2.1 WATER STOPS

11389.3.2.2 Water stops shall be ribbed, having a hollow center bulb cross-section and they shall uniform in dimensions and as detailed on the Drawings. Water stops shall be free of porosity and shall be made of a dense, homogeneous, virgin PVC compound. No reclaimed PVC shall be used in the compound. Water stops shall be by Vinylex Corporation, 2636 Byington-Solway Road, Knoxville, TN 37921 (ph. 615-690-2211), Greenstreak Plastic Products, Box 7139, St. Louis, MO 63177 (ph. 314-225-9400), or approved equal. Water stops shall meet the minimum material requirements of the table below.

WATER STOP MATERIAL SPECIFICATIONS		
Tensile Strength	2,000 PSI	(ASTM D-412)
Ultimate Elongation	350%	(ASTM D-412)
Shore Hardness	75 + 5	(ASTM D-2240)
Specific Gravity	1.3	(ASTM D-792)
Stiffness in Flexure	600 PSI	(ASTM D-747)
Cold Brittleness	-35°F	(ASTM D-746)
Water Absorption: 48 Hours	0.320% (Max.)	(ASTM D-570)
Tear Resistance	290 pounds/inch	(ASTM D-624)

11389.3.2.3 Water stops shall be installed in the joints designated on the Drawings, with precautions taken to ensure proper location, support, and protection of the water stop during concrete placement.

Water stops shall be correctly positioned and held in place within the forms by using split forms, or other approved method that will positively hold the water stop in the correct position and alignment, so that the center of the water stop is centered on the joint. Horizontal water stops shall be bent up during concrete placement, until the concrete has been brought to the level of the water stop; additional concrete shall then be placed over the water stop, after which the concrete shall be thoroughly vibrated.

11389.3.2.4 All water stops shall be tied off in two directions every 12 inches in such a manner that bending over one way or another is prevented. In cases where preformed expansion joint material is used in conjunction with the water stop, allowance shall be made for equal water stop embedment on each side in the concrete. A hog ring or a nail may be driven through both outside ends of the water stop (within ½" of the outside edge) to facilitate placement and/or tying of water stops to reinforcing steel, forms, or form-ties.

11389.3.2.5 All water stops shall be properly spliced and joints shall be checked for strength and pinholes after splicing. Splices shall be strong enough to develop a pulling force of 75 percent of the strength of the water stop, and shall be watertight. The Contractor shall connect the ends of the radial water stop in the wall-footing joints to the circumferential water stop in the wall to wall-footing joint and to the circumferential water stops in the floor to wall-footing joints if they should exist.

11389.3.3 CONCRETE

11389.3.3.1 Concrete work shall conform to the provisions of Division 03000 of the Standard Specifications as supplemented and modified by this Section. Concrete forms, reinforcement, concrete and wet well appurtenances shall be located and placed as shown on the Drawings, and in accordance with Division 03000 of the Standard Specifications, unless noted otherwise herein.

11389.3.3.2 The proposed concrete mix design shall be submitted to the Engineer for review a minimum of two weeks in advance of the first planned concrete placement along with certified compression test results for that mix design. No concrete for the wet well may be placed until the Engineer has approved the mix design.

11389.4 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all labor, equipment, and materials required to furnish and install the fully functional diversion structure as shown on the Drawings and as required by these Specifications. The Contractor shall complete all work and install all equipment and components at the locations required in accordance with the equipment manufacturer's recommendations and the requirements of these specifications.

11389.5 METHOD OF MEASUREMENT

11389.5.1 This items shall be measured as lump sum, and shall include furnishing and installing of the diversion structure and accessories, including, all necessary piping within 5 feet of the structure, all hydraulic control gates and appurtenances, all grating, railing, ships ladders, lids and rings, access hatches, steps, concrete work, etc. In short all labor and equipment necessary to provide a fully functioning diversion structure as shown on the plans and described in the specifications.

11389.6 BASIS OF PAYMENT

11389.6.1 When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNITS
Diversion Structure	L.S.

DIVISION 13
SPECIAL PROVISIONS

SUNRISE
ENGINEERING

13150.1 GENERAL

Specifications for the materials and construction of a steel building as outlined herein and as shown on the drawings. Metal building manufacturer shall be on the Utah Division of Facilities Construction and Managements current list of Approved Fabricators.
(See: http://dfcm.utah.gov/downloads/bldg_official/approved_fabricator_list_10.pdf)

13150.1.1 RELATED WORK

Section 02105 - Earthwork Materials
Section 02201 - Earthwork
Section 02201SP – Earthwork for Structures
Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 03300 - Concrete Structures and Slab Work
Section 03305SP – Steel Building Foundation and Floor
Section 08110 – Door Frames and Hardware
Section 08130 – Roll-Up Overhead Doors
Section 08210 – Metal Windows
Section 08220 – Aluminum Windows

13150.1.2 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. AISC- Code of Standard Practice – Manual of Steel construction -Allowable Stress Design (ASD).

B. American Iron and Steel Institute (AISI):
   1. AISI – Cold-Formed Steel Design Manual.

C. Metal Building Manufacturers Association (MBMA):
   1. MBMA – Design Practices Manual.

D. American Society for Testing and Materials (ASTM):
   1. ASTM A36/A36M – Structural Steel.
   2. ASTM A53 – Hot Dipped, Zinc-coated Welded and Seamless Steel Pipe
   3. ASTM A307- Carbon Steel Externally Threaded Standard Fasteners.
   4. ASTM A325 – High Strength Bolts for Structural Steel Joints
   5. ASTM A500 – Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
   5. ASTM A529/A529M – Structural Steel with 42 KSI (290 Mpa) Minimum Yield Point (½ in. (12.7 mm Maximum Thickness)
   6. ASTM A572/A572M – High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality

E. American Welding Society (AWS):
   1. AWS D1.1 – Structural Welding Code.

F. International Building Code (IBC Current Edition)

13150.1.3 SUBMITTALS

A. Provide Engineered Certified shop drawings stamped by a Utah State Registered Professional Engineer.

B. Provide engineered certified calculations for the metal building and the footing and foundation design.

C. Provide product information and manuals for all materials and equipment associated with the steel building for approval. This must be submitted and approved by the engineer and steel building manufacturer prior to construction of any part of the project.

13150.2 DESIGN REQUIREMENTS

A. Structures shall be designed in accordance with the requirements of the "International Building Code", "American Institute of Steel Construction" specifications, "American Iron and Steel Institute" specifications, and "Metal Building Manufacturers Association - Design Practices Manual". The latest edition of each of these publications shall apply.

B. Standard design loads shall be as follows:

Roof Snow Load	Wind Load	Seismic
30 Psf (IBC)	90 MPH Exposure C	Per IBC, Zone D
20 Psf Live Load		
Building Category 4		

C. Standard Load Combinations are:
Dead Load + Live Load.
Dead Load + Wind Load.
Dead Load + Live Load + ½ Wind Load.
Dead Load + Wind Load + ½ Live Load.

D. Design building with vertical concentrated foundation design load not to exceed a 45,000 pounds.

E. Provide Engineered Certified shop drawings stamped by a Utah State Registered Professional Engineer.

F. Verify and include all mechanical equipment and auxiliary building loads in the building structural design.

13150.3 PRIMARY FRAMING

A. Rigid Frames – shall be either tapered or constant-depth "I" beam sections, fabricated by automatic or hand welding. . Frames shall be spaced nominal per need. Roof slope shall be 1 inch in 12 inches (low profile). Rigid frames shall be bolted together where required with A-325 or 1-490 bolts.

B. Post and Beam End Frames: Shall be fabricated of either cold-formed sections 8" or 10" inches deep or built-up sections. Standard end-post spacing is 20 feet maximum center to center.

C. Anchorage: Building shall be anchored to concrete foundations at the base of frame columns with cast in place anchor bolts furnished and engineered by the building manufacture to resist the design loads produced by the building frame. Column base reactions in the structural calculations as well as the anchor bolt drawings shall be included.

D. Foundation Design and Layout: shall also be provided by the Contractor either by the Steel Building Manufacturer or other licensed professional engineer in order to insure that the foundation is compatible with the layout and load of the building.

13150.4 SECONDARY FRAMING

Purlins and Girts: Purlins and girts shall be fabricated of cold-formed steel 8" or 10" inches deep, with LGSI shape. Minimum thickness is 16 US gage; built-up sections are acceptable where required. Purlins and girts shall be a "Z" or "C" shape. Spacing and gage of these members shall be as determined by design and shown on the plans. Purlins and girts shall be attached to the primary framing members with ½" diameter A-307 bolts.

13150.5 PRIMARY AND SECONDARY FRAMING PAINT

All frames, purlins and girts shall receive one (1) shop coat of rust inhibitive primer after being thoroughly cleaned of loose mill and scale rust or other materials deleterious to paint bonding.

13150.6 PRIMARY AND SECONDARY FRAMING MATERIAL SPECIFICATIONS

A. Plates and bars used in fabricating automatically continuous welded beams and columns: Materials all conform to the chemistry requirements of ASTM A-36 modified minimum YP 50 ksi.

B. Structural Pipes: Materials all conform to the chemistry requirements of ASTM A-36 minimums.

C. Cold Formed Steel: Steel used to form purlins and girts shall be hot rolled steel. Materials all conform to the chemistry requirements of ASTM A607grade 50 or ASTM A570 grade.

13150.7 WIND BRACING

A. Diaphragm strength of wall panel is used for wind bracing in endwalls, if sufficient wall panel is available. Where necessary, cable or rod bracing will be used to resist forces, sized to withstand required loading.

B. Galvanized Cable: meeting ASTM A475, sized to withstand required loading.

C. Adjustable Rod: meeting ASTM A36/A36M; ASTM A572/A572M Grade D; or ASTM A529/A529M, sized to withstand required loading.

D. Wind Columns: fabricated from shop welded, built-up steel plates, meeting ASTM A36/A36M, sized to withstand required loading, where seismic forces will allow.

E. Portal Frames: fabricated from shop welded, built-up steel plates, meeting ASTM A36/A36M, sized to withstand required loading.

13150.8 ROOF AND WALL COVERING

A. Roof and wall covering shall be "PBR" panels formed from galvanized steel of minimum 26 U.S. gage, with not less than 1.250 oz. per sq. ft. of zinc coating.

B. Material specification: Materials shall conform to the chemistry requirements of ASTM A446.

C. Roof and wall panels shall be fastened to framing members by the stainless steel Sealed N Safe ® Fastener or approved equal per thermal block and metal building manufacturer's recommendations. And shall be supplied in the same color as the panel to which it is attatched.

D. Factory coated silicon modified polyester colored roof and wall sheets will be provided optionally with color to be selected by customer from available standard colors.

E. High ribs of the panel shall be spaced at 12 inches on center. These ribs shall be 1-1/4 inches in depth. Two secondary ribs shall be located between the major ribs. Roof and wall panels shall be made to overlap one rib. The panels shall provide a net coverage of 3'-0". All wall panels shall be continuous from base to eave except where length becomes prohibitive. If translucent roof or sidewall panels are indicated they shall have a profile matching the adjacent steel panels. Nominal weight of panels shall be 8 oz. per sq. ft. and a nominal thickness of .060 inches.

F. Roof and Wall Insulation: WMP-VR; white polypropylene film fiberglass & polyester scrim. R25 minimum value in wall; Full cavity or double layer system as shown on plans in roof meeting R25 minimum value. An R-5 minimum Sealed N Safe Thermal Block or approved equal shall be installed continuously along all structural metal members that are in contact w/ outside metal siding per thermal block manufacturer's recommendations. A foam sealant shall be injected under metal siding as shown on the plans above a corrugated metal foam insert mounted in place with water-proof caulking at the base of the metal siding. A flashing and drip edge shall be installed at the base of the metal siding as well.

13150.9 WALKDOORS, WINDOWS AND OVERHEAD DOORS

A. Walk-in Doors: Standard walk-in door shall be 3'0 x 7'0 , 4'0x 7'0 , 6'0 x 7'0, with a 1 ¾ inch thick single swing flush type steel construction with commercial grade lever lockset meeting ANSI #A156.2, Series 4000, Grade 2. 6'0x 7'0 will be double swing type.

B. All walk-in doors and frames shall be insulated, they shall be galvanized and bonderized for maximum rust protection and paint adherence. In addition, they shall receive one shop coat of high grade oven baked paint. Doors face sheets shall be 20ga. Frames shall be 16ga. and meet R15 insulation value.

C. Provide 8" x 16 gauge C channel windows frames with commercial grade vinyl double pane Low E (0.2 E factor with ½ inch air space) windows furnished installed complete with sealants, flashing and trim.

D. Sectional Overhead Doors shall be commercial grade overhead sectional doors manually operated with commercial grade operator and locks assembly as follows:

1. Sectional overhead doors and all accessories and components required for complete and secure installations shall manufactured as a system from one manufacturer.
2. Sectional overhead doors shall be tested and labeled certifying compliance with ASTM D1929 andASTME84-91Astandards.
3. Thermospan 150 as manufactured by Wayne-Dalton Corp., Mt. Hope, Ohio. or approved equal, steel-backed, Polyurethane insulated sectional doors with

continuous angle mounting for steel jambs, standard lift, manual push-up, upgraded to 20,000 cycle springs. Unless otherwise indicated on the plans.

4. Windows: One row of Security Lites per door.
5. Contractor shall submit shop drawings which clearly indicate the design and installation details to withstand standard wind-load, all details required for complete operation and installation, hardware locations, type of metal and finish for door sections, finish for miscellaneous components and accessories. Contractor shall also submit product data indicating manufacturer's product data, and installation instructions.
6. Contractor shall provide manufacturer's SEVEN-YEAR warranty against separation/degradation of the polyurethane foam from the steel skin of the panel under provisions. And Manufacturer's TEN-YEAR warranty against cracking, splitting or deterioration due to rust-through.
7. Door Sections: Shall be of steel/polyurethane/steel sandwich type construction with thermal break and minimum calculated materials "R"-value of 14.16, in accordance with industry guidelines.
8. Exterior Skin: Structural quality, hot-dipped galvanized steel, .022" minimum embossing, factory finished with baked-on polyester primer and polyester finish coats
9. Interior Skin: Structural quality, hot-dipped, galvanized steel, factory-finished with a polyester primer and white finish coat. Interior skin shall have two 1-3 4" roll-formed integral struts per section. Ends of section shall be sealed with 16-gauge 18-Gauge hot-dipped galvanized steel full-height end caps.
10. Insulation: Cavity shall be filled with formed in-place CFC free polyurethane core separated by a factory extruded thermal break. Insulated sections shall be tested by an I.C.B.O. certified laboratory in accordance with ASTM E-84-91A and shall achieve a Flamespread Index of 10 or less, and a Smoke Developed Index of 210 or less. Insulation material shall be tested by an I.C.B.O. certified laboratory in accordance with ASTM D-1929 and shall achieve a minimum Flash Ignition temperature of 734 degrees F, and a minimum Self Ignition temperature of 950 degrees F. Insulated sections shall be tested and meet all requirements of the UBC 17-5 corner burn.
11. Track: Track design shall be standard lift. Vertical mounting angles and brackets shall be hot-dipped galvanized. Track size shall be 2". Vertical track shall be graduated to provide wedge type weather-tight closing with continuous angle mounting for steel jambs, and shall be fully adjustable to seal door at jambs. Horizontal track shall be reinforced with continuous angle of adequate length and gauge to help prevent deflection.
12. Hardware: Hinge and Roller Assembly: Hinges and brackets shall be made from hot-dipped, galvanized steel. Track rollers shall be case-hardened inner steel races with 10-ball 2" rollers. All factory authorized attachments shall be made at locations indicated and reinforced with backup plates.
13. Counterbalance: Springs shall be torsion type, low-stress, helical wound, oil-tempered spring wire to provide minimum 25,000 cycles of use, on continuous steel shaft. Spring fittings and drums made of die cast, high-strength aluminum. Pre-formed galvanized steel aircraft cable shall provide a minimum of a 5:1 safety factor.
14. Locks shall engage the right-hand vertical track
15. Weather-stripping: doors shall be equipped with factory-applied co-polymer joint seals between sections and vinyl "bulb" shaped astragal provided for bottom section.
16. Installation: Install doors in accordance with manufacturer's instructions and standards Installation shall be by an authorized manufactures representative. Overhead door support framing shall be designed to resist applicable wind loads

and shall consist of channel jambs with a structural header at the top of the opening with required flashing and trim.

13150.10 GRAVITY RIDGE VENTILATORS

A. Where specified, ventilators shall be either continuous or circular, ridge mounted.

B. The base of the ventilators shall be provided to match the roof slope.

13150.11 GUTTER, TRIM AND DOWNSPOUTS

A. Eave gutters shall be of 26 U.S. gage galvanized steel. All gutter splices shall be riveted and caulked to provide leak-proof joints.

B. Gable, corner, eave and window and door trim shall be of 26 U. S. gage.

13150.12 RIDGE CAP

The standard formed ridge cap shall be formed to match the roof slope and shall be of the same material, color and configuration as the roof panels up to and including 3:12 slopes. Slopes over 3: 12 require universal ridge cap.

13150.13 SEALANTS

A. Closure Strips: Strips shall be constructed of semi-rigid polyethylene foam and shall match the standard panel.

B. Tape Sealant: Ribbon mastic 3/32” x 3/8” shall be provided for side and end laps of panels where indicated.

13150.14 CONSTRUCTION REQUIREMENTS

13150.14.1 The CONTRACTOR shall complete construction of the erection of the building in a manner that conforms with the requirements of the DRAWINGS and these SPECIFICATIONS, using good workmanship practices, and applicable building regulations.

13150.14.2 Steel building layout shall match the concrete foundation layout.

13150.14.2 Assemble building materials and all specified components as per manufacturer’s recommendations and to the specified code.

13150.15 METHOD OF MEASUREMENT

13150.15.1 The method of measurement for the steel building shall be “lump sum” and shall include but not limited to all windows and doors, insulation, anchor bolts, rain gutters, down spouts, and all incidental work and materials, and construction as shown on the drawings or described in the specification needed to provide a complete and functional building.

13150.16 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Steel Building	Lump Sum

GANTRY CRANE AND HOIST — SECTION 13320SP

13320.1 DESCRIPTION

The Contractor shall furnish and install an adjustable gantry crane, along with a manual chain hoist and Eye Manual Trolley, and appurtenances as shown on the Drawings and as described in these specifications.

13320.1.1 RELATED WORK

Not used.

13320.1.2 SUBMITTALS

The Contractor shall provide complete information, which includes cutaway drawings, parts lists, fabrication details, and manufacturer's installation instructions in accordance with the requirements of Section 01300.

13320.1.2.3 DEFINITIONS

Not used.

13320.2 MATERIALS

13320.2.1 QUALITY CONTROL

This specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if, in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

13320.2.2 GANTRY CRANE

13320.2.2.1 The Gantry Crane shall be Model BAHS 4-10-12 as manufactured by Beacon Industries, Inc. or approved equal. Crane shall have a 4,000 lb capacity with beam length of 10’ and an available travel distance along beam of 9 feet. Under I-Beam range shall be a minimum of 7 foot 6 inches to 12 feet which shall be adjustable in 6" Increments. Beam shall be an 8 inches high with a flange width of 4 inches. Crane shall include four (4) 8" 4-position Swivel Lock Phenolic Casters with roller bearings; to facilitate easy mobility from one area to another.

13320.2.2.2 GANTRY CRANE ACCESSORIES

Gantry crane shall be supplied with a two (2) Come-A-Long Kit, for Height adjustment, Model BAHS-KIT by Beacon Industries Inc. Or approved Equal.

13320.2.2.3 CHAIN HOIST

Gantry Crane Shall be supplied with a Beacon Industries Inc. Model BHCH-4-15 Manual Chain Hoist or approved equal. Chain hoist shall have a 4,000 lb capacity. Chain Hoist shall be supplied with a 15’ lift. Manual chain hoists shall be tested at 150 percent rated capacity and meet ANSI B30.16-2003 requirements. The chain hoist shall feature grade 80 black chain tempered to ISO 3077, galvanized pull chain, hardened two-stage gears and forged steel upper and lower hooks with safety latches. The hoist shall be supplied with double ratchet pawls with self-adjusting disc brake.

13320.2.2.4 EYE MANUAL TROLLY

The contractor shall furnish and install an Eye Manual Trolley model BE-MT-4 with chain/gear by Beacon Industries, Inc. or approved equal. Trolley shall have a 4,000 lb capacity. The width of the trolley shall be adjustable by rotating the center rod with lifting eye clockwise or counterclockwise. Once hoist is attached center rod shall not be able to be rotated which shall prevent trolley width from accidentally changing. Trolley shall be geared trolley. The trolley position shall be adjustable with a manual pull chain. Each trolley shall include four rollers with sealed bearings for long life. A lifting eye shall be located at the bottom of the trolley for attaching the hoist. Trolley shall be of Steel construction and painted finish.

13320.3 CONSTRUCTION REQUIREMENTS

The Contractor shall assemble the Gantry Crane and attach the Eye Manual Trolley and Manual Chain Hoist, per manufacturer's recommendations.

13320.4 METHOD OF MEASUREMENT

Gantry Crane and Hoist and Appurtenances quantities shall be measured by counting the number of cranes and hoist assemblies in place and accepted. In such cases, measurement will include all necessary labor, equipment, and materials required to complete installation and assembly of the crane and hoist to provide a fully functional system in accordance with these Specifications, as shown on the plans, and as required by the applicable Regulatory Agencies.

13320.5 BASIS OF PAYMENT

When gantry crane and hoist are identified as individual line items on the Bid Schedule, the accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
GANTRY CRANE AND HOIST	Each

DIVISION 15

MECHANICAL

SUNRISE
ENGINEERING

15010.1 DESCRIPTION

15010.1.1 WORK INCLUDED

A. Basic requirements common to the work in general of Division 15 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under other Sections of this Division 15.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.

D. Inspection: Inspect work preceding or interfacing with work of Division 15 and report any known or observed defects that affect the Work to the Construction Manager/General CONTRACTOR. Do not proceed with the work until defects are corrected.

E. Existing Utilities: Are indicated as accurately as possible on the Drawings. Close openings and repair damage in acceptable manner to utilities encountered. This CONTRACTOR shall be responsible for field surveying all aspects of existing conditions prior to bid date. Change orders will not be issued for a failure to review existing conditions which affect Division 15 work.

15010.1.2 RELATED WORK

Requirements: Provide Basic Requirements in accordance with the Contract Documents.

15010.1.3 UTILITIES, EXTENSIONS, CONNECTIONS AND FEES FOR WATER AND SEWER

A. Provide all building services extensions and connections to off-site and on-site utilities.

B. Sewer connection charges, typically based on fixture units, that in principle allow the right to obtain the sewer services from the utility will be arranged and paid for by the Division 15 CONTRACTOR.

C. Water system development fees, typically based on meter size, that in principle allow the right to obtain the water services from the utility will be arranged and paid for by the Site Utilities CONTRACTOR.

D. Sewer tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities CONTRACTOR.

E. Water tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities CONTRACTOR.

F. In the event that the serving utility company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Division 15 CONTRACTOR. Extensions from termination points to connection with building services and systems will be the responsibility of the Division 15 CONTRACTOR.

G. Be responsible for all pads, vaults, manholes, manhole covers, meter enclosures, valves, services boxes, and the like, all in conformance with requirements of the serving utility company.

H. In the event that the water service to the building is a combination domestic and fire protection service, the responsibility of said "combination service" to the point of domestic connection shall be that of a licensed Fire Protection CONTRACTOR, including tap, valves, excavation, backfill, compaction and meters, if any. After point of domestic connection, responsibility for separate fire and domestic services is with appropriate trades including all labor and materials as herein before mentioned.

1. CONTRACTOR shall coordinate with other trades all interface piping and types of connections to be provided for interface.
2. Provide fire hydrant, auxiliary gate valve, tapping sleeve and valve or tee, service boxes, and anchor or swivel couplings, thrust blocks, deadmen, rods, and the like, all in conformance with the requirements of serving utility company.

15010.1.4 REFERENCES

General:

1. For products or workmanship specified by association, trades, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

2. The date of the standard is that in effect as the date of the Contract Documents, except when a specific date is specified.

3. When required by individual Specifications section, obtain copy of standard. Maintain copy at job site during work until substantial completion.

15010.1.5 DEFINITIONS

A. Specification Language Explanation: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of words of phrases such as "the CONTRACTOR shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "the", are intentional. Supply when "NOTE" occurs on Drawings. Supply words "shall be" or "shall" by inference when colon is used with sentences or phrases. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

C. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

D. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

E. Indicated: The term "Indicated" is a cross-reference to graphics, notes or schedules on Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purpose of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

F. General CONTRACTOR: The term "General CONTRACTOR" used in Division 15 and elsewhere in the Contract Documents means the party with whom the OWNER has executed the OWNER-CONTRACTOR Agreement.

G. Approved equal: Except as otherwise defined in greater detail, term "approved equal" means that any materials, equipment, work procedures and techniques shall be either addressed on the drawing, specifications or addendum by manufacturer or by detailed material description. When brand names are referenced it implies that only the manufacturers listed are approved. All approved material, equipment, work procedures, and techniques will be noted in the specifications, drawings, or by addendum prior to bid date. Items not approved in this manner will not be considered.

15010.1.6 QUALITY ASSURANCE

A. Quality Control

1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.
2. Furnish the services of an experienced superintendent, who will be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, certified welders, plumbers, millwrights, sprinkler fitters, drain layers, helpers, and labor required to unload, transfer, erect, connect, adjust, start, operate and test for each system.
3. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

B. Proof of Performance

1. Division 15000 CONTRACTOR shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design. This proof of performance shall include, but shall not be limited to, actual demonstration of all temperature/pressure control loops, operation of all heating/cooling equipment and other required tests upon request by the Engineer or OWNER. A signed certificate from the piping, sheetmetal, control, and balancing subcontractors stating that they have personally checked the operation of all equipment and control loops and that everything under their subcontract is operating as specified. These certificates shall be furnished to the 15000 CONTRACTOR for inclusion in the Operation and Maintenance Manual.

15010.1.7 REGULATORY REQUIREMENTS

A. Execute Work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.

B. Comply with editions of all applicable codes, ordinances and regulations in effect at the time of bid opening including but not necessarily limited to the following:

International Mechanical Code
International Plumbing Code
State Department of Health Requirements
Model Energy Code
National Fire Protection Association Standards
International Fire Code
International Building Code
National Electrical Code NFPA-70
State Boiler Code
Jurisdictional County Health Department
Jurisdictional City Wastewater Management Division or District
Jurisdictional City Water Department
Jurisdictional Water Conservation Standards

C. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.

D. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the UBC, and listed by Underwriters Laboratories, Inc.

15010.1.8 SUBMITTALS

A. CONTRACTORs are required to submit Mechanical Cost Breakdown to Engineer when submitting shop drawings. Shop drawings will not be accepted without a complete Mechanical Cost Breakdown. See last page of this Section for requested breakdown. If your standard compilation of bids is different than our requested breakdown, please send it in your format. We need the data to keep our cost estimating files up to date. Just fill-in blanks with a pencil, typing is not required.

B. Submit Samples, Shop Drawings and Product Data as required by various Sections of Division 15 in accordance with The General Conditions of the Contract. The CONTRACTOR agrees that these Submittals processed by the Engineer are not Change Orders; that the purpose of these Submittals by the CONTRACTOR is to demonstrate to the Engineer that the CONTRACTOR understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. CONTRACTOR further agrees that if deviations, discrepancies, or conflicts between these Submittals and the Contract Documents in the form of design drawings and specifications are discovered either prior to or after these Submittals are processed by the Engineer, the Design Drawings and Specifications shall control and shall be followed.

C. The submittals shall be submitted in a single package with all mechanical equipment for the project enclosed. The submittals shall be enclosed in a stiff back, 3-ring binder. All mechanical equipment shall be separated with tabbed index cards with an indexed legend provided in the front of the binder.

D. Test Reports: Submit certified test reports as required by various Sections of Division 15 showing compliance in accordance with General Conditions of the Contract. Signed copies shall be included in the Operation and Maintenance Manual.

E. Operating Instructions and Maintenance Data: Prepare and submit printed operating instructions and maintenance data in accordance with Operating and Maintenance Data paragraph in this Section.

15010.1.9 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions and Prior Approvals: Substitutions and prior approvals will be acceptable only when the proposed substitute has been submitted to the Engineer and approved through an addendum or change order. Request for prior approval shall be submitted a minimum of 10 calendar days prior to bid.

B. Some materials and equipment are specified by manufacturer and catalog numbers. The manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

C. NOTE: When alternate or substitute materials and equipment are used Division 15 CONTRACTOR shall be responsible for engineering/redesign costs, space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Notification of General CONTRACTOR and other affected subcontractors shall be the responsibility of the Division 15 CONTRACTOR.

15010.1.10 PROJECT RECORD DOCUMENTS

A. General: Comply with Division 1.

B. Job Site Documents: Maintain at the job site, one record copy of the following:
1. Drawings
2. Specifications
3. Addenda
4. Reviewed Shop Drawings
5. Field Test Records

Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.

C. Record Information: Label each document “Record Document”. Mark information with red ink. Keep each record current. Do not permanently conceal any work until required information is recorded.

D. Record following information on Drawings:
1. Horizontal and vertical location of underground utilities to be dimensioned from column lines.
2. Dimensioned location of internal utilities and appurtenances concealed in construction.
3. Field changes of dimension and detail.
4. Changes by change order or field order.
5. Details not on original contract drawings.

6. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed shall be indicated on equipment schedules.

E. Record the following information on Specifications.
1. Changes by change order or field order.
2. Other matters not originally specified.

F. Shop Drawings: Maintain shop drawings as record documents recording changes made after review as specified for drawings above.

G. Submittal: At completion of project, deliver record documents to OWNER's representative and transmit a copy of signed receipt from OWNER to the Engineer.

15010.1.11 OPERATING AND MAINTENANCE DATA

A. Division 15 CONTRACTOR shall submit three (3) typed and bound copies of the maintenance manual, 8-1/2" x 11" in size, to the Mechanical Consulting Engineer for approval. These approved copies will be returned to the CONTRACTOR and shall then be transmitted to the OWNER.

B. Organization of the manuals shall follow the recommendations in ASHRAE Guideline 4-1993.

C. The manual shall be enclosed in a stiff-back, three-ring binder and shall have:
1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/ shutdown and long-term shutdown.
3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
4. All test reports and proof of performance certificates.
5. Manufacturer's data on each piece of equipment, including the following. Provide original printed material in each book, faxes and photocopies are NOT acceptable.
   a. Installation instructions.
   b. Drawings and specifications (final shop drawings).
   c. Parts lists.
   d. Complete "as-built" wiring and temperature control diagrams. (Shop drawings are not acceptable.)
   e. Lubrication and other preventative maintenance data.
   f. Equipment warranties.

D. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified on drawings. Insert a copy of the Equipment List or Equipment Schedules in manual.
1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches. Label with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".
2. Tag all manual operating valves per requirements in Section 15010.

3. Provide a typed tag list or schedule mounted under glass in the equipment room stating number, location, and function of each tagged item. Insert a copy of tag list in each "Maintenance Manual".

E. Division 15990 CONTRACTOR shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Architect, Construction Manager/General CONTRACTOR and far enough in advance so that all necessary personnel can be adequately notified.

15010.1.12 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.

B. Protection: Store materials and equipment off the ground and under cover, protected from damage. Maintain caution labels on hazardous materials.

C. Large Items: Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.

D. Handling of Materials: Materials shall be handled, sorted and distributed using appropriate handling methods to protect all materials from damage. Dented, rusted, corroded or otherwise damaged materials shall be removed from the project site. Determination of materials deemed unusable or inappropriate for installation shall be made by the Architect/Engineer.

15010.1.13 PROJECT CONDITIONS

A. Accessibility:

1. Division 15 CONTRACTOR shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with CONTRACTORs of other Divisions of the Work whose work is in the same space and shall advise the Construction Manager/General CONTRACTOR of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.
2. Division 15 CONTRACTOR shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include (but not be limited to) valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, filters, VAV boxes, control valves, balancing valves, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect/Construction Manager/General CONTRACTOR prior to making the change.
3. Division 15 CONTRACTOR shall provide the Construction Manager/General CONTRACTOR with the exact locations of access doors for each concealed valve, shock absorber control, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

B. Fabrication: Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the CONTRACTOR shall assure himself that they can be run as contemplated in cooperation with CONTRACTORS of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

C. Freeze Protection: Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

D. Scaffolding, Rigging and Hoisting: Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required.

15010.1.14 COORDINATION

A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordination with Electrical Work: Section 15010.

C. Utility Interruptions: Coordinate mechanical utility interruptions with the OWNER and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

D. Cutting and Patching: Section 15010.

E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural Drawings and equipment to be furnished.

F. Each Division 15 subcontractor shall coordinate with other contractors to make certain that any of his equipment; piping or ductwork which is mounted on isolators or flexibly connected does not become “grounded” by another contractors work (e.g. walls, ceiling, etc.).

G. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Construction Manager/General CONTRACTOR and obtain written instructions for any changes necessary.

H. Order of Precedence: The precedence of mechanical construction documents are as follows:
1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.
2. Should there be a conflict within the Specifications or within Drawings of the same scale, the more stringent or higher quality requirements shall apply.
3. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.

4. Should there be a conflict in dimensions or locations between Mechanical Drawings and Architectural Drawings, the Architectural Drawings shall have precedence.

15010.1.15 START-UP PROCEDURES

A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition which may cause damage to equipment or endanger personnel.

B. Insure that all control systems are fully operational in automatic mode. Individually test each control loop to make certain it is operating as intended and is communicating properly with other devices.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to insure against accidental operation or operation by unauthorized personnel. Provide padlocks on disconnect switches where applicable.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify Engineer at least 2 weeks prior to the scheduled start-up date of all major mechanical equipment and systems.

15010.1.16 SCHEDULE OF TESTING

A. Provide testing in accordance with the General Conditions of the Contract.

B. A schedule of testing shall be drawn up by the Division 15 CONTRACTOR in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. All testing must be performed in the presence of the Architect's/Construction Manager's/General CONTRACTOR's representative; his signature for verification of the test must appear on the schedule.

D. All testing must be performed in accord with the procedures set forth in Division 15 and other Sections of the Specifications where referenced. At completion of testing, the completed schedule shall then be submitted in triplicate to the Architect and a copy shall be forwarded to the 15990 CONTRACTOR for inclusion in Operation and Maintenance Manual.

E. Make all specified tests on piping, ductwork and related systems as specified in this specification.

F. Make sure operational and performance tests are made on seasonal equipment.

G. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.

H. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air filters cleaned or replaced, valve and pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

15010.1.17 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Conditions of the Contract and Division 1.

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 15 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

15010.1.18 WARRANTIES

A. Warranty: Provide a written warranty to the OWNER covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance.

B. During this period provide labor and materials as required to repair or replace defects. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the Construction Manager/General CONTRACTOR for delivery to the Architect. Include a copy of all warranties in the Operation and Maintenance Manual.

C. This warranty will be superseded by the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for construction heat or ventilation.

D. All refrigeration compressors shall have a (4) four year extended warranty from the manufacturer of the equipment in addition to the standard one-year warranty.

15010.1.19 PROJECT CLOSEOUT

Project Observation Reports: At or near the completion of the construction phase of this project, the Engineer will generate one or more Project Observation Reports for the owner. These reports will list the items of construction observed by the Engineer which are not in compliance with the Contract Documents. The Mechanical CONTRACTOR and/or subcontractors shall certify completion of each listed item in writing and forward copies to the Architect, Engineer and General CONTRACTOR. The Engineer will not recommend the payment of retainage until this compliance certification has been received. Each item on the Project Observation Report shall have a signature/date in the margin of the report indicating completion of that item.

15010.1.20 CERTIFICATES AND KEYS

A. Certificates: Upon completion of the work, deliver to the Construction Manager/General CONTRACTOR one copy of Certificate of Final Inspection.

B. Keys: Upon completion of work, submit keys for mechanical equipment, panels, etc. to the Construction Manager/General CONTRACTOR.

15010.1.21 METHOD OF MEASUREMENT

The method of measurement for payment of Mechanical & HVAC Equipment will be lump sum. Measurement will included furnishing and installing all Mechanical and HVAC equipment and accessories, including but not limited to, all supports, seismic restraints, instrumentation, fittings,

fasteners, terminal electrical connections, shields, hardware, surface material, coatings, penetrations, gaskets, flashing, valves, measurement devices, sensors, control units, and all other accessories, components, and sub-systems required to provide a complete and functioning Mechanical and HVAC system as outlined in the specifications, manufactures requirements, owners requirements and or drawings and scheduling. A complete and functioning system will be based on all applicable codes mentioned and not mentioned in the specification, Owners and/or Engineers documentation, local code enforcement jurisdiction and industry standards.

15010. 1.22 BASIS OF PAYMENT

Complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNITS
Mechanical & HVAC Equipment	L.S.

15110.1 DESCRIPTION

This section is a materials specification and is included for guidance in selecting materials for pipe and related fittings and appurtenances used in the construction of water and sewer systems.

15110.1.1 RELATED WORK

Section 02222 - Waterline Pipe Installation
Section 02224 - Sewer Line Pipe Installation
Section 15230 - Waterline Valves and Hydrants
Section 15232 - Water System Control Valves

15110.1.2 SUBMITTALS

The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, couplings, coatings, linings, supports, mechanical restraints, thrust blocks and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall accompany each delivery of material.

15110.1.3 DEFINITIONS

Not used.

15110.2 MATERIALS

15110.2.1 NSF COMPLIANCE

All pipe and materials furnished and installed for culinary use shall comply with NSF International Standard 61. Also, all plastic pipe must be approved by the NSF for potable water use and shall carry the factory "NSF" stamped label on the pipe indicating such approval.

15110.2.2 POLYVINYL CHLORIDE PIPE (PVC)

15110.2.2.1 PVC PIPE FOR WATER LINE CONSTRUCTION – Shall be as follows:

- For sizes less than 4 inches OD, PVC pipe shall be Schedule Rated pressure pipe meeting the requirements of ASTM D1785 of the schedule and size shown on the Drawings.

- PVC pipe 4 inches and larger, shall be rigid, thermoplastic Class Rated pressure pipe meeting the requirements of ANSI/AWWA Standard C900 or C905 (latest revision). The pressure class or the dimensional ratio and the size shall be as shown on the Drawings.

- While Class Rated and Pressure Rated pipe materials are not interchangeable, when specifically allowed in the Contract Documents, for size 4" and larger, rigid thermoplastic Pressure Rated pressure pipe, meeting the requirements of ASTM D2241, may be furnished and installed. Operating pressure for this pipe shall be as shown on the Drawings.

15110.2.2.2 FITTINGS FOR PVC PIPE – Unless specifically authorized otherwise, fittings for 4 inch and larger size PVC pipe in underground service shall be ductile iron (DI) and shall meet the requirements of NSF 61 and ANSI/AWWA C-153. They shall have a standard coating of cement mortar on the interior surfaces in compliances with AWWA C-104. DI fittings meeting these requirements may be used with smaller PVC piping. PVC fittings meeting the requirements of

ANSI/AWWA C-907 may be used with PVC pipe smaller than 4 inches, and, in some instances, where specifically authorized, with PVC pipe sizes 4 inches through 8-inches.

15110.2.3 DUCTILE IRON PIPE

15110.2.3.1 INTERIOR COATING - The interior surface of all DI pipe shall be coated with a standard coating of cement-mortar in accordance with ANSI/AWWA Standard C-104 unless required otherwise in the Contract Documents. Field coating of DI pipe will not be acceptable.

15110.2.3.2 BURIED PIPE – Unless shown otherwise on the Drawings, shall be as follows:

- Buried ductile iron pipe shall be Thickness Class 51.
- Shall meet requirements of ANSI/AWWA C-151.
- Joints shall be bell and spigot or mechanical, which meet the requirements of ANSI/AWWA C-111.

15110.2.3.3 EXPOSED PIPE – Shall meet these requirements, unless shown otherwise on the Drawings:

- Exposed ductile iron pipe shall be Thickness Class 53.
- Pipe shall comply with ANSI/AWWA Standard C-151.
- Pipe joints shall be flanged, meeting the requirements of ANSI/AWWA C-115, or mechanical type couplings (MTC), meeting the requirements of ANSI/AWWA C-606. MTC shall be Victaulic grooved couplings, as manufactured by Victaulic Company of America or approved equal), unless shown otherwise on the drawings.
- 3” to 12” compact flanged fittings shall be ductile iron and shall be produced in accordance with laying lengths specified in ANSI/AWWA C10/A21.10. Flange surface shall be faced and drilled in accordance with ANSI Class 125 B16.1. Nominal body thickness shall be Manufacturer’s Standard, but shall not be less than those specified in ANSI/AWWA C153/A21.53 “Standards for Ductile Iron Compact Fittings”. Flange thickness shall be in accordance with the Manufacturer’s Standards. Working pressure rating shall be 250 psi for water. Fittings shall be made in the United States of America and shall not have been refurbished or reworked by anyone other than the manufacturer. When greater than 250 psi is called for on the Plans, then the Supplier shall furnish higher class rated flanges. Standard Class 125 template for drilling shall be used for all flanges. Drilling templates shall be in multiples of four, so that fittings may be made to face in any quarter. Boltholes shall straddle the centerline and shall be equally spaced. Misalignment of boltholes of two opposing flanges shall not exceed 0.12 inches. Blind flanges 12 inches and over shall be provided with lifting eyes. Insulated flanges shall be provided where required.
- Gaskets shall be full faced, 1/16-inch thick compressed sheets of Aramid fiber base, with nitrile binder and non stick coating, suitable for temperatures to 700°, pressures to 1000 psig and a pH range of 1 to 11. Blind flange gaskets shall cover the entire inside face of the flange and shall be cemented in place. Gaskets shall be as manufactured by John Crane, style 2160; Garlock, style 3000; or approved equal.

15110.2.4 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

15110.2.4.1 PIPE – Shall be as follows:

- PE pipe shall be classified as a Type III, Grade P-34, Class C, Category 5, according to ASTM D1248. All PE pipe shall be manufactured according to ASTM D2513, D3035, F714, or API 15LE and AWWA C906.

- Pipe shall be made of high density, high molecular weight resin. PE plastic shall have a cell classification of 345434C as defined by ASTM D3350/AWWA C906. It shall be rated as PE3408 according to the requirements of the Plastics Pipe Institute. Internal pressure rating shall be as specified elsewhere in the project documents.

15110.2.4.2 FITTINGS FOR HDPE – Molded fittings shall be made of pre-blended virgin resins in accordance with the materials specifications of ASTM D1248. PE3408 fittings shall be made from a Type III, Class C, Category 5, Grade P-34 plastic resin having a cell classification of 345434C according to ASTM D3350. Socket fusion fittings shall be manufactured in compliance with ASTM D2683 and butt fusion fittings with ASTM D3261. Measurements of fittings shall be as required by ASTM D2122. All fittings shall be compatible for heat fusion with any pipe manufactured for like or similar resins.

Heat welded Flange Adapter Couplings shall be used for transition to other type piping material. The Contractor shall follow the manufacturer's recommendations, as well as specified procedures herein in fusing fittings to the polyethylene pipe.

15110.2.5 GALVANIZED IRON PIPE AND FITTINGS

Shall be of the schedule rating shown on the Drawings and shall be used only in exposed, non-corrosive atmospheres where piping diameters are less than 4 inches.

15110.2.6 PIPE AND FITTINGS FOR WATER SERVICE LINES

Shall meet the requirements provided in Section 15234 for water service connections.

15110.2.7 PIPE FOR GRAVITY SEWER SYSTEMS

Gravity sewer pipelines may be constructed with PVC or polyethylene (PE) plastic sewer pipe and fittings. Such materials shall be of the type, configuration and size shown on the Drawings and/or on the Bid Schedule.

15110.2.7.1 PVC PIPE - All PVC sewer pipe and fittings shall meet the standards of ASTM D3034 and F679. Such pipe shall be manufactured with a rubber gasketed joining system which meets ASTM D3212 and shall be furnished with a standard dimensional ratio of 35 (SDR 35) for wall thickness, unless shown otherwise on the Drawings.

15110.2.7.2 PE PIPE - All PE sewer pipe and shall be smooth, solid wall, high density polyethylene pipe manufactured from PE 3408 material conforming to ASTM D1248, Type III, Class C, Category 5, Grade P34 with a P3408 rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound equal to or exceeding the properties of the pipe being supplied.

15110.2.8 PIPE FOR PRESSURE SEWER SYSTEMS

Pressure sewer pipelines shall be constructed with DI, PVC, or PE plastic sewer pipe. Fittings and materials shall be of the type, SDR rating, (or pressure class) and size shown on the Drawings and/or on the Bid Schedule.

15110.2.8.1 PVC PIPE - All PVC pipe for pressure sewer lines shall be rigid, pressure rated, thermoplastic pipe which meets the standards of ASTM D2241. Fittings for PVC pipelines shall be Class 50, cement mortar lined, rubber gasketed, DI which meet the requirements of ANSI/AWWA C-153 and C-104.

15110.2.8.2 PE PIPE - PE pipe for pressure sewer lines shall be smooth, solid wall, high density polyethylene pipe manufactured from PE 3408 material conforming to ASTM D1248, Type III, Class C, Category 5, Grade P34 with a P3408 rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound equal to or exceeding the properties of the pipe being supplied.

15110.2.9 PIPE AND FITTINGS FOR IRRIGATION SYSTEMS

Shall be either DI or Pressure Rated PVC, of the type and class shown on the Drawings, for line diameters 4-inches and greater. Buried lines smaller than 4 inches in diameter shall be Schedule Rated PVC as shown on the Drawings.

15110.2.10 PIPE FOR DRAIN SYSTEMS

Piping for sub-drainage may be constructed with polyvinyl chloride (PVC) or polyethylene (PE) plastic non-pressure drainage or sewer pipe and fittings. Such materials shall be of the type, configuration and size shown on the Drawings and/or on the Bid Schedule.

15110.2.10.1 PVC PIPE - All PVC drainage pipe and fittings shall meet the standards of ASTM F794. Such pipe shall be manufactured with a rubber gasketed joining system which meets ASTM D3212 and may be furnished with ribbed, corrugated or smooth exterior walls with smooth interior wall surfaces, unless shown otherwise on the Drawings. Rubber gasketed joints will not be required for collection pipe applications with perforated or slotted pipe sections.

15110.2.10.2 PE PIPE - All PE drainage pipe shall be solid, corrugated or ribbed wall high-density polyethylene pipe with smooth interior wall surfaces. Material shall conform to ASTM D1248, Type III, Class C, Category 5, Grade P34 with a P3408 rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound and with equivalent properties and configurations specifically designed to fit the pipe being supplied.

15110.2.11 MISCELLANEOUS FITTINGS AND MATERIALS

15110.2.11.1 PIPE SUPPORTS - Floor mounted pipe supports for suspended, exposed piping systems shall be adjustable stanchion type supports designed to cradle the pipe diameter by 170 degrees. The support shall fit ductile iron or steel diameters snugly, without excessive gaps between the support and the pipe. Support saddle width shall be a minimum of 2 inches wide. The support must offer a minimum of 3 inches of final adjustment, after installation. Supports shall be supplied with independent base and adjustment collar designed to accept standard sized Schedule 40 galvanized steel pipe for coarse adjustment. Supports shall be fabricated from A36 mild steel, and shall have an electro-galvanized finish. Floor mounted pipe supports shall be the Standon Model S92 or C92 as manufactured by Material Resources, Inc., 22700 N. W. Quatama Street, Hillsboro, Oregon 97124, or approved equal. The standard required model shall be the S92. Non standard materials or model numbers shall be as specified on the Drawings.

15110.2.11.2 "Y" STRAINERS - shall be constructed of high-tensile ASTM A126 Class B Cast Iron with blow-off connections and self-aligning cylindrical screens and shall be equal to Watts Regulator Series 77F or better quality.

15110.2.11.3 FASTENERS – Fastener requirements are as follows:

- Unless otherwise required in these Specifications or shown on the Drawings, all bolting hardware for buried pipe, fittings, valves, and components shall be of manufacturer's standard materials.

- Unless otherwise required in these Specifications or shown on the Drawings, all bolting materials for exposed pipe, fittings, valves, and components shall be Type 316 stainless steel. Where space restrictions preclude the use of regular bolts, stainless steel threaded studs may be used on all valve flange connections.

- In all instances where stainless steel threaded fasteners are used, a coating of an approved, permanent anti-seize compound shall be applied to the fastener to prevent galling and to assist in disassembly.

- All bolts and/or studs shall extend through the nuts at least 1/4 inch.

15110.2.11.4 COUPLINGS – Couplings shall meet the following requirements:

- Unless prescribed otherwise on the Drawings or in these Specifications, couplings shall meet the requirements of ANSI/AWWA C-219. All flexible couplings shall meet the minimum requirements of Smith Blair 400 series.

- Sleeves shall have a smooth inside taper and there shall be no surface irregularities on any sealing surface. Gaskets shall be suitable for the project application.

- Flexible couplings for buried DI and PVC pipe sizes 2 through 16 inches in diameter shall be fabricated of steel or ductile iron. For pipe sizes larger than 16 inches, flexible couplings shall be of steel. Coupling components for use in potable water systems shall be factory coated with an FDA approved, bonded epoxy coating, applied to an average 12 mil thickness.

- Flexible couplings for exposed pipe shall be manufactured of steel, unless shown otherwise on the Drawings, or approved by the Engineer. Coupling components for use in potable water systems shall be factory coated with an FDA approved, fusion-bonded epoxy coating, applied to an average 12 mil thickness.

15110.2.11.5 RESTRAINT HARNESS – Where required, restraint harness for bell and spigot pipe joints shall be as manufactured by EBAA Iron Co. or an approved equal. The restraint shall consist of a split bell ring to go behind the bell and a split, serrated ring to grip the pipe on the other side of the joint. The harness shall be held together with clamping bolts and tie bolts. The rings shall be fabricated of 60-42-10 DI conforming to ASTM A-536. Clamping bolts shall be grade 5 galvanized machine bolts. Tie bolts are of low alloy steel. The harness shall have a minimum working pressure of 150 psi. Harness size shall be as shown in the schedule on the Drawings or as specified in the Special Provisions.

15110.2.11.6 VALVES AND FITTINGS - Shall be as specified in their respective sections in these Specifications.

15110.2.11.7 BOXES AND ENCLOSURES – Shall be of the size, type, and configuration indicated on the Drawings and Contract Documents.

15110.3 CONSTRUCTION REQUIREMENTS

See Sections 02222 and 02224 for construction requirements for applicable piping systems.

15110.4 METHOD OF MEASUREMENT

In general, fittings for pipe and piping systems are, and will be, considered appurtenant to the pipeline being installed unless specifically called out for separate payment on the Bid Schedule.

15110.5 BASIS OF PAYMENT

Not used.

15110.1 DESCRIPTION

This section is a materials specification and is included for guidance in selecting materials for pipe and related fittings and appurtenances used in the construction of water and sewer systems.

15110.1.1 RELATED WORK

Section 02222 - Waterline Pipe Installation
Section 02224 - Sewer Line Pipe Installation
Section 15230 - Waterline Valves and Hydrants
Section 15232 - Water System Control Valves

15110.1.2 SUBMITTALS

The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, couplings, coatings, linings, supports, mechanical restraints, thrust blocks and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall accompany each delivery of material.

15110.1.3 DEFINITIONS

Not used.

15110.2 MATERIALS

15110.2.1 NSF COMPLIANCE

All pipe and materials furnished and installed for culinary use shall comply with NSF International Standard 61. Also, all plastic pipe must be approved by the NSF for potable water use and shall carry the factory "NSF" stamped label on the pipe indicating such approval.

15110.2.2 POLYVINYL CHLORIDE PIPE (PVC)

15110.2.2.1 PVC PIPE FOR WATER LINE CONSTRUCTION – Shall be as follows:

- For sizes less than 4 inches OD, PVC pipe shall be Schedule Rated pressure pipe meeting the requirements of ASTM D1785 of the schedule and size shown on the Drawings.

- PVC pipe 4 inches and larger, shall be rigid, thermoplastic Class Rated pressure pipe meeting the requirements of ANSI/AWWA Standard C900 or C905 (latest revision). The pressure class or the dimensional ratio and the size shall be as shown on the Drawings.

- While Class Rated and Pressure Rated pipe materials are not interchangeable, when specifically allowed in the Contract Documents, for size 4" and larger, rigid thermoplastic Pressure Rated pressure pipe, meeting the requirements of ASTM D2241, may be furnished and installed. Operating pressure for this pipe shall be as shown on the Drawings.

15110.2.2.2 FITTINGS FOR PVC PIPE – Unless specifically authorized otherwise, fittings for 4 inch and larger size PVC pipe in underground service shall be ductile iron (DI) and shall meet the requirements of NSF 61 and ANSI/AWWA C-153. They shall have a standard coating of cement mortar on the interior surfaces in compliances with AWWA C-104. DI fittings meeting these requirements may be used with smaller PVC piping. PVC fittings meeting the requirements of

ANSI/AWWA C-907 may be used with PVC pipe smaller than 4 inches, and, in some instances, where specifically authorized, with PVC pipe sizes 4 inches through 8-inches.

15110.2.3 DUCTILE IRON PIPE

15110.2.3.1 INTERIOR COATING - The interior surface of all DI pipe shall be coated with a standard coating of cement-mortar in accordance with ANSI/AWWA Standard C-104 unless required otherwise in the Contract Documents. Field coating of DI pipe will not be acceptable.

15110.2.3.2 BURIED PIPE – Unless shown otherwise on the Drawings, shall be as follows:

- Buried ductile iron pipe shall be Thickness Class 51.
- Shall meet requirements of ANSI/AWWA C-151.
- Joints shall be bell and spigot or mechanical, which meet the requirements of ANSI/AWWA C-111.

15110.2.3.3 EXPOSED PIPE – Shall meet these requirements, unless shown otherwise on the Drawings:

- Exposed ductile iron pipe shall be Thickness Class 53.
- Pipe shall comply with ANSI/AWWA Standard C-151.
- Pipe joints shall be flanged, meeting the requirements of ANSI/AWWA C-115, or mechanical type couplings (MTC), meeting the requirements of ANSI/AWWA C-606. MTC shall be Victaulic grooved couplings, as manufactured by Victaulic Company of America or approved equal), unless shown otherwise on the drawings.
- 3” to 12” compact flanged fittings shall be ductile iron and shall be produced in accordance with laying lengths specified in ANSI/AWWA C10/A21.10. Flange surface shall be faced and drilled in accordance with ANSI Class 125 B16.1. Nominal body thickness shall be Manufacturer’s Standard, but shall not be less than those specified in ANSI/AWWA C153/A21.53 “Standards for Ductile Iron Compact Fittings”. Flange thickness shall be in accordance with the Manufacturer’s Standards. Working pressure rating shall be 250 psi for water. Fittings shall be made in the United States of America and shall not have been refurbished or reworked by anyone other than the manufacturer. When greater than 250 psi is called for on the Plans, then the Supplier shall furnish higher class rated flanges. Standard Class 125 template for drilling shall be used for all flanges. Drilling templates shall be in multiples of four, so that fittings may be made to face in any quarter. Boltholes shall straddle the centerline and shall be equally spaced. Misalignment of boltholes of two opposing flanges shall not exceed 0.12 inches. Blind flanges 12 inches and over shall be provided with lifting eyes. Insulated flanges shall be provided where required.
- Gaskets shall be full faced, 1/16-inch thick compressed sheets of Aramid fiber base, with nitrile binder and non stick coating, suitable for temperatures to 700°, pressures to 1000 psig and a pH range of 1 to 11. Blind flange gaskets shall cover the entire inside face of the flange and shall be cemented in place. Gaskets shall be as manufactured by John Crane, style 2160; Garlock, style 3000; or approved equal.

15110.2.4 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

15110.2.4.1 PIPE – Shall be as follows:

- PE pipe shall be classified as a Type III, Grade P-34, Class C, Category 5, according to ASTM D1248. All PE pipe shall be manufactured according to ASTM D2513, D3035, F714, or API 15LE and AWWA C906.

- Pipe shall be made of high density, high molecular weight resin. PE plastic shall have a cell classification of 345434C as defined by ASTM D3350/AWWA C906. It shall be rated as PE3408 according to the requirements of the Plastics Pipe Institute. Internal pressure rating shall be as specified elsewhere in the project documents.

15110.2.4.2 FITTINGS FOR HDPE – Molded fittings shall be made of pre-blended virgin resins in accordance with the materials specifications of ASTM D1248. PE3408 fittings shall be made from a Type III, Class C, Category 5, Grade P-34 plastic resin having a cell classification of 345434C according to ASTM D3350. Socket fusion fittings shall be manufactured in compliance with ASTM D2683 and butt fusion fittings with ASTM D3261. Measurements of fittings shall be as required by ASTM D2122. All fittings shall be compatible for heat fusion with any pipe manufactured for like or similar resins.

Heat welded Flange Adapter Couplings shall be used for transition to other type piping material. The Contractor shall follow the manufacturer's recommendations, as well as specified procedures herein in fusing fittings to the polyethylene pipe.

15110.2.5 GALVANIZED IRON PIPE AND FITTINGS

Shall be of the schedule rating shown on the Drawings and shall be used only in exposed, non-corrosive atmospheres where piping diameters are less than 4 inches.

15110.2.6 PIPE AND FITTINGS FOR WATER SERVICE LINES

Shall meet the requirements provided in Section 15234 for water service connections.

15110.2.7 PIPE FOR GRAVITY SEWER SYSTEMS

Gravity sewer pipelines may be constructed with PVC or polyethylene (PE) plastic sewer pipe and fittings. Such materials shall be of the type, configuration and size shown on the Drawings and/or on the Bid Schedule.

15110.2.7.1 PVC PIPE - All PVC sewer pipe and fittings shall meet the standards of ASTM D3034 and F679. Such pipe shall be manufactured with a rubber gasketed joining system which meets ASTM D3212 and shall be furnished with a standard dimensional ratio of 35 (SDR 35) for wall thickness, unless shown otherwise on the Drawings.

15110.2.7.2 PE PIPE - All PE sewer pipe and shall be smooth, solid wall, high density polyethylene pipe manufactured from PE 3408 material conforming to ASTM D1248, Type III, Class C, Category 5, Grade P34 with a P3408 rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound equal to or exceeding the properties of the pipe being supplied.

15110.2.8 PIPE FOR PRESSURE SEWER SYSTEMS

Pressure sewer pipelines shall be constructed with DI, PVC, or PE plastic sewer pipe. Fittings and materials shall be of the type, SDR rating, (or pressure class) and size shown on the Drawings and/or on the Bid Schedule.

15110.2.8.1 PVC PIPE - All PVC pipe for pressure sewer lines shall be rigid, pressure rated, thermoplastic pipe which meets the standards of ASTM D2241. Fittings for PVC pipelines shall be Class 50, cement mortar lined, rubber gasketed, DI which meet the requirements of ANSI/AWWA C-153 and C-104.

15110.2.8.2 PE PIPE - PE pipe for pressure sewer lines shall be smooth, solid wall, high density polyethylene pipe manufactured from PE 3408 material conforming to ASTM D1248, Type III, Class C, Category 5, Grade P34 with a P3408 rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound equal to or exceeding the properties of the pipe being supplied.

15110.2.9 PIPE AND FITTINGS FOR IRRIGATION SYSTEMS

Shall be either DI or Pressure Rated PVC, of the type and class shown on the Drawings, for line diameters 4-inches and greater. Buried lines smaller than 4 inches in diameter shall be Schedule Rated PVC as shown on the Drawings.

15110.2.10 PIPE FOR DRAIN SYSTEMS

Piping for sub-drainage may be constructed with polyvinyl chloride (PVC) or polyethylene (PE) plastic non-pressure drainage or sewer pipe and fittings. Such materials shall be of the type, configuration and size shown on the Drawings and/or on the Bid Schedule.

15110.2.10.1 PVC PIPE - All PVC drainage pipe and fittings shall meet the standards of ASTM F794. Such pipe shall be manufactured with a rubber gasketed joining system which meets ASTM D3212 and may be furnished with ribbed, corrugated or smooth exterior walls with smooth interior wall surfaces, unless shown otherwise on the Drawings. Rubber gasketed joints will not be required for collection pipe applications with perforated or slotted pipe sections.

15110.2.10.2 PE PIPE - All PE drainage pipe shall be solid, corrugated or ribbed wall high-density polyethylene pipe with smooth interior wall surfaces. Material shall conform to ASTM D1248, Type III, Class C, Category 5, Grade P34 with a P3408 rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound and with equivalent properties and configurations specifically designed to fit the pipe being supplied.

15110.2.11 MISCELLANEOUS FITTINGS AND MATERIALS

15110.2.11.1 PIPE SUPPORTS - Floor mounted pipe supports for suspended, exposed piping systems shall be adjustable stanchion type supports designed to cradle the pipe diameter by 170 degrees. The support shall fit ductile iron or steel diameters snugly, without excessive gaps between the support and the pipe. Support saddle width shall be a minimum of 2 inches wide. The support must offer a minimum of 3 inches of final adjustment, after installation. Supports shall be supplied with independent base and adjustment collar designed to accept standard sized Schedule 40 galvanized steel pipe for coarse adjustment. Supports shall be fabricated from A36 mild steel, and shall have an electro-galvanized finish. Floor mounted pipe supports shall be the Standon Model S92 or C92 as manufactured by Material Resources, Inc., 22700 N. W. Quatama Street, Hillsboro, Oregon 97124, or approved equal. The standard required model shall be the S92. Non standard materials or model numbers shall be as specified on the Drawings.

15110.2.11.2 "Y" STRAINERS - shall be constructed of high-tensile ASTM A126 Class B Cast Iron with blow-off connections and self-aligning cylindrical screens and shall be equal to Watts Regulator Series 77F or better quality.

15110.2.11.3 FASTENERS – Fastener requirements are as follows:

- Unless otherwise required in these Specifications or shown on the Drawings, all bolting hardware for buried pipe, fittings, valves, and components shall be of manufacturer's standard materials.

- Unless otherwise required in these Specifications or shown on the Drawings, all bolting materials for exposed pipe, fittings, valves, and components shall be Type 316 stainless steel. Where space restrictions preclude the use of regular bolts, stainless steel threaded studs may be used on all valve flange connections.

- In all instances where stainless steel threaded fasteners are used, a coating of an approved, permanent anti-seize compound shall be applied to the fastener to prevent galling and to assist in disassembly.

- All bolts and/or studs shall extend through the nuts at least 1/4 inch.

15110.2.11.4 COUPLINGS – Couplings shall meet the following requirements:

- Unless prescribed otherwise on the Drawings or in these Specifications, couplings shall meet the requirements of ANSI/AWWA C-219. All flexible couplings shall meet the minimum requirements of Smith Blair 400 series.

- Sleeves shall have a smooth inside taper and there shall be no surface irregularities on any sealing surface. Gaskets shall be suitable for the project application.

- Flexible couplings for buried DI and PVC pipe sizes 2 through 16 inches in diameter shall be fabricated of steel or ductile iron. For pipe sizes larger than 16 inches, flexible couplings shall be of steel. Coupling components for use in potable water systems shall be factory coated with an FDA approved, bonded epoxy coating, applied to an average 12 mil thickness.

- Flexible couplings for exposed pipe shall be manufactured of steel, unless shown otherwise on the Drawings, or approved by the Engineer. Coupling components for use in potable water systems shall be factory coated with an FDA approved, fusion-bonded epoxy coating, applied to an average 12 mil thickness.

15110.2.11.5 RESTRAINT HARNESS – Where required, restraint harness for bell and spigot pipe joints shall be as manufactured by EBAA Iron Co. or an approved equal. The restraint shall consist of a split bell ring to go behind the bell and a split, serrated ring to grip the pipe on the other side of the joint. The harness shall be held together with clamping bolts and tie bolts. The rings shall be fabricated of 60-42-10 DI conforming to ASTM A-536. Clamping bolts shall be grade 5 galvanized machine bolts. Tie bolts are of low alloy steel. The harness shall have a minimum working pressure of 150 psi. Harness size shall be as shown in the schedule on the Drawings or as specified in the Special Provisions.

15110.2.11.6 VALVES AND FITTINGS - Shall be as specified in their respective sections in these Specifications.

15110.2.11.7 BOXES AND ENCLOSURES – Shall be of the size, type, and configuration indicated on the Drawings and Contract Documents.

15110.3 CONSTRUCTION REQUIREMENTS

See Sections 02222 and 02224 for construction requirements for applicable piping systems.

15110.4 METHOD OF MEASUREMENT

In general, fittings for pipe and piping systems are, and will be, considered appurtenant to the pipeline being installed unless specifically called out for separate payment on the Bid Schedule.

15110.5 BASIS OF PAYMENT

Not used.

Replace Section 15120.4 of the Standard Specifications with the following.

15120.4 METHOD OF MEASUREMENT

The method of measurement for payment of Install Plant Piping/Equipment will be lump sum. Measurement will included furnishing and installing all piping, fittings, closure pieces, supports, gaskets, joining materials, valves, air valves, air piping, vent pipes, sunshine valves, sluice gates, weirs, troughs, drains, cleanouts, the pump located on the UV discharge, check valves, and sub grade plumbing inside of, and within 10 feet of the building as shown on the drawings and described in the specifications.

Replace Section 15120.5 of the Standard Specifications with the following.

15120.5 BASIS OF PAYMENT

PAY ITEM	UNIT
Treatment Plant Piping/Equipment	Lump Sum

15121.1 DESCRIPTION

The Contractor shall furnish and install a fiberglass reinforced plastic (FRP) effluent launders and supports with all appurtenances and accessories necessary to produce a complete, operable, and serviceable installation, as shown in the drawings and specified herein, all in accordance with the requirements of the Contract documents.

15121.1.1 RELATED WORK

Section 01019 – Measurement and Payment
Section 02222 – Water Pipe Installation
Section 03100 – Concrete Forming, Finishing and Curing
Section 15120SP – Plant Piping

15121.2.2 SUBMITTALS

15121.2.2.1 Descriptive literature, which identifies the manufacturer and materials used. The contractor shall furnish shop drawings of all fabricated items and accessories in accordance with the provisions of the contract.

15121.2.2.2 The contractor shall furnish manufacturer's shop drawings, certification, and test reports verifying compliance with the requirements specified herein, and literature giving instructions and recommendations for installation.

15121.2.2.3 The contractor shall submit sample pieces of each item specified herein for acceptance, as to quality and color by the Engineer.

15121.3 MATERIALS

15121.3.1 GENERAL REQUIREMENTS

15121.3.1.1 All FRP items shall be composed of glass fiber reinforcements and resin in qualities, quantities, properties, arrangements, and dimensions as necessary to meet the design, requirements, and dimensions as specified herein and shown on the drawings.

Glass fiber reinforcements shall consist of a combination of roving, continuous strand mat, and veil materials in sufficient quantities as needed by the application and/or physical properties required.

Resins shall be polyester, unless noted otherwise, with chemical formulations as necessary to provide the corrosion resistance, strength, and other physical properties required.

All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids, and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.

All FRP items shall be protected with an ultraviolet light inhibitor to avoid deterioration.

All fasteners used to connect FRP items shall be made of Type 316 stainless steel.

Resin shall be commercial grade, chemical resistant polyester thermosetting resin which has either been evaluated in a laminate, or which has been determined by a previous documented service to be acceptable for the service conditions.

Metal reinforcements, when used, shall be free of rust, oil and any foreign matter, it shall be completely encapsulated with a minimum of 1/8 inch laminate.

15121.3.1.2 MANUFACTURE

The inside of the trough shall provide a smooth flow surface. The minimum wall thickness shall be 1/4 inch with suitable stiffeners molded integrally as needed.

The top edges of the trough shall be level and parallel with a tolerance of +/- 1/8 inch, measured when the trough is not loaded. The length of a trough section shall have a tolerance of +/- 1/8 inch per 10 feet of length. The laminate thickness tolerance shall be + or - 1/8

Thickness at locations of supports such as saddles shall be a minimum of 1.5 times the nominal thickness of the trough and shall conform to the stress limitations specified herein.

Cross braces or spreader rods shall be bolted between the trough walls on approximate 3 foot centers to enhance the structural rigidity of the trough system.

The trough shall be designed and manufactured for use as described herein and shown on the plans.

15121.3.2 CONSTRUCTION

15121.3.2 TROUGH

The trough shall be as manufactured by Midwestern Fabricators, LLC located at 1235 S. Pioneer Rd., Salt Lake City, Utah 84104, Phone (801) 708-7254, Fax (801) 708-7255, or approved equal.

The trough shall be as indicated on the contract drawings and shall be 12” wide x 34 ½” deep x 14’-0” long and will include 6 each 8” dia. Flanged drop pipes and shall be supported using B-Line B22A channel or equivalent as indicated on the drawings, or recommended by the manufacturer, and shall include all required 316 SS fasteners and anchors. Piping shall be strapped to channel using B2400 pipe strap sized for the pipe indicated on the plans. And manufacturer shall coordinate tie down brackets on trough to match location of supports, location of which to be field verified.

15121.4 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all labor, equipment, and materials required to furnish and install the fully functional overflow trough as shown on the Drawings and as required by these Specifications. The Contractor shall complete all work and install all equipment and components at the locations required in accordance with the equipment manufacturer’s recommendations and the requirements of these specifications.

INSTALLATION

All drilled holes, cut edges, scratches, or gouges shall be resin sealed with a resin matching that used in the manufacture of the item.

Troughs shall be installed so that the trough edges are level to within +/ 1/8 inch over the length of the trough.

Anchor bolts shall be located a minimum of 3 inches from the edge of concrete wall openings or support beams.

15121.5 METHOD OF MEASUREMENT

15121.5.1 Payment for this item shall be included in plant piping, and shall include the FRP trough, hardware, supports, piping, fittings, and all labor and materials necessary to provide a fully functioning overflow trough as shown on the plans and described in these specifications. No separate payment will be made for this item but shall be included in plant piping as shown in 15120 SP.

15121.6 BASIS OF PAYMENT

Not Used

15200.1 GENERAL

15200.1.1 SECTION INCLUDES

A. Hooded roof fans

B. Centrifugal roof exhaust fans

15200.1.2 RELATED SECTIONS

A. Division 16000 – Electrical

15200.1.3 DESIGN REQUIREMENTS

A. Provide fans with variable pitch V-belt drives for 15 hp and smaller and fixed drives for 20 hp and larger. Provide variable pitch drive for purposes of initial system balancing on 20 hp and larger fans. Provide fixed pitch drives for final system balancing. V-belt drives shall be designed for 150% of motor rating.

B. Fans shall be statically and dynamically balanced and shall operate without objectionable noise or vibration. Variable speed fans shall be statically and dynamically balanced for entire range of speed operation.

C. Where fan drives are exposed, provide guards in accordance with applicable code requirements. Provision shall be made so tachometer may be used to verify fan speed without removing guard assembly.

D. Fans size, fan class, wheel type, inlet type, capacity, arrangement, operating characteristics and other special requirements shall be as scheduled.

E. Fans shall be Class 1, unless otherwise indicated.

F. Equivalent fan selections shall not increase motor horsepower, increase noise level, increase tip speed by more than 10% or increase inlet air velocity more than 20% from that specified.

G. Explosion-proof fans shall have explosion-proof motor enclosure and electrical accessories and AMCA type A spark-resistant fan construction.

15200.1.4 SUBMITTALS

A. Product Data:
1. Catalog data showing selection and options.
2. Manufacturer's installation instructions.

B. Shop Drawings:
1. Dimension drawings
2. Fan curves
3. Sound ratings
4. Material of construction
5. Weights
6. Tag numbers
7. Vibration isolation
8. Motor data as specified

C. Closeout submittals:
   1. Operation and maintenance data.

15200.1.5 QUALITY ASSURANCE

A. Insofar as practicable, provide fans of same manufacturer throughout.

B. Test fans as complete units in accordance with applicable test code of AMCA. Fans shall be certified my AMCA.

C. Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

D. Fabrication and installation shall be in accordance with SMACNA and manufacturer's recommendations.

E. Industrial Ventilation, 25th Edition, American Conference of Governmental Industrial Hygienists.

15200.1.6 JOB CONDITIONS

A. Do not operate fans for any purpose, temporary or permanent, until ductwork is cleaned, filters are in place and bearings are lubricated.

15200.2 PRODUCTS

15200.2.1 ACCEPTABLE MANUFACTURERS

A. Loren Cook

B. Greenheck

C. Twin Cities Fan and Blower

D. Aerovent

E. Hartzell

F. New York Blower

15200.2.2 FINISHES

A. Application:

All, unless specified or scheduled otherwise.

B. Aluminum Components:

None

C. Interior Concealed Steel Components:

Galvanized

D. Exterior or interior exposed to air stream:

Polyester powder coat, 1.5 to 3 mils thickness, Loren Cook "Lorenized", Greenheck "Permatector" or equal.

E. Color: Manufacturer's standard as selected by Owner

15200.2.3 HOODED ROOF FANS

A. Type: Supply

B. Performance: As scheduled.
1. Airflow: _____
2. External static pressure: _____
3. Revolutions per minute: _____
4. Brake horsepower: _____
5. Motor horsepower: _____
6. Sound level: _____
7. Electrical: _____

C. Construction
1. Casing:
   a. Up to 60" (1500 mm): Steel, 14-gauge minimum.
   b. 72" (1800 mm) and larger: Steel, 12-gauge minimum
2. Propeller: Cast aluminum
3. Hood:
   a. Type: Pivoting removable.
   b. Steel:
      1) Up to 60" (1500 mm): 18-gauge minimum.
      2) 72" (1800 mm) and larger: 16-gauge minimum.
4. Wind loading: 40 lbs/ft^2.

D. Drive: Belt-drive

E. Motor: Refer to Division 16000. Provide heavy industrial motor mount.

F. Bearings:
1. Re-greasable with grease tubing extended to outside fan casing for ease of service.
2. Self-aligning, pillow block ball type.
3. L50 rated at not less than 200,000 hours.

G. Accessories:
1. Unit-mounted disconnect switch.
2. Motor weather cover.
3. Motor operated damper.
4. Belt guard.
5. Bird screen.
6. Inlet screen.
7. Roof curbs:
   a. Provided by equipment manufacturers

b. Galvanized steel roof mounting curb as recommended by manufacturer; with wood nailing strip.
c. Minimum 12" (300 mm) from top of curb to finished roof surface.
d. Insulation: 2: (50 mm) thick minimum on inside of curb.
e. Curb shall adjust for roof or structure slope. Top of curb shall be level.

8. Lifting lugs.
9. Filters.

H. Manufacturer: Aerovent Type Tu-Way, or equal by Hartzell or New York Blower.

15200.2.4 POWERED ROOF EXHAUST FANS

A. Performance: As scheduled.
1. Airflow: _____
2. External static pressure: _____
3. Revolutions per minute: _____
4. Brake horsepower: _____
5. Motor horsepower: _____
6. Sound level: _____
7. Electrical: _____

B. Construction:
1. Arrangement: Up blast or down blast, as scheduled.
2. Housing: Heavy-gauge spun aluminum.
3. Wheel: Centrifugal, backward inclined aluminum.
4. *Explosion-proof*.

C. Drive: Belt-drive

D. Bearings
1. Regreasable with fittings extending outside of casing for ease of service.
2. Heavy-duty, self-aligning, pillow block, ball-bearing type.
3. L50 rated at not less than 200,000 hours.

E. Accessories:
1. Unit-mounted disconnect switch.
2. Roof curbs:
a. Provided by equipment manufacturers
b. Galvanized steel roof mounting curb as recommended by manufacturer; with wood nailing strip.
c. Minimum 12" (300 mm) from top of curb to finished roof surface.
d. Insulation: 2: (50 mm) thick minimum on inside of curb.
e. Curb shall adjust for roof or structure slope. Top of curb shall be level.
3. Factory-fabricated roof curbs.
4. Hinged base.
5. Motor-operated damper.
6. Bird screen.
7. Lifting lugs.
8. Drive assembly vibration isolators.

F. Manufacturer: Loren Cook ACE or ACRU, or equal, by Greenheck or Twin Cities Fan and Blower.

15200.3 EXECUTION

15200.3.1 INSTALLATION – GENERAL

A. Install units in accordance with manufacturer's installation instructions.

B. Provide sheaves as necessary for final air balancing.

C. Furnish and install miscellaneous hangers, steel and support to adequately support unit.

D. Construct sheet metal transition fittings as required to connect ductwork and equipment in accordance with requirements of Section 15310. Provide flexible connections at fan inlet and outlet.

E. Arrangement of components shall provide easy access to items requiring periodic maintenance, including; but not limited to, belts, filters and grease fittings.

F. Repair marred or scratched surfaces with manufacturer's touch-up paint.

G. Where fan speed controller is provided, mount to fan housing. Use controller for balancing of direct drive fans.

15200.3.2 INSTALLATION – ROOF MOUNTED FANS

A. Mount on factory-fabricated curbs flashed and counter flashed into roof to prevent leakage.

B. Roof-mounted utility vent sets shall be mounted on rails above roof surface and provided with weather enclosures.

C. Mount drip pans below inducted roof openings.

15200.3.3 FAN SCHEDULE

A. See Project Mechanical Drawings.

15200.4 METHOD OF MEASURMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 15010SP.

15200.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

15211 GENERAL

15211.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)
AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
AMERICAN PETROLEUM INSTITUTE (API)
AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
AMERICAN WELDING SOCIETY (AWS)
ASME INTERNATIONAL (ASME)
ASTM INTERNATIONAL (ASTM)
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)
THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)
UNDERWRITERS LABORATORIES (UL)

15211.1.2 SYSTEM DESCRIPTION

The gas piping system includes natural gas liquid petroleum piping and appurtenances from point of connection with supply system, as indicated, to gas operated equipment within the facility. Submit operation and maintenance data for all equipment scheduled in this specification or in associated drawings, in three separate packages.

15211.1.2.1 GAS FACILITY SYSTEM AND EQUIPMENT OPERATION

Include shop drawings showing piping layout, locations of system valves, gas line markers and cathodic protection system if used; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system drawings); isolation procedures including valve operation to shutdown or isolate each section of the system index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different.

15211.1.2.2 GAS FACILITY SYSTEM MAINTENANCE

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer.

15211.1.2.3 GAS FACILITY EQUIPMENT MAINTENANCE

Include identification of valves, shut-offs, disconnects, and other equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide.

15211.1.3 SUBMITTALS

Submit pipe technical sheet and permit from Gas Company for connection.

15211.1.4 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with MSS SP-25.

15211.1.4.1 WELDING QUALIFICATIONS

a. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with API RP 2009, ASME BPVC SEC IX, and ASME B31.9. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9. Notify the Contracting Officer at least 24 hours in advance of tests, and perform at the work site if practicable.

b. Submit a certified copy of welders procedures and qualifications metal and PE in conformance with ASME B31.9 for each welder and welding operator. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder to the Owner or Owners Engineer

15211.1.4.2 JOINTING THERMOPLASTIC AND FIBERGLASS PIPING

Perform all jointing of piping using qualified joiners and qualified procedures in accordance with AGA XR0603. Furnish the Contracting Officer with a copy of qualified procedures and list of and identification symbols of qualified joiners. Submit manufacturer's installation instructions and manufacturer's visual joint appearance chart, including all PE pipe and fittings.

15211.1.4.3 SHOP DRAWINGS

Submit drawings for complete Gas Piping System, within 30 days of contract award, showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of gas equipment connectors and supports. Include LP storage tank, pad, and mounting details.

15211.1.5 DELIVERY, STORAGE, AND HANDLING

Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe and fittings ends during transportation or storage to minimize dirt and moisture entry. Do not subject piping to abrasion or concentrated external loads. Discard PE pipe sections and fittings that have been damaged.

15211.2 PRODUCTS

15211.2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to NFPA 54

NFPA 58 and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

15211.2.2 GAS PIPING SYSTEM AND FITTINGS

15211.2.2.1 STEEL PIPE, JOINTS, AND FITTINGS

a. Pipe: Black carbon steel in accordance with ASTM A 53/A 53M, Schedule 40 threaded ends for sizes 50 mm 2 inches and smaller; otherwise, plain end beveled for butt welding.

b. Threaded Fittings: ASME B16.3, black malleable iron.

c. Socket-Welding Fittings: ASME B16.11, forged steel.

d. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

e. Unions: MSS SP-83ASME B16.39, black malleable iron.

f. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1, with flange faces having integral grooves of rectangular cross sections which afford containment for self-energizing gasket material. Provide steel pipe conforming to ASME B36.10M; and malleable-iron threaded fittings conforming to MSS SP-86 ASME B16.1 and ASME B16.3. Provide steel pipe flanges and flanged fittings, including bolts, nuts, and bolt pattern in accordance with ASME B16.5 and ASTM A 105/A 105M. Provide wrought steel buttwelding fittings conforming to ASME B16.9. Provide socket welding and threaded forged steel fittings conforming to MSS SP-83 ASME B16.11.

15211.2.2.2 ALUMINUM ALLOY PIPE AND TUBING, JOINTS, AND FITTINGS

Provide aluminum alloy pipe conforming to ASTM B 241/B 241M, except that alloy 5456 is not allowed. Mark the ends of each length of pipe indicating it conforms to NFPA 54 NFPA 58. Thread, flange, braze, or weld pipe joints. Provide aluminum alloy tubing conforming to ASTM B 210M ASTM B 210, Type A or B, or ASTM B 241/B 241M, Type A or equivalent, with joints made up with gas tubing fittings recommended by the tubing manufacturer.

15211.2.2.3 COPPER TUBING, JOINTS AND FITTINGS

Provide copper tubing conforming to ASTM B 88M ASTM B 88, Type K or L, or ASTM B 280, with tubing joints made up with tubing fittings recommended by the tubing manufacturer. Provide copper and copper alloy press fittings, with sealing elements of Hydrogenated Nitrile Butadiene Rubber (HNBR), factory installed, or an alternative supplied by the fitting manufacturer.

15211.2.2.4 STEEL TUBING, JOINTS AND FITTINGS

Provide steel tubing conforming to ASTM 01.01, and ASTM A 513, with tubing joints made up with gas tubing fittings recommended by the tubing manufacturer.

15211.2.2.5 THERMOPLASTIC PIPE, TUBING, JOINTS, AND FITTINGS

Provide thermoplastic pipe, tubing, casing and joints and fittings conforming to ASTM D 2513 and API Spec 5CT.][2.2.6 Fiberglass Pipe, Joints, and Fittings Provide fiberglass piping systems conforming to ASTM D 2517 and API Spec 15LR.][2.2.7 Sealants for Steel Pipe Threaded Joints Provide joint sealing compound as listed in UL Gas & Oil Dir, Class 20 or less. For taping, use tetrafluoroethlene tape conforming to UL Gas & Oil Dir.]

15211.2.2.6 WARNING AND IDENTIFICATION

Provide pipe flow markings, warning and identification tape, and metal tags as required.

15211.2.2.7 FLANGE GASKETS

Provide gaskets of non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 316 degrees C 600 degree F service, to be used for hydrocarbon service.

15211.2.2.8 PIPE THREADS

Provide pipe threads conforming to ASME B1.20.1.

15211.2.2.9 ESCUTCHEONS

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

15211.2.2.10 GAS TRANSITION FITTINGS

a. Provide steel to plastic (PE) designed for steel-to-plastic with tapping tee or sleeve conforming to AGA XR0603 requirements for transitions fittings. Coat or wrap exposed steel pipe with heavy plastic coating.

b. Plastic to Plastic: Manufacturer's standard bolt-on (PVC to PE) plastic tapping saddle tee, UL listed for gas service, rated for 690 kPa (gage) 100 psig, and O-ring seals. Manufacturer's standard slip-on PE mechanical coupling, molded, with stainless-steel ring support conforming to ASTM A 666, O-ring seals, and rated for 1035 kPa (gage) 150 psig gas service. Manufacturer's standard fused tapping (PE-to-PE) tee assembly with shut-off feature.

c. Provide lever operated non-lubricated gas shut-off valves conforming to CSA CGA 3.16-M88.

15211.2.2.11 INSULATING PIPE JOINTS

15211.2.2.12 INSULATING JOINT MATERIAL

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

15211.2.2.13 THREADED PIPE JOINTS

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

15211.2.2.14 FLANGED PIPE JOINTS

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts. [Provide lap joint flange pipe ends conforming to ASTM F 2015.]

15211.2.2.15 FLEXIBLE CONNECTORS

a. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to CSA/AM Z21.24, ANSI Z21.45, or CSA/AM Z21.41 for quick disconnect devices, and flexible connectors for movable food service equipment conforming to CSA/AM Z21.69.

b. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

15211.2.3 VALVES

Provide lockable shutoff or service isolation conforming to the following:

15211.2.3.1 VALVES 50 MM 2 INCHES AND SMALLER

Provide valves 50 mm 2 inches and smaller conforming to ASME B16.33 of materials and manufacture compatible with system materials used. Provide manually operated household cooking gas appliance valves conforming to CSA/AM ANSI Z21.1 and CSA/AM Z21.15.

15211.2.3.2 VALVES 65 MM 2-1/2 INCHES AND LARGER

Provide valves 65 mm 2-1/2 inches and larger of carbon steel conforming to API Spec 6D, Class 150.

15211.2.4 RISERS

Provide manufacturer's standard riser, transition from plastic to steel pipe with 0.18 to 0.30 mm 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide remote bolt-on or bracket or wall-mounted riser supports.

15211.2.5 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58 and MSS SP-69.

15211.2.6 REGULATORS AND SHUTOFF VALVES

Provide diaphragm-type meter as required by local gas utility supplier, including valve box conforming to NFPA 54. Provide pressure gauges and attachments conforming to ASME B40.100. Provide regulators conforming to CSA/AM Z21.18 for appliances CSA/AM Z21.78 for combination gas controls for gas appliances, and CSA/AM Z21.80 for line pressure regulators. Provide shutoff valves conforming to CSA/AM Z21.15 for manually controlled gas shutoff valves and CSA/AM Z21.21 for automatic shutoff valves for gas appliances.

15211.2.7 SEISMIC PROVISIONS

Provide earthquake automatic gas shutoff valve conforming to ASCE 25, SMACNA 1650, and UL listed or AGA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The valve may be either pendulum or ball construction with remote electronic or electric actuator.

15211.3 EXECUTION

15211.3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy or areas of conflict before performing the work.

15211.3.2 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, defined as the outlet of the shutoff valve, to the connections to each gas utilization device.

15211.3.3.1 PROTECTION AND CLEANING OF MATERIALS AND COMPONENTS

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

15211.3.3.2 WORKMANSHIP AND DEFECTS

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

15211.3.4 PROTECTIVE COVERING

15211.3.4.1 UNDERGROUND METALLIC PIPE

Protect buried metallic piping from corrosion with protective coatings as specified in Specification Section NATURAL-GAS / LIQUID PETROLEUM GAS DISTRIBUTION. When dissimilar metals are joined underground, use gastight insulating fittings.

15211.3.4.2 ABOVEGROUND METALLIC PIPING SYSTEMS

15211.3.4.2.1 FERROUS SURFACES

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed. Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances by power wire brushing or commercial sand blasted conforming to SSPC SP 6 and prime with ferrous metal primer or vinyl type wash coat. Finish primed surfaces with two coats of exterior oil paint or vinyl paint.

15211.3.4.2.2 NONFERROUS SURFACES

Except for aluminum alloy pipe, do not paint nonferrous surfaces. Paint surfaces of aluminum alloy pipe and fittings to protect against external corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by such liquids as water, detergents or sewage. Solvent-clean the surfaces and treat with vinyl type wash coat. Apply a first coat of aluminum paint and a second coat of alkyd gloss enamel or silicone alkyd copolymer enamel.

15211.3.5 INSTALLATION

Install the gas system in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54NFPA 58, AGA XR0603, and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. On steel pipe 150 mm 6 inches and larger, an approved gas cutting and beveling machine may be used. Cut thermoplastic and fiberglass pipe in accordance with AGA XR0603.

15211.3.5.1 METALLIC PIPING INSTALLATION.

Bury underground piping a minimum of 450 mm 18 inches below grade. Make changes in direction of piping with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Do not use aluminum alloy pipe in exterior locations or underground.

15211.3.5.2 METALLIC TUBING INSTALLATION

Install metallic tubing using gas tubing fittings approved by the tubing manufacturer. Make branch connections with tees. Prepare all tubing ends with tools designed for that purpose. Do not use aluminum alloy tubing in exterior locations or underground.

15211.3.5.3 THERMOPLASTIC AND FIBERGLASS PIPING, TUBING, AND FITTINGS

Installation of thermoplastic and fiberglass piping, tubing, and fittings is permitted only outside and underground. Bury piping a minimum of 450 mm 18 inches below grade. Install the piping to avoid excessive stresses due to thermal contraction, and use only where indicated.

15211.3.5.4 CONNECTIONS BETWEEN METALLIC AND PLASTIC PIPING

Connections between metallic and plastic piping are only allowed outside, underground, and with approved transition fittings.

15211.3.5.5 PIPING BURIED UNDER BUILDINGS

Run underground piping installed beneath buildings in a steel pipe casing protected from corrosion with protective coatings as required by local utility. Extend casing at least 100 mm 4 inches outside the building, and provide the pipe with spacers and end bushings to seal at both ends to prevent the entrance of water and/or the escape of gas. Extend a vent line from the annular space above grade outside to a point where gas will not be a hazard, and terminate in a rain/insect-resistant fitting.

15211.3.5.6 CONCEALED PIPING IN BUILDINGS

Do not use combinations of fittings (unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints) to conceal piping within buildings.

15211.3.5.6.1 PIPING IN PARTITIONS

Locate concealed piping in hollow, rather than solid, partitions. Protect tubing passing through walls or partitions against physical damage both during and after construction, and provide appropriate safety markings and labels.

15211.3.5.6.2 PIPING IN FLOORS

Lay piping in solid floors except where embedment in concrete is indicated] in channels suitably covered to permit access to the piping with minimum damage to the building. [Surround piping embedded in concrete by a minimum of 40 mm 1-1/2 inches of concrete and do not allow physical contact with other metallic items such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quickset additives or cinder aggregate.

15211.3.5.7 ABOVEGROUND PIPING

Run aboveground piping as straight as practicable along the alignment and elevation indicated, with a minimum of joints, and separately supported from other piping system and equipment. Install exposed horizontal piping no farther than 150 mm 6 inches from nearest parallel wall and at an elevation which prevents standing, sitting, or placement of objects on the piping.

15211.3.5.8 FINAL GAS CONNECTIONS

Unless otherwise specified, make final connections with rigid metallic pipe and fittings. Make final connections to kitchen ranges using flexible connectors not less than 1.02 m 40 inch long, to afford access to coupling and to permit movement of equipment for cleaning. Flexible connectors may be used for final connections to residential dryers.
Flexible connectors may be used for final connections to gas utilization equipment. In addition to cautions listed in instructions required by ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet. Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.5.9 Seismic Requirements

Support and brace piping and attached valves to resist seismic loads in conformance with ASCE 25 and as specified in UFC 3-310-04 SEISMIC DESIGN FOR BUILDINGS.

15211.3.6 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

15211.3.6.1 THREADED METALLIC JOINTS

Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 40 mm 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 50 mm 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.

15211.3.6.2 WELDED METALLIC JOINTS

Conform to NFPA 54 for beveling, alignment, heat treatment, and inspection of welds. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and re-weld. After filler metal has been removed from its original package, protect and store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating.

15211.3.6.3 THERMOPLASTIC AND FIBERGLASS JOINTS

a. Thermoplastic and Fiberglass: Conform jointing procedures to AGA XR0603. Do not make joints with solvent cement or heat of fusion between different kinds of plastics.

b. PE Fusion Welding Inspection: Visually inspect butt joints by comparing with, manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints or replacing fittings. Inspect, in conformance with API 570,

100 percent of all joints and re-inspect all corrections. Arrange with the pipe manufacturer's representative in the presence of the Contracting Officer to make first time inspection.

15211.3.6.4 FLARED METALLIC TUBING JOINTS

Make flared joints in metallic tubing with special tools recommended by the tubing manufacturer. Use flared joints only in systems constructed from nonferrous pipe and tubing, when experience or tests have demonstrated that the joint is suitable for the conditions, and when adequate provisions are made in the design to prevent separation of the joints. Do not use metallic ball sleeve compression-type tubing fittings for tubing joints.

15211.3.6.5 Solder or Brazed Joints

Make all joints in metallic tubing and fittings with materials and procedures recommended by the tubing supplier. Braze joints with material having a melting point above 538 degrees C 1000 degrees F, containing no phosphorous.

15211.3.6.6 JOINING THERMOPLASTIC OR FIBERGLASS TO METALLIC PIPING OR TUBING

When compression type mechanical joints are used, provide gasket material in the fittings compatible with the plastic piping and with the gas in the system. Use an internal tubular rigid stiffener in conjunction with the fitting, flush with end of the pipe or tubing, extending at least to the outside end of the compression fitting when installed. Remove all rough or sharp edges from stiffener. Do not force fit stiffener in the plastic.
Split tubular stiffeners are not allowed.

15211.3.6.7 PRESS CONNECTIONS

Make press connections in accordance with manufacturer's installation instructions using tools approved by the manufacturer. Fully insert the tubing into the fitting and then mark at the shoulder of the fitting. Check the fitting alignment against the mark on the tubing to assure the tubing is fully inserted before the joint is pressed.

15211.3.7 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall, floor or roof, and cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Extend sleeves in mechanical room floors above grade at least 100 mm 4 inches above finish floor. Unless otherwise indicated, use sleeves large enough to provide a minimum clearance of 6.4 mm 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas. Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant.

15211.3.8 PIPES PENETRATING WATERPROOFING MEMBRANES

Install pipes penetrating waterproofing membranes as specified in drawings and associated drawings and details.

15211.3 .9 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in accordance with NFPA requirements.

15211.3.10 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

15211.3.11 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54 & NFPA 58.

15211.3.12 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

15211.3.13 PIPING SYSTEM SUPPORTS

Support gas piping systems in buildings with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Do not support any gas piping system by other piping. Conform spacing of supports in gas piping and tubing installations to the requirements of NFPA 54 & NFPA 58. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 3.2 mm 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

15211.3.14 ELECTRICAL BONDING AND GROUNDING

Provide a gas piping system within the building which is electrically continuous and bonded to a grounding electrode as required by NFPA 70.

15211.3.15 SHUTOFF VALVE

Install the main gas shutoff valve controlling the gas piping system to be easily accessible for operation, as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

15211.3.16 CATHODIC PROTECTION

Not to be used in this project. All buried pipe shall be non-metallic.

15211.3.17 TESTING

Submit test reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas piping system to ensure

that it is gastight prior to putting into service. Prior to testing, blow out the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in conformance with API Std 598 and API Std 607. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the Contracting Officer. Do not use oxygen as a testing medium.

15211.3.17.1 PRESSURE TESTS

Submit test reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 21 kPa 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54as specified in NFPA 58 without showing any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 1 kPa 0.1 pound. Isolate the source of pressure before the pressure tests are made.

15211.3.17.2 TEST WITH GAS

Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. Conform all testing to the requirements of NFPA 54NFPA 58. If leakage is recorded, shut off the gas supply, repair the leak , and repeat the tests until all leaks have been stopped.

15211.3.17.3 PURGING

After testing is completed, and before connecting any appliances, fully purge all gas piping. LPG piping tested using fuel gas with appliances connected does not require purging. Conform testing procedures to API RP 1110. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54NFPA 58 are followed.

15211.3.17.4 LABOR, MATERIALS AND EQUIPMENT

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

15211.3.18 PIPE COLOR CODE MARKING

Provide color code marking of piping as conforming to ASME A13.1.

15211.4 METHOD OF MEASURMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 15010SP.

15211.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

15238.1 DESCRIPTION

Includes furnishing and installing pressure gauges and their support piping and fittings in buildings and other structures at locations shown on the Drawings.

15238.1.1 RELATED WORK

Section 02222 – Waterline Pipe Installation
Section 15110 – Pipe and Piping Systems

15238.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300.

15238.1.3 DEFINITIONS

Not used.

15238.2 MATERIALS

15238.2.1 PRESSURE GAUGES

Shall be US Gauge, Model 550L, stem mounted and oil filled, as manufactured by AMETEK or an approved equal. Gauges have a 2 1/2-inch (minimum) stainless steel case with a pressure relief plug. The window shall be polycarbonate plastic with neoprene sealing gasket. The pressure reading range shall be as shown on the Drawings or as prescribed in the Special Provisions.

15238.2.2 SUPPORTING PIPE AND FITTINGS

Shall be 1/4-inch threaded Schedule 40 galvanized pipe.

15238.3 CONSTRUCTION REQUIREMENTS

Pressure gauges shall be installed in accordance with the manufacturer's recommendations and at the locations shown on the Drawings. The Contractor shall provide sufficient supporting pipe to mount pressure gauges vertically and oriented to be read easily. When possible, pressure gauges should be installed at least three pipe diameters downstream from any valve in the pipeline.

15238.4 METHOD OF MEASUREMENT

Separate measurement of pressure gauges and their supporting piping will not be made. Measurement will be included with the building or structure that it serves.

15238.5 BASIS OF PAYMENT

Separate payment for pressure gauges will not be made.

15300.1 DESCRIPTION

The Contractor shall furnish and install floor drains in structures of the size and type, and at the locations shown on the Drawings.

15300.1.1 RELATED WORK

Section 02222 – Waterline Pipe Installation
Section 02105 - Earthwork Materials

15300.1.2 SUBMITTALS

Not used.

15300.1.3 DEFINITIONS

Not used.

15300.2 MATERIALS

15300.2.1 DRAIN

Floor Drains shall be cast iron body, 6-inch (minimum) diameter heavy-duty grated type with a removable cast iron or stainless steel cover.

15300.2.2 PIPING

Drain piping shall be drain waste and vent (DWV) schedule 40 PVC pipe and fittings sized to fit the floor drain in accordance with the Drawings.

15300.2.3 P-TRAPS

P-traps, when required on the Drawings, shall meet the requirements of Schedule 40 PVC pipefittings sized to fit the drainpipe.

15300.2.4 DRAIN GRAVEL

Drain gravel for floor drain sumps, where applicable, shall meet requirements of Section 02105 and shall be installed as shown on the Drawings.

15300.2.5 CHECK VALVES

Floor drain check valve, when required by the Drawings, shall be a rubber slip-on check valve capable of draining drainpipe under low flows and low pressures. The valves shall require no maintenance or repair. The check valves shall be attached to the drainpipe by stainless steel clamps.

15300.3 CONSTRUCTION REQUIREMENTS

15300.3.1 SETTING DRAINS

Where floor drains are required, the floor will have been designed with a slope to a low point where the drain is to be placed. Typically, the floor drain will be cast in the low point in the floor at the time of installation of the floor. The Contractor shall take care to coordinate the setting of

the drain and the pouring of the concrete so that the top surface of the drain cover is flush with the floor surface to allow complete drainage of any water which accumulates on the floor.

15300.3.2 PIPE WORK

Piping shall be connected and run on a 1% minimum slope away from the drain as shown on the Drawings. Where termination of the piping is in drain gravel, care shall be taken to locate the pipe end in the top one-third of the gravel sump. Where termination of the piping is at daylight, the Contractor shall provide a 5-foot section of cast iron or ductile iron pipe, sized to match the drain pipe, at the daylight end of the pipeline so that the thermoplastic pipe will not be exposed to daylight.

15300.4 METHOD OF MEASUREMENT

15300.4.1 NO MEASUREMENT

Unless provided for as a separate bid item in the Bid Schedule, no separate measurement of the floor drain, its connecting piping, gravel sump, etc., will be made. Measurement of the drain will be included with the building or structure identified in the Bid Schedule.

15300.4.2 SEPARATE MEASUREMENT

When provided for in the Bid Schedule, the cost of all material and labor required of the floor drain assembly will be measured by counting the number of floor drain assemblies installed and accepted.

15300.5 BASIS OF PAYMENT

When a separate bid item is provided, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Floor Drain Assembly	Lump Sum
Floor Drain Assembly	Each

15310.1 GENERAL

15310.1.1 SECTION INCLUDES

A. Metal ducts.

15310.1.2 DEFINITIONS

A. Duct sizes:
1. Inside clear dimensions.
2. For acoustically lined or internally insulated ducts, maintain scheduled sizes inside lining or insulation.

B. Low pressure: Static pressure in ducts less than 2" (50 mm) w.g. and velocities less than 2,000 fpm (10.2 m/sec).

C. High pressure: Static pressure over 6" (150 mm) w.g. and less than 10" (250 mm) w.g. or velocities greater than 2,000 fpm (10.2 m/sec).

15310.1.3 PERFORMANCE REQUIREMENTS

A. Guarantee ductwork to be free of vibration, chatter, objectionable pulsation, and excessive leakage under all conditions of operation.

15310.1.4 SUBMITTALS

A. Shop Drawings: Duct fittings, including particulars such as gage sizes, welds, and configurations.

B. Samples: Duct fittings.

15310.1.5 QUALITY ASSURANCE

A. Qualifications:
1. Installer: Work shall be performed by Johns Manville qualified contractor.
2. Fabricator:
a. Fiberglass duct fabrication shall be performed by Johns Manville qualified fabricator.

OR

b. Document fabrication capabilities by complying with following requirements prior to starting work:
1) Written submittal of past job experience with fiberglass.
2) Contractor's certificate of training in fabrication and installation of fiberglass duct.
3) Submittal of fitting fabrication drawings.
4) Submittal of typical fitting samples.

B. Use material, weight, thickness, gage, construction, and installation methods as outlined in following SMACNA publications:
1. SMACNA Duct Construction Standards Metal & Flexible, Second Edition.
2. SMACNA Fibrous Glass Duct Construction Standards, Seventh Edition.

C. Construct and install ductwork in accordance with provisions of National Standard Mechanical Code.

15310.2 PRODUCTS

15310.2.1 MATERIALS

A. Galvanized sheet steel:
   1. Cold-rolled, soft sheet steel capable of double seaming without fracture.
   2. Galvanized coating: G90 in accordance with ASTM A653 and ASTM A90.

15310.3 EXECUTION

15310.3.1 FABRICATION

A. Fabricate and install duct, fittings, reinforcement, and supports in accordance with SMACNA recommendations except as modified below.
   1. Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 18", cross break for rigidity. Open corners are not acceptable.
   2. Increase duct sizes gradually, not exceeding 15º divergence wherever possible. Maximum divergence upstream of equipment to be 30º and 45º convergence downstream.
   3. Provide easements where ductwork conflicts with piping and structure. Where easements exceed 10% of duct area, split into two ducts maintaining original duct area.

B. Low-pressure ductwork:
   1. Construct ductwork so interior surfaces are smooth. Use rivets or nuts and bolts for fabricating ductwork. Sheet metal screws may be used on duct hangers, transverse joints, and other SMACNA-approved locations if screw does not extend more than 1/2" (13 mm) into duct. Seal fastener locations where leakage could occur and seal ductwork according to SMACNA recommendations with regard to pressure class of duct.
   2. Use elbows and tees with a centerline radius to width or diameter ratio of 1.5 wherever space permits. When shorter radius must be used due to limited space, install sheet metal turning vane through entire length of fitting. Where space will not allow the use of shorter radius elbow or tee, install mitered fitting with double-wall turning vanes. Square throat-radius heel elbows will not be acceptable.
   3. Construct branch take off with 45º take off fitting connection 1-1/2 times area of branch duct.
   4. Use splitter dampers and/or extractors only where manual volume dampers will not accomplish intended balancing. Use of splitter dampers and/or extractors shall not eliminate need for specified or indicated manual volume dampers.
   5. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.
   6. Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate, or sag.

7. Fasten hangers to duct with nuts and bolts or surround duct with hanger strap to provide a single hanging point for round duct. Trapeze hangers may be used. Internal duct hangers will not be accepted.

C.

15310.3.2 APPLICATION

A. Low-pressure ductwork:
   1. Supply downstream of high-velocity terminal devices.
   2. Return air systems.
   3. Outside and return air ductwork between fans and supply and relief louvers where velocities are less than 1,500 fpm (457 mpm).

D. Do not apply duct lining to the following ductwork:
   1. Exhaust systems ductwork
   2. Return system ductwork not specified above
   3. Outside air and relief air ductwork

15310.3.3. DUCTWORK INSTALLATION

A. Pressure test ductwork with Contractor-furnished test apparatus. Conduct test at pressure rating of duct section, record data in a neat manner before allowing duct to be insulated. Leakage rate shall not exceed more than 1% of system air quantity for high-pressure ductwork or 5% of system air quantity for low-pressure ductwork. Locate leak sources, repair, and retest when necessary.

B. If air leakage more than specified above is found during the pressure testing and/or air balancing, locate and seal the source of the leakage. Repair any damage to insulation or other construction.

C. Provide sufficient clearances between the duct and beams, pipes, or other obstructions in building construction and for work of other trades. Check drawings showing work of other trades and consult with Engineer in event of any interference. Transform, divide, or offset ducts as required, in such a manner as to maintain same cross sectional area of duct as indicated on Drawings. Where it is necessary to take pipes or similar obstruction through ducts, ducts need not be enlarged if decrease in area does not exceed 10%. If decrease in area would exceed 10%, enlarge duct to maintain duct area not less than 90%. In all cases, provide a streamlined casement or collar designed in accordance with SMACNA and seal to prevent air leakage.

D. Provide frames constructed of angles or channels for coils, filters, dampers, or other devices installed in duct systems, and make connections to such equipment including equipment furnished by others. Secure frames with felt gaskets, nut, bolts, and washers.

E. Remove dirt and foreign matter from the entire duct system and clean diffusers, registers, and grilles before operating fans and/or before balance begins.

F. Install motor-operated dampers and connect to or install equipment furnished by others.

G. At outside air intakes, install duct to pitch to intakes and to drain to outside of building. Solder or calk on airside seams to form watertight joints. Blank off unused portions of

louvers with 1-1/2" (64 mm) board insulation with galvanized sheet metal backing on both sides.

H. Fiberglass duct installation:

1. Installation shall be in strict accordance with SMACNA Fibrous Glass Duct Manual and manufacturer's recommendations, which shall be maintained on job site for reference. Closures of duct sections shall be made using heat-activated tape, with automatic bond indicator, or glass fabric and mastic.
2. Hangers: 1" x 2" x 1" (25 mm x 50 mm x 25 mm), 22-gage (0.8 mm), trapeze-type, maximum spacing as follows:

Longest Side of Duct	Hanger Spacing
0" - 35"	8' – oc
36" - 59"	6' – oc
Over 59"	4' – oc

Longest Side of Duct	Hanger Spacing
0 - 889 mm	2.4 m – oc
914 – 1498 mm	1.8 m – oc
Over 1498 mm	1.2 m – oc

3. Support duct at changes of direction.
4. Additional duct metal strapping shall be in strict accordance with SMACNA Standards.
5. In-duct equipment shall be mounted in sheet metal sleeves and supported independently.
6. Equipment connections and connections to metal shall be made with glass fabric and mastic.

15310.4 METHOD OF MEASURMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 15010SP.

15310.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

15480.1 DESCRIPTION

This section covers furnishing and installing compressed air piping, fittings, and specialties as shown on the Drawings and as required by these Specifications.

15480.1.1 RELATED WORK

Section 02105 - Earthwork Materials
Section 02200 - Trench Excavation and Backfill
Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 03500 - Concrete Structures and Slab Work
Section 09910 - Painting

15480.1.2 SUBMITTALS

15480.1.2.1 The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, supports, mechanical restraints and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall be provided with each delivery of material.

15480.1.2.2 As Construction proceeds, the Contractor shall submit test documentation in accordance with this section of these Specifications.

15480.1.3 DEFINITIONS

Not used.

15480.2 MATERIALS

Where materials not listed herein are required for completion of the compressed air piping system, these needs shall be submitted to the Engineer for review and approval prior to their purchase and installation.

15480.2.1 PIPE

Compressed air piping shall be ASTM A53, Schedule 40, seamless, galvanized steel pipe, or ASTM B88 Type K copper pipe.

15490.2.2 FITTINGS FOR GALVANIZED PIPE

15480.2.2.1 FOR PIPE 2 1/2 INCHES AND SMALLER - Fittings for galvanized steel pipe, 2 ½-inch and smaller, shall be 300# class galvanized malleable iron ANSI B16.3, and joint connections shall be prepared in accordance with ANSI B2.1. Threads shall be cut full and clean, using sharp dies. Threaded ends shall be reamed to remove burrs and to restore full inside diameter of the pipe.

15480.2.1.2 FOR PIPE 3 INCHES AND LARGER - Fittings for galvanized steel pipe 3-inch or larger shall be flanged 150# class, ANSI B16.5, full penetration, butt-welded, ANSI B 16.9, or grooved or shouldered mechanical couplings. Where mechanical couplings are used, the Contractor shall ensure that the pipe wall thickness meets the manufacturer's requirements for coupling installation for the required pressures and service.

15480.2.3 FITTINGS FOR COPPER PIPE

Fittings for copper piping shall be wrought copper, ASTM B75, or cast bronze, ASTM B62, 150# class. Joints shall be soldered, ANSI B16.18 or ANSI B16.22. Dual ferrule Swagelok™, or approved equal compression fittings are acceptable for lines under 2-inch. Underground or embedded pipe shall use soldered wrought copper fittings only, unless directed otherwise by the Engineer.

15480.2.4 PIPE COATING

Pipe coating shall be the standard Polyken Joint Wrap System:

15480.2.4.1 PRIMER - Polyken Pipeline Coatings Primer No. 927 is a composition of rubber solids and a solvent, which is readily applied to the properly prepared pipe surface. The primer's function is to prepare the pipe surface to effect a superior bonding medium between the pipe surface and the Polyken 930 Joint Wrap tape.

15480.2.4.2 TAPE - Polyken No. 930 Joint Wrap Tape consists of a polyethylene backing and a butyl rubber adhesive. This highly elastic product is specifically formulated to achieve a highly conformable, smooth and wrinkle free wrap when applied under tension to the primer-coated pipe surface. No. 930 is required in 35 mils total thickness.

15480.2.5 VALVES

15480.2.5.1 COMPRESSED AIR VALVES - Compressed air valves shall be swing-out style stainless steel ball valves, with reinforced TFE seats and stainless steel ball. The valves shall be prepared with female NPT connections on both ends. The valves shall be by Parker, Whitey, or approved equal.

15480.2.5.2 PRESSURE REDUCING VALVES - Pressure reducing valves shall be constructed with a zinc die cast body with a corrosion resistant coating and shall be furnished complete with a mounting bracket. The valves shall have balanced valve design nylon reinforced seals, Buna N diaphragm, and a self-cocking adjustment knob. The maximum inlet pressure rating shall be 250-psig. The output pressure range shall be 0-50 psi. The valves shall be furnished with a 0-160-psig pressure gauge. The valves shall be by Fisher, ARO, or approved equal.

15480.2.5.3 SOLENOID VALVES - Compressed air solenoid valves shall be ASCO, 8210 Series, 120 volt, normally closed, 150 psi operating differential, brass body, or approved equal.

15480.2.6 REGULATORS

Filter regulators shall be as manufactured by Watts, Fisher, ARO, or approved equal. Combination filter regulators shall operate between 5 and 125 psi and shall include an integral pressure gauge.

15480.2.7 FILTERS

15480.2.7.1 IN-LINE FILTERS - In-line filters shall be as manufactured by ARO, Fisher, or approved equal. In-line filters shall be coalescing type and shall have a replaceable filter element, polycarbonate bowl with guard, and a manual drain.

15480.2.7.2 DESSICANT FILTER - The desiccant filter, if required, shall be as manufactured by Deltech, Balston, or approved equal. The desiccant filter shall be a wall or frame mounted, packed column, desiccant media filter for absorption of moisture and oil. The replaceable media shall change color as it becomes exhausted. The desiccant filter shall be sized such that the capacity matches the compressor capacity.

15480.2.8 COUPLINGS

Quick couplings shall be ARO, Series 310, or approved equal.

15480.3 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all materials and labor required to complete all work in accordance with the best practice of the trade, and to the satisfaction of the Engineer.

15480.3.1 CODE COMPLIANCE

All piping installed under this Section shall be installed in accordance with the Uniform Building Code and the Uniform Plumbing Code.

15480.3.2 DIAGRAMMATIC DESIGN

Piping layout on the Drawings shall be considered diagrammatic for all piping not shown with detailed dimensions. Drawings indicate the general location and arrangement of the piping systems. Pipe size and location are provided, but the Drawings are not intended to show every offset, fitting, or structural difficulty that will be encountered during project construction. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, compressor sizing, and other design considerations. So far as practical, pipe shall be installed to neat lines and grades, as shown on the Drawings. However, piping alignment may be varied from that shown on the Drawings, to avoid structural or mechanical difficulties, or to avoid the work of other trades, at no additional cost to the Owner.

15480.3.3 HANDLING AND STORAGE OF PIPE COATING MATERIALS

Polyken primer and tape materials shall be stored and/or transported in their original factory containers or packages. Storage shall be under cover in locked, dry warehousing, and/or vehicles, up to the point of use. Storage shall be at normal room temperatures, and shall be away from radiators, stoves, heating pipes, and similar heat sources. Primer in drums or other metal containers should be stored in accordance with local regulations, as they apply to hazardous materials.

No. 930 Joint Wrap should not be stored or transported at high temperatures as blocking of 930 adhesive to its backing may occur. If this situation occurs, cooling of the roll will reverse this roll blocking and 930 will be totally functional.

Factory rolls and/or cartons of Polyken Joint Wrap coatings shall be stacked on end at all times, no more than 72 inches (2 meters) high. Stocks are to be rotated as new shipments are received.

15480.3.4 INSTALLATION OF PIPING SYSTEM

15480.3.4.1 VERIFICATION OF DIMENSIONS - The Contractor shall verify all dimensions by field measurements, and verify that all air distribution piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

15480.3.4.2 PIPING - Compressed air piping shall be installed with a 1/32” per foot (1/4 percent) downward slope towards drain points.

15480.3.4.3 JOINTS - Threaded joints shall be cleaned to remove cutting oil and shavings. Pipe joint compound suitable for compressed air system use shall be applied on the male threads at each joint. Finished joints shall be tight with no more than three threads exposed. Soldered joints shall be thoroughly cleaned and properly prepared and fluxed, to ensure properly soldered joints.

15480.3.4.4 SHUTOFF VALVES - Shutoff valves shall be installed on inlet of each quick coupler, and upstream of each PRV, filter, filter regulator, and elsewhere as indicated.

15480.3.4.5 COUPLERS AND FILTERS - Quick couplers and filters shall be installed on exposed piping where indicated.

15480.3.4.6 PRESSURE REGULATING VALVES - Pressure regulating valves shall be installed with inlet and outlet shutoff valves, and a pressure gage shall be installed at each valve outlet.

15480.3.5 PRESSURE TESTING OF PIPE

The Contractor shall test all new air distribution piping systems and parts of existing systems, which have been altered, extended or repaired for leaks and defects. The test method shall be a bubble test, unless otherwise authorized by the Engineer. All leaks and defects shall be repaired using new materials, and the system or portion thereof shall be re-tested until satisfactory results are obtained. Piping to be buried or to be installed under a building slab shall be pressure tested prior to burial or to the installation of the slab.

Pressure testing shall take place before the pipe is coated with the Polyken Wrap System.

15480.3.6 APPLICATION OF PIPE COATING

After successful pressure test, pipe to be buried or to be placed under concrete slabs shall be wrapped using the standard Polyken Joint Wrap System, which consists of Polyken Pipeline Coatings Primer No. 927 and Polyken No. 930 Joint Wrap Tape.

15480.3.6.1 PRIMER – Application of Polyken primer shall be as follows:

- All buried or under-slab piping shall be protected by one coat of Polyken pipeline primer.
- The pipe surface should be free of any moisture, mud, oil, grease, rust, or any other foreign material prior to the application of the Polyken primer. Visible oil and grease should be removed through the use of a suitable solvent. Kerosene shall not be used for cleaning.
- The primer should be thoroughly mixed or agitated prior to brushing onto pipe. This procedure will insure that any rubber solids that have settled out will be returned to proper solution.
- The primer should not be diluted. However, if the primer solids need to be dissolved again, use solvents recommended by a Polyken factory authorized representative.
- The primer shall be applied to the cleaned, dry pipe surface by brush at a coverage rate of approximately 400 square feet per gallon. The primer should cover all exposed pipe and joint surfaces, which will be buried or installed under a slab. Avoid runs and drips while applying the primer.
- Primer cans should remain covered when not in use to avoid solvent evaporation and contamination.

15480.3.6.2 TAPE – Application of Polyken tape shall be as follows:

- The Polyken primer shall be free of any surface contaminants and “tacky to dry” before the 930 Joint Wrap Tape is applied directly over the primer.

- No. 930 Joint Wrap coatings shall be installed in accordance with the width and lap specifications for the various pipe diameters listed in the Material Requirements chart:

  ⇒ Polyken 930 Joint Wrap tape shall normally be applied at a roll body temperature above 40°F (5°C) and at an ambient temperature above -30°F (-34°C). The joint wrap tape shall be stored up to the point of application under such conditions and for a sufficient period of time that the roll body temperature should be above 40°F (5°C) at the time of application.

  ⇒ The tape shall be applied to the pipe in a spiral fashion. The wrapping process should start at a minimum of 6 inches beyond the point where the pipe will be covered at the downside of the pipe. Caution should be taken during the wrapping process to avoid contaminating the tape with foreign material.

  ⇒ Two coats of Polyken tape shall be applied. This may be accomplished either by half lapping the primary wrap of No. 930 or by application of an initial wrap of tape with normally specified overlap followed by a second wrap over the initial wrap. If the second method of obtaining the double wrap is used, the overlaps of the first and second wraps must not coincide.

  ⇒ The joint wrap shall be ended so that the uncovered edge on the final lap is directed downward. This procedure will prevent any damage to the pipe joint wrap when the trench is backfilled.

- Use of a constant tension machine is required for all tape widths 6” or wider for proper tensioning of the tape. The joint wrap shall be applied under taut machine tension (approximately 5-10 lbs. per inch width) except for its initial and final 1/3 turns. Special attention should be given to specified overlapping of the joint wrap. A tapster or machine application is required.

- Prior to burying or otherwise covering the wrapped pipe, the coating shall be tested for holidays.

15480.3.7 FINISH WORK

15480.3.7.1 INSPECTION - The Contractor shall ensure that the Engineer’s inspector shall inspect all compressed air system installations. New, altered, extended, or replaced compressed air distribution piping system shall not be enclosed, covered, or put into operation until it has been inspected and approved. All such work that has been covered or concealed before it has been tested and approved shall be exposed for testing.

15480.3.7.2 BACKFILL - After the backfill is completed, the tape can be trimmed back to the surface of the concrete slab or wall, but should be left in place for 6 inches above ground surface if outside.

15480.3.10.3 PURGING - The Contractor shall thoroughly purge all new air distribution piping systems and parts of existing systems, which have been altered, extended, or repaired prior to use.

15480.4 METHOD OF MEASUREMENT

15480.4.1 NO MEASUREMENT

Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

15480.4.2 SEPARATE MEASUREMENT

Where items installed under this section are listed separately in the Bid Schedule, the items shall be measured at the unit rates for each item listed.

15480.5 BASIS OF PAYMENT

Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work. When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Compressed Air Piping *(Type) (Size)*	Lineal Foot
Valve *(Type) (Size)*	Each
Pressure Reducing Valve *(Type) (Size)*	Each
Solenoid Valve *(Type) (Size)*	Each
Filter Regulator *(Type) (Size)*	Each
Filter *(Type) (Size)*	Each
Quick Couplers *(Type) (Size)*	Each

ALUMINUM HYDRAULIC CONTROL GATE — SECTION 15515SP

15515.1 DESCRIPTION

15515.1.1 The Contractor shall furnish and install aluminum hydraulic control gates which include both downward-opening weir gates and Sluice Gates as shown on the drawings and as specified herein. The equipment shall include control gate, frame, and handwheel operator. The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.

Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of fabricated gates.

15515.1.2 The control gate and operator shall be the product of a manufacturer having a minimum of five (5) years experience in the design and production of water control equipment of this type. At the request of the Engineer, the manufacturer shall submit evidence of performance on other projects with similar specialty fabrication requirements as specified herein.

15515.1.3 Except as modified or supplemented herein, all gates and operators shall conform to the applicable requirements of AWWA standards.

15515.2 QUALITY ASSURANCE

15515.2.1 The manufacturer shall have 5 years experience in the production of substantially similar equipment, and shall show evidence of satisfactory operation in at least 10 installations. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of AWS Sections D1.1, 1.2 and 1.6.

15515.2.2 The fully assembled gates shall be shop inspected, tested for operation and leakage, and adjusted before shipping. There shall be no assembling or adjusting on the job sites other than for the lifting mechanism.

15515.2.3 **Manufacturer**

Hydraulic Control Gates shall be Model GH-40 and or GH-60 as manufactured by Golden Harvest Inc. or engineer approved equal.

15515.3 SUBMITTALS

The manufacturer shall submit for approval by the purchaser, drawings showing the principal dimensions, general construction and materials used in the gate and lift mechanism.

The manufacturer shall submit for approval by the purchaser, complete engineering design calculations in compliance with AWWA standards latest edition.

All applicable requirements for submittals as specified in section 01300 shall also be met.

15515.4 MATERIALS AND CONSTRUCTION

15515.4.1 The gate shall be water tight at 4 ft of water depth over the control gate. See drawings for mounting location details. Gates shall be either self-contained or non self-contained of the rising stem configuration as indicated on the plans or otherwise specified by the engineer.

15515.4.2 **Frame –**The gate frame shall be extruded aluminum weighing not less than 4-1/4 pounds per foot. The guide grooves in which the head guide angle travel shall contain ultra high molecular weight polyethylene bearing bars in dovetail slots.

The frame configuration shall be of the flush-bottom type and shall allow the replacement of the top and side seals without removing the gate frame from the wall or wall thimble.

15515.4.3 **Yoked & Pedestal –** Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection of the yoke shall be 1/360 of the gate's span.

Non-self contained gates shall be provided with pedestal mounted lifts. Pedestal shall be provided with shop coating.

15515.4.4 **Slide** – The gate slide shall consist of a flat plate, reinforced with welded stiffeners. Stiffeners shall be of type, spacing and number such that, at the design head, bending stress is limited to 1/5 the ultimate strength of the materials and deflection is limited to 1/360 of the gate width. Stem connection will be by means of a threaded block, either directly welded to the slide or contained in a pocket designed to distribute operating forces to the upper region of the slide. The slide shall consist of aluminum plate reinforced with "U" shaped aluminum extrusion welded to the plate to limit its deflection to 1/360 of the gate's span under the design head.

15515.4.5 **Guides and Seals** – The guide groves shall contain UHMW bearing bars in dovetail slots and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

Side and top seals shall be field adjustable resilient J-bulb seals attached to the spigot and held in place by a bolted retainer bar. Seals shall be fully adjustable.

The flush bottom resilient neoprene seal shall be mounted to bottom of disc and seal against the invert portion of the frame. Embedded gates <u>only</u> may have frame mounded invert seal. Downward opening weir gates shall have side and bottom seals of the resilient J-bulb type attached to the spigot and held in place by a bolted retainer bar. Seals shall be fully adjustable.

15515.4.6 **Lifting Assemblies –**The operating stem shall be of stainless steel designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lb effort on the crank or handwheel.

Gates having a width equal to or greater than two times their height shall be provided with two geared lifting mechanisms interconnected by a tandem shaft.

The operating stem shall be sized to safely withstand without buckling or permanent distortion the stresses induced by normal operating forces. The stem shall have a minimum diameter of 1-1/2 inches and the stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have Acme type cold rolled threads with a maximum surface of 16 micro-inches.

Stem lengths requiring more than one piece shall be coupled or pinned to an extension tube.

15515.4.7 **Stem Guides** – Stem guides shall be fabricated from stainless steel. Stem guides shall be equipped with a UHMWPE bushing. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The L/R ratio shall not be greater than 200.

15515.4.8 **Stem Cover –** Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents and a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

15515.4.9 **Lifting Mechanism** – Manual operators shall be provided by the gate manufacturer. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lb on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lb.

Gearboxes shall be provided when required to maintain the operating force below 40 lb. All bearings and gears shall be totally enclosed in a weather tight housing. Geared operators shall be furnished with a threaded bronze lift nut to engage the threaded portion of the stem. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings. The operating shaft shall be fitted with a 2 inch square operating nut and removable crank. The crank shall be fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 15 inches and the maximum handwheel diameter shall be 24 inches.

1515.4.10 **Materials**

Part	***Material***
Frame, yoke, slide, stem extension	Aluminum 6061-T-6 ASTM B-209, ASTM B-211
Side and top seals	Neoprene ASTM D-2000
Bearing bar, guides, stem guide liner	Ultra High Molecular Weight Polyethylene ASTM D4020
Bottom seal	Neoprene ASTM D-2000
Threaded stem, stem guides, hand crank	Stainless steel ASTM A-276, Type 304 or 304L
Fasteners	Stainless steel Type 304 or 304L
Pedestal/ Wall Bracket	Cast Iron ASTM A126, class B or Mild Steel A36/A36M
Stem cover	Polycarbonate ASTM A-707
Lift and stop nut	Manganese bronze , ASTM B584, UNS-C86500

15515.2.7 All surfaces, in which contact between aluminum and concrete may occur, shall be coated with epoxy paint in order to prevent aluminum-concrete contact.

15515.4.12 Gap between the mounting surface and gate frame shall be filled with non-shrink grout, to provide a water-tight seal between the frame and the mounting surface.

15515.3 METHOD OF MEASUREMENT

15515.3.1 Separate measurement for Hydraulic Control Gates will not be made as they are furnished and installed as components in other buildings, structure or other items identified in the Bid Schedule.

15515.4 BASIS OF PAYMENT

15515.4.1 Separate payment for Hydraulic Control gates will not be made but will be furnished and installed as equipment in a building, structure or other item identified in the Bid Schedule.

ALUMINUM STOP GATE — SECTION 15525SP

15525.1 DESCRIPTION

15525.1.1 The Contractor shall furnish and install aluminum stop gates as shown on the drawings and as specified herein. The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.
Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of fabricated gates.

15525.2 MATERIALS

15525.2.1 All parts of the gate shall have a minimum thickness of 1/4 inch. Gates shall be designed for embed, surface, or in-channel mounting as shown on drawings.

15525.2.2 GUIDES – The gate frame shall be extruded aluminum weighing not less than 4-1/4 pounds per foot. The guide grooves in which the head guide angle travel shall contain ultra high molecular weight polyethylene bearing bars in dovetail slots. The frame configuration shall be of the flush-bottom type and shall allow the replacement of the side seals without removing the gate frame from the wall.

The gate frame shall be a rigid, welded unit with a clear opening as shown on the drawings, unless otherwise specified. The guides shall be of structural aluminum extrusions. The guides will be of the length specified.

15525.2.3 SLIDE – The slide shall be plate reinforced with structural shapes welded to the plate. The slide shall not deflect more than 1/360 of the span of the gate under maximum head.

15525.2.4 FLUSHBOTTOM CLOSURE – The gates shall be furnished with a flush seal arrangement. A resilient neoprene seal shall be securely attached to the frame along the invert, and shall extend to the depth of the guide groove.

15525.2.5 "J" BULB SEALS –The gate shall be provided with resilient "J" bulb seals along the sides of the gate. Seals shall be mounted either on the frame or slide, such that seals do not protrude into the specified opening of the gate. Side seals shall be field adjustable.

15525.2.6 Gates shall be furnished complete with ultra high molecular weight (UHMW) polymer seats which contact the slide face. For aluminum gates, strips shall be installed in dovetail grooves in the extruded frame.

15525.2.7 MATERIAL

A. Frames and slides shall be aluminum ASTM B-209 and B-211 alloy 6061-T6
B. Fasteners and anchor bolts shall be stainless steel ASTM A-276, Type 304 or 316
C. Flush bottom seals and "J" bulb seals shall be rubber ASTM D-2000 BC 610/615 or other suitable composition for extended use in water and sewage
D. Bearing Bar, guides (seats) Ultra High Molecular Weight Polyethylene ASTM D4020
E. Finish shall be mill finish on all aluminum

15525.3 METHOD OF MEASUREMENT

15525.3.1 Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

15525.3.2 Where items installed under this section are listed separately in the Bid Schedule, the items shall be measured by counting the total number of units installed, complete and accepted.

15525.4 BASIS OF PAYMENT

15525.4.1 Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work.

15525.4.2 When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Aluminum Stop Gate	Each

15541 GENERAL

15541.1 REFERENCE

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

CSA AMERICA, INC. (CSA/AM)
CSA Directory (updated continuously online) Certified Products Listings
CSA/AM Z21.66 (1996; R 2006) Automatic Vent Damper Devices for Use with Gas-Fired Appliances
CSA/AM Z21.86 (2008) Vented Gas-Fired Gravity Space Heating Appliances
CSA/AM Z83.19 (2001; R 2005; Addenda 2007) Gas-Fired Infrared Heaters
CSA/AM Z83.4 (2003; A 2004, 2006) Non-Circulating Direct Gas-Fired Industrial Air Heaters
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
NEMA MG 1 (2007; Errata 2008) Standard for Motors and Generators
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
NFPA 211 (2006) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
NFPA 54 (2008) National Fuel Gas Code
UNDERWRITERS LABORATORIES (UL)
UL Gas & Oil Dir (2008) Flammable and Combustible Liquids and Gases Equipment Directory

15541.1.2 SUBMITTALS

A. Approval is required for all equipment scheduled below.

B. Equipment schedule.

INFRARED HEAT SCHEDULE

ID	MANUFACTURER AND MODEL NUMBER	LOCATION	TYPE	INPUT CAPACITY (BTUH)	OUTPUT CAPACITY (BTUH)	LENGTH (FT)	FUEL TYPE	VACUUM PUMP ELECTRICAL MOTOR SPEED (RPM)	HP	AMPS	VOLT/PH
IR-1	SUPERIOR RADIANT PRODUCTS,UA10N4A	FILTRATION BUILDING	TUBE & REFLECTOR	100,000	89,000	40	NATURAL GAS	NA	FRAC	20	120/1
IR-2	SUPERIOR RADIANT PRODUCTS,UA04N2A	ELECTRICAL ROOM	TUBE & REFLECTOR	40,000	27,000	20	NATURAL GAS	NA	FRAC	20	120/1

C. Shop Drawings
Submit Fabrication Drawings in accordance with paragraph entitled, "General Requirements," of this section.

D. Product Data
Submit Equipment and Performance Data in accordance with paragraph entitled, "General Requirements," of this section.
Submit manufacturer's catalog data for all items scheduled in drawings and/or above

E. Manufacturer's Instructions
Submit Manufacturer's Instructions in accordance with paragraph entitled, "General Requirements," of this section.

15541.1.3 QUALITY ASSURANCE

Submit detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system. Detail drawings for space heating equipment, controls, associated equipment, and for

piping and wiring. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

15541.1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from weather, humidity and temperature variations, dirt and dust, or other contaminants.

15541.1.5 EXTRA MATERIALS

Submit spare parts for each different item of material and equipment specified, after approval of the detail drawings, and not later than 2 months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

15541.2 MATERIALS AND EQUIPMENT

15541.2.1 GENERAL

Provide materials and equipment which are standard products of a manufacturer regularly engaged in manufacturing of the products and that essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

15541.2.2 NAMEPLATES

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. Also, affix an ENERGY STAR label as applicable.

15541.2.3 EQUIPMENT GUARDS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be completely enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of type specified for service.

15541.2.4 ELECTRICAL WORK

Electrical motor driven equipment shall be provided complete with motors, motor starters, and controls. Motors shall conform to NEMA MG 1. Electrical equipment and wiring shall be in accordance with Division 16000. Electrical characteristics shall be as specified or indicated. Integral size motors shall be premium efficiency type in accordance with NEMA MG 1. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

15541.2.5 HEATERS

Heaters shall be equipped for and adjusted to burn [natural][liquefied petroleum][dual fuel natural/liquified petroleum] gas. Each heater shall be provided with a gas pressure regulator that will satisfactorily limit the main gas burner supply pressure. Heaters shall have an intermittent or interrupted electrically ignited pilot or a direct electric ignition system. Safety controls shall

conform to the ANSI standard specified for each heater. Mounting brackets and hardware shall be furnished by the heater manufacturer and shall be factory finished to match the supported equipment. Seismic details shall be [in accordance with UFC 3-310-04 SEISMIC DESIGN FOR BUILDINGS and as indicated.

15541.2.6 INFRARED HEATERS

Heaters shall conform to the requirements of CSA/AM Z83.19 and shall be [vented][or][unvented] type[as indicated].[Vented heaters shall be vented to the outside atmosphere.] Heater style shall be [surface combustion][tubular] type[as indicated]. Reflector shape shall be [parabolic][horizontal][or][standard][as indicated]. Heaters shall be provided with space thermostats which control the unit's burner. Thermostats located in the direct radiation pattern shall be covered with a metal shield.

15541.2.7 THERMOSTATS

Thermostats shall be the adjustable electric or electronic type. Control wiring required to complete the space temperature control system shall be included. Thermostats shall have a 2 degree C 3 degree F differential and a set point range of [4 to 24 degree C 40 to 75 degrees F][minus 18 to plus 38 degrees C 0 to 100 degrees F][27 to 49 degrees C 80 to 120 degrees F]. Thermostats shall be the [single][two] stage type.

15541.2.8 VENT PIPING

Vent piping shall conform to the requirements of NFPA 54. Plastic material polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

15541.2.9 ELECTRIC AUTOMATIC VENT DAMPERS

Electric automatic vent dampers shall conform to the requirements of CSA/AM Z21.66 and shall be provided in the vents of heaters [except unvented infrared heaters] using indoor air for combustion air.

15541.2.10 FACTORY FINISHES

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish.

15541.3 EXECUTION

15541.3.1 EXAMINATION

After becoming thoroughly familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

15541.3.2 INSTALLATION

Install equipment as indicated and in accordance with the recommendations of the equipment manufacturer and the listing agency, except as otherwise specified.

15541.3.3 HEATING EQUIPMENT

Install heaters with clearance to combustibles, complying with minimum distances as determined by CSA Directory, UL Gas & Oil Dir and as indicated on each heater approval and listing plate. Support heaters independently from the building structure, as indicated, but not relying on suspended ceiling systems for support.

15541.3.4 VENTS

Locate vent dampers, piping and structural penetrations as indicated. Vent damper installation shall conform to CSA/AM Z21.66. Vent pipes, where not connected to a masonry chimney conforming to NFPA 211, shall extend through the roof or an outside wall and shall terminate, in compliance with NFPA 54. Vents passing through waterproof membranes shall be provided with the necessary flashings to obtain waterproof installations.

15541.3.5 GAS PIPING

Connect gas piping as indicated, complying with the applicable requirements at Section 15211 FACILITY GAS PIPING.

15541.3.6 TRAINING

Conduct a training course for the maintenance and operating staff. The training period of 4 hours normal working time shall start after the system is functionally complete but before the final acceptance tests. The training shall include all of the items contained in the approved operation and maintenance instructions as well as demonstrations of routine maintenance operations. Give the Contracting Officer at least two weeks advance notice of such training.

15541.4 METHOD OF MEASURMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 15010SP.

15541.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

15721 GENERAL

15721.1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
INTERNATIONAL (ASTM)
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
UNDERWRITERS LABORATORIES (UL)

15721.1.2 SYSTEM DESCRIPTION

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Division 16000. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 746 W 1 horsepower and above with open, drip-proof, totally enclosed, or explosion proof fan cooled enclosures, shall be the premium efficiency type in accordance with NEMA MG 1. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

15721.1.3 SUBMITTALS

A. Product Data:
   1. Catalog data showing selection and options.
   2. Manufacturer’s Installation Instructions.

B. Shop Drawings:
   3. Dimension drawings.
   4. Fan curves.
   5. Sound ratings.
   6. Material of construction.

7. Weights.
8. Tag numbers.
9. Vibration isolation.
10. Motor data as specified.
11. Heating and cooling capacity at altitude
12. Heating and cooling efficiency at altitude

C. Closeout submittals: Operation and maintenance data.

15721.1.3.1 SUBMITTAL PROCEDURES:

A. Shop Drawings

Drawings provided in adequate detail to demonstrate compliance with contract requirements, as specified.

B. Product Data Materials and Equipment

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, Options, performance charts and curves, etc. in adequate detail to Demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing Catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.

C. Spare Parts

Spare parts data for each different item of equipment specified.

D. Posted Instructions

Posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

E. Verification of Dimensions

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, confirmation of existing conditions, and any discrepancies found.

F. Coil Corrosion Protection

Product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement.

F. System Performance Tests

A schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules shall identify the proposed date, time, and location for each test.

G. Demonstrations

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

G. Test Reports

Refrigerant Tests, Charging, and Start-Up
Six copies of each test containing the information described below in bound 216 by 279 mm 8-1/2 by 11 inch booklets. Individual reports shall be submitted for the refrigerant system tests.

a. The date the tests were performed.
b. A list of equipment used, with calibration certifications.
c. Initial test summaries.
d. Repairs/adjustments performed.
e. Final test results.

System Performance Tests
Six copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The report shall document Compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

H. Certificates Materials and Equipment

Where the system, components, or equipment are specified to comply with requirements of AHRI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard AHRI rating conditions, computer printouts, catalog, or other application data certified by AHRI or a nationally recognized laboratory as described above shall be included. If AHRI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

I. Service Organization

A certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

K. Operation and Maintenance Data

Operation and Maintenance Manuals Six complete copies of an operation manual in bound 216 by 279 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features. Six complete copies of maintenance manual in bound 216 by 279 mm 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

15721.1.4 QUALITY ASSURANCE

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Submit drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

15721.1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

15721.1.6 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

15721.2 PRODUCTS

15721.2.1 MATERIALS AND EQUIPMENT

15721.2.1.1 STANDARD PRODUCTS

Provide Materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

15721.2.1.2 NAME PLATES

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

15721.2.1.3 SAFETY DEVICES

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

15721.2.2 UNITARY EQUIPMENT, SPLIT SYSTEM

Unit shall be an air-cooled split system which employs a remote condenser a separate indoor unit, and interconnecting refrigerant piping. Unit shall be the air-conditioning type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with AHRI 210/240. Unit shall be provided with necessary fans, air filters, coil frost protection, internal dampers, mixing boxes, supplemental heat, and cabinet construction as specified in paragraph "Unitary Equipment Components". The remote unit shall be as specified in paragraph REMOTE CONDENSER OR CONDENSING UNIT. Evaporator or supply fans shall be double-width, double inlet forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Condenser or outdoor fans shall be the manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors shall have drip proof enclosures.

15721.2.2.1 AIR-TO-REFRIGERANT COIL

Coils shall have copper or aluminum tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

15721.2.2.2 COMPRESSOR

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 35 kW 10 tons and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, lubrication pump, high pressure safety cutoffs and protection against short cycling.

15721.2.2.3 REFRIGERATION CIRCUIT

Refrigerant-containing components shall comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices

shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. A refrigerant suction line [thermostatic][thermostatic and water flow switch] control shall be provided to prevent freeze-up in event of loss of water flow during heating cycle.

15721.2.2.4 UNIT CONTROLS

Unit shall be internally prewired with a 24 volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high pressure, and low oil pressure for compressors with positive displacement oil pumps, supply fan failure, and safety Interlocks on all service panels. Head pressure controls shall sustain unit operation with ambient temperature of 100 degrees F. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995. Low cost cooling shall be made possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

15721.2.2.5 REMOTE CONDENSER OR CONDENSING UNIT

Units with capacities less than 39.5 kW 135,000 Btuh shall produce a maximum AHRI sound rating of 25 bels when rated in accordance with AHRI 270. Units with capacities 39.5 kW 135,000 Btuh or greater shall produce a maximum AHRI sound rating of 20 bels when rated in accordance with AHRI 370. Each remote condenser coil shall be fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature shall not exceed 49 degrees C 120 degrees F at 40 degrees C 95 degrees F ambient. Unit shall be provided with low ambient condenser controls to ensure proper operation in an ambient temperature of 32 degrees F. Fan and cabinet construction shall be provided as specified in paragraph "Unitary Equipment Components". Fan and condenser motors shall have drip proof enclosures.

15721.2.2.6 AIR-COOLED CONDENSER

Unit shall be rated in accordance with AHRI 460 and conform to the requirements of UL 1995. Unit shall be factory fabricated, tested, packaged, and self-contained. Unit shall be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

15721.2.2.7 CONNECTIONS

Interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit shall be provided as required and as indicated. Electrical and refrigeration piping terminal connections between condensing unit and evaporator units shall be provided.

15721.2.2.8 CONDENSING COIL

Coils shall have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

15721.2.2.9 UNIT CONTROLS

The control system shall be complete with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Unit mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include control transformer, overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

15721.2.2.10 PAN SECTION

The pan shall be watertight and be provided with drain, overflow, and make-up water connections. Standard pan accessories shall include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

15721.2.2.11 FAN SECTION

Fan shall be the [centrifugal][propeller] type in accordance with paragraph "Fans". Fan and fan motor shall not be located in the discharge airstream of the unit. Motors shall have splash proof enclosure and be suitable for the indicated service. The condensing unit design shall prevent water from entering into the fan section.

15721.2.4 EQUIPMENT EFFICIENCY

Unit shall have efficiency as indicated on the drawings.

15721.2.5 UNITARY EQUIPMENT COMPONENTS

15721.2.5.1 REFRIGERANT AND OIL

Refrigerant shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 15 & 34. Refrigerants shall meet the requirements of AHRI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil shall be of a type and grade recommended by the

manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

15721.2.5.2 FANS

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, shall be magnetic across-the-line type with a drip proof enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings shall be of galvanized steel, and both centrifugal and propeller fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels or propellers shall be statically and dynamically balanced. Forward curved fan wheels shall be limited to 2 inches. Direct-drive fan motors shall be of the multiple-speed variety. Belt-driven fans shall have adjustable sheaves to provide not less than5 percent fan-speed adjustment. The sheave size shall be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans shall be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans shall be V-belt]drive type with adjustable pitch blades. V-belt driven fans shall be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings shall be protected with water slingers or shields. V-belt drives shall be fitted with guards where exposed to contact by personnel and [fixed pitch] [adjustable pitch] sheaves.

15721.2.5.3 AIR FILTERS

Air filters shall be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method shall be as listed under the label service and shall meet the requirements of UL 586. 2.8.4.1 Extended Surface Pleated Panel Filters. Filters shall be 50 mm 2 inch depth sectional type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested in accordance with ASHRAE 52.1. Initial resistance at 2.54 m/s 500 feet/minute will not exceed 90 Pa 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be unwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. Four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

15721.2.6 ACCESSORIES

15721.2.6.1 COIL

Coils shall have copper or aluminum tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

15721.2.6.2 INSTALLATION IDENTIFICATION

Each new refrigeration system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.
b. Refrigerant number and amount of refrigerant.
c. The lubricant identity and amount.
d. Field test pressure applied.

15721.2.6.3 GASKETS

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 370 degrees C 700 degrees F service.

15721.2.7 SUPPLEMENTAL COMPONENTS/SERVICES

15721.2.7.2 REFRIGERANT PIPING

Refrigerant piping for split-system unitary equipment shall be provided and installed in accordance with Manufactures recommendations and industrial standards.

15721.3 EXECUTION

15721.3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

15721.3.2 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1and ASME BPVC SEC IX,

the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

15721.3.2.1 EQUIPMENT

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15 & 34. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 150 mm 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators shall limit vibration to 5 percent at lowest equipment rpm. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

15721.3.2.2 FIELD APPLIED INSULATION

Field applied insulation shall be as required my International Mechanical Code 2006, except as defined differently herein.

15721.3.3 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

15721.3.4 DEMONSTRATIONS

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 72 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted

instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

15721.3.5 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems shall be tested and charged as required by equipment manufacturer. Packaged refrigerant systems which are factory charged shall be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems shall be tested for leaks with a halide torch or an electronic leak detector.

15721.3.5.1 REFRIGERANT LEAKAGE

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

15721.3.5.2 CONTRACTOR'S RESPONSIBILITY

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 85 g 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

15721.3.6 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Make corrections and adjustments, as necessary, tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and lightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Submit a report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart):

a. Date and outside weather conditions.
b. The load on the system based on the following:
    (1) The refrigerant used in the system.
    (2) Condensing temperature and pressure.
    (3) Suction temperature and pressure.
    (4) Ambient, condensing and coolant temperatures.
    (5) Running current, voltage and proper phase sequence for each phase of all motors.
c. The actual on-site setting of operating and safety controls.
d. Thermostatic expansion valve superheat - value as determined by field test.
e. Subcooling.
f. High and low refrigerant temperature switch set-points
g. Low oil pressure switch set-point.
h. Defrost system timer and thermostat set-points.
i. Moisture content.
j. Capacity control set-points.
k. Field data and adjustments which affect unit performance and energy consumption.
l. Field adjustments and settings which were not permanently marked as an integral part of a device.

DIVISION 16

ELECTRICAL

SUNRISE
ENGINEERING

16010.1 DESCRIPTION

The General Conditions, Supplementary General Conditions, Alternates and Addenda, applicable drawings and the Technical Specifications herein shall apply to the providing and construction of a complete electrical system under the requirements of this Division 16.

16010.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01300 - Submittals
Section 02200 - Trench Excavation and Backfill
Section 16050 - Basic Materials and Methods
Section 16150 - Electrical Control Devices
Section 16210 - Lighting Fixtures
Section 16400 - Service and Distribution System

16010.1.2 SCOPE

A. The Work required under this Section consists of the Electrical General Requirements and related items necessary to complete the Work indicated within the Contract Documents.

B. This Section describes procedures and incidental items of Work relating to Electrical Division 16.

C. The drawings are diagrammatic, intended to indicate the general scope and location of the Work to be installed and are not to be considered as complete in every detail. The Contractor shall install all Work indicated and/or specified herein, complete in every way to perform the function (s) intended without additional cost.

D. Plans and Specifications are complementary; whatever is called for in either shall be as called for in both. In the event Work is called for in more than one place and is of conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.

16010.1.3 CONTRACT DOCUMENTS

A. Contract documents consist of drawings, specifications, and other documents issued by the Engineer. Each is complementary and requirements shown, written or reasonably inferable there-from on one is considered as written, shown and implied in all.

B. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and Work of other Contractors will permit. Runs to panels from outlets referred to as “home runs” are indicated, by pointing in the general direction of panels. Contractor shall continue such circuits to the panels as though the routes were completely indicated.

C. Deviations from the Drawings required to make Work of this Contract conform to Building as constructed, or as to Work of other contractors or subcontractors, shall be made by the Contractor at his expense. The Engineer reserves the right to make minor changes in the location of equipment and outlets without additional charges.

D. The Contractor shall familiarize himself with the architectural and mechanical plans. The Contractor shall perform all Work and provide all material required by the electrical Contractor shown under these and all other sections of the plans and specifications.

16010.1.4 SUBMITTALS

All submittals shall meet the requirements of Section 01300 of these Specifications.

16010.1.4.1 SHOP DRAWINGS – Submittal of shop drawings shall be as follows:

A. Submittal of shop drawings shall meet the requirements of Section 01300 of these Specifications.

B. Shop drawings shall be submitted within fifteen (15) days after the award of contract.

C. Shop drawing shall include functional and descriptive literature of the particular item furnished complete with dimensional drawings, rough-in and installation instructions, knock-out locations, hangers or mounting devices, etc., as required for the proper checking and installation of the equipment. Catalog sheets without any reference made to the particular item will not be acceptable. All special features called for in the Contract Documents shall be noted. Where performance test results of a product design are called for in the technical sections of these specifications, test data sheets shall be provided with the shop drawing submittal.

D. Shop drawings shall be submitted for all switch gear, motor control centers, motor starters, control panels, telemonitoring panels, alarms, electrical controls, electrical instrumentation, communication devices and circuitry, lighting fixtures, and equipment anchors and supports for seismically supported components.

E. In connection with seismic restraint requirements, shop drawings are required for all equipment anchors, supports, and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, centers of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment so that the final design can be properly reviewed.

F. Three preliminary sets shall be submitted to the Architect/Engineer for their review. Following review, two sets will be returned to the Contractor for correction. After corrections have been made, the formal six sets of the corrected shop drawings shall be submitted for final review and distribution.

G. Each shop drawing required under this or other sections of Division 16 shall be bound together in sets in one hard back three ring binder per set, properly indexed for the formal submittal. Binders shall be properly sized to adequately contain all of the materials to be placed therein and shall be labeled to identity the Owner, the name of the job, the name of the Contractor and/or any sub-contractor (s), and any other pertinent information.

16010.1.4.2 MATERIALS LIST - A materials list including manufacturer, type, size, model number and other properties shall be submitted for all raceway, conduit, fittings, support materials, wire, cable, junction boxes, and wiring devices, including boxes for weather proof devices.

16010.1.4.3 EQUIPMENT/INSTRUMENT LIST - Equipment/Instrument list(s) including manufacturer, type, size, model number and other properties shall be submitted for all equipment and instruments.

16010.1.4.4 OPERATION AND MAINTENANCE MANUAL – The Contractor, or electrical subcontractor, shall assemble and deliver to the Owner an operation and maintenance (O&M) manual for the electrical systems furnished and installed in connection with the Work. O&M manuals shall be as follows:

A. Number of copies shall be as specified in Section 01300 or as required in the Special

Provisions or by the Engineer or the Owner. The O&M manual shall be reviewed and approved prior to the final inspection.

B. Each copy of the O&M manual shall be bound in a hard-backed binder. The front of each binder shall have the following information printed on it by silk screen process:

OPERATION AND MAINTENANCE MANUAL
FOR
(*PROJECT NAME*)
(*SPECIFIC SYSTEM NAME AND/OR LOCATION*, as appropriate)
(*OWNER'S NAME*)

C. Each copy shall contain a master index at the beginning of the manual showing all items included.

D. A separate section for each different type of item of equipment or information furnished shall be provided. Use plastic tab indexes for all sections of the book.

E. The first section of the manual shall consist of the names, addresses and telephone numbers of the Mechanical Engineer, Electrical Engineer, General Contractor, Electrical Contractor.

F. Descriptive literature (manufacturer's catalog cuts and other data) of each manufactured item shall be included. Literature shall show capacities and size of equipment used and shall be marked indicating each specific item with all applicable data underlined.

G. Operating instructions shall, at a minimum, include:

1. General description of the electrical system.
2. Where applicable, a step-by-step procedure to follow in putting each piece of electrical equipment in operation.
3. Provide diagram for the electrical control system showing the wiring of all related electrical control items, such as fuses, interlocks, electrical switches and relays.
4. Test results of all items requiring testing as called for in the technical section of specifications.

H. Maintenance instructions shall, at a minimum, include:

1. Manufacturer's maintenance instructions for each piece of electrical equipment installed in the project. Instructions should include installation instructions, parts numbers and lists, operation instructions of equipment, name of vendor, and maintenance and lubrication instructions.

2. A summary list of each piece of electrical equipment requiring lubrication, showing the name of the equipment, location, type and frequency of lubrication.

3. A complete list of all electrical equipment used indicating name, model, serial number and nameplate data of each item, together with number and name of each system with which the item is associated.

I. An approved copy of the manual shall be used during final inspection and shall be left with the Owner for its use and disposition.

16010.1.4.5 OTHER INFORMATION - Other information shall be provided as required by the Engineer.

16010.2 MATERIALS

All equipment and materials shall be as specified, new, of the best quality and free from defects. Each type of equipment or material shall be the same make and quality.

16010.2.1 UNDERWRITERS LABORATORIES

All equipment, materials, and devices shall be approved by Underwriters Laboratories, Inc. (UL). Custom designed items shall be fabricated using UL approved materials. All custom panels shall bear the UL label certifying UL-508 standards.

16010.2.2 MATERIALS AND EQUIPMENT TO BE SUPPLIED

The Contractor or electrical Subcontractor shall provide all materials, equipment, and any other fittings or devices required for a complete and finished installation. Materials and equipment shall be as shown on the Drawings and/or as called for in these Specifications, including the Special Provisions if any, unless otherwise approved, in writing, by the Engineer.

16010.2.3 APPROVAL OF SUBSTITUTIONS

Equipment and materials are designated by one or more manufacturer's name brands or numbers. It is not the intent of the Specifications to exclude other equipment or materials that equal the standard of those specified. If the Bidder, in its bid, desires to use equipment or materials other than those specified, the Bidder must obtain written approval from the Engineer in this regard at least seven (7) calendar days prior to bidding. Submit complete data, including detailed specifications and drawings with written request in duplicate. Samples may be requested if deemed necessary. Certificates of compliance with specifications or a list of all exceptions to the specifications shall be included with request.

16010.2.4 STORAGE OF EQUIPMENT AND MATERIALS

A. The Contractor shall be responsible for the proper transportation, unloading, storage, and holding of all electrical systems, materials, and equipment until they are installed in the Work, and accepted by the Owner. This shall include responsibility for damage, loss, theft, and pilferage.

B. Materials and equipment shall be handled and stored in accordance with the manufacturer’s and/or supplier’s instructions. Packaged items shall be stored in original, undamaged condition with manufacturer’s seals and labels intact. Materials and equipment shall be stored in a neat and orderly condition at all times and allowing for easy access for inspection.

16010.2.5 RACEWAYS AND FITTINGS

The manufacturer shall be Republic Steel, Triangle, National, Carlon, Allied or approved equal. All conduits shall be in accordance with the requirements of the National Electric Code (NEC) and applicable local codes. Steel conduit shall be in accordance with recommendations of the latest edition of American Iron and Steel Institute “Design Manual on Steel Electric Raceways.”

A. RIGID GALVANIZED STEEL CONDUIT (RGS)

1. Shall be USAS C80.1, zinc-coated by hot-dip galvanizing or sheradizing with additional enamel or lacquer coating.
2. Fittings shall be threaded type and of the same material as the conduit.
3. Unless otherwise noted, rigid metallic conduit shall be used for underground runs, under slab runs, and where runs are placed in concrete. It shall also be used for exposed runs in mechanical rooms and for other exposed runs where the conduit is exposed to moisture, weather or mechanical injury.
4. Where rigid metallic conduit is used for underground installations, including elbows required to make sweeps in PVC conduit runs, the conduit shall be wrapped with 3m-50 10 mil pipe wrap or approved equal.

B. INTERMEDIATE METAL CONDUIT (IMC)

1. Shall be UL Standard 1242, hot-dip galvanized steel.
2. Fittings shall be threaded type and of the same material as the conduit.
3. It can be used for exposed runs in mechanical rooms and for other exposed runs where the conduit is exposed to moisture, weather or mechanical injury.
4. **This conduit shall not be used in hazardous areas.**

C. ELECTRICAL METALLIC TUBING (EMT)

1. Shall be in accordance with UL "Standard for Electrical Metallic Tubing" No. 797, galvanized mild steel with interior coat of enamel.
2. Fittings shall be steel compression type.
3. **Cast type, indenter, or set-screw type fittings shall not be used**.
4. EMT shall be used for exposed and concealed runs to lighting fixtures above 10 feet or above ceilings.
5. **Not approved for any exposed conduit runs or drops**.

D. NON-METALLIC CONDUIT (PVC)

1. Shall be PVC Schedule 40 heavy wall suitable for direct burial.
2. Fittings shall be threaded or solvent welded type of the same material as the conduit.
3. **Shall not be used above grade or embedded in concrete, except as noted specified for runs above 600 volts. PVC shall not be used where exposed or concealed in walls or floors**.
4. PVC may be used for all underground runs, except for bends exceeding 22 degrees where jacketed or wrapped rigid galvanized steel is required, and runs under concrete slabs. Runs under concrete slabs shall be embedded in earth a minimum of 4 inches below the bottom of the slab. Risers through concrete slabs shall be rigid steel or intermediate metal conduit.
5. Provide PVC to steel adapters as required.

E. FLEXIBLE LIQUID-TIGHT CONDUIT

1. Shall be galvanized steel, liquid-tight, with moisture and oil- proof extruded PVC cover.
2. Fittings shall be liquid-tight, compression type.
3. Approved for flexible connections to equipment, items or instruments subject to vibration such as motors, fans, pumps, dry transformers, etc.
4. **Flexible Liquid-tight conduit shall not be less than 18 inches in length and not more than 3 feet in length**.

F. FLEXIBLE STEEL CONDUIT

1. Shall be galvanized steel.
2. Fittings shall be compression type of the same material as the conduit.
3. Shall be used for lighting fixture runs above drop ceiling grid systems or other devices required or approved by NEC or as requested or approved by the Engineer. (Install ground conductor per NEC in runs over 6 feet in length.)

G. PVC COATED CONDUIT

1. Rigid Steel conduit coated with a minimum of 40 mil of PVC coating shall be used in all corrosive areas or where required by NEC or the Engineer.
2. **All fittings, boxes, support materials, clamps, etc., used with PVC coated conduit shall be PVC coated in a like manner**.
3. Wiring devices shall be corrosion resistant UL rated in corrosive areas requiring PVC coated conduit.

H. WALL AND FLOOR SLEEVES

1. Shall be galvanized sheet steel or pipe.

I. CLAMPS

1. Shall be galvanized malleable iron one-hole straps, beam clamps or other approved device with necessary bolts and expansion shields.
2. **Perforated metal straps shall not be used**.

J. CONDUIT SIZES

1. Shall be as indicated on the drawings.
2. **Shall not be smaller than ¾ inch exposed or 1 inch buried conduit unless otherwise specifically approved by the Engineer**.

K. CONDUIT BUSHINGS

1. For conduit 1-1/4 inch and larger use OZ type BLG or SBLG with Lay-in-Lug.
2. Use Lay-in-Lug bushings on multiple conduit entrances to enclosures or gutters.
3. Bonding bushings shall be used on conduits containing service entrance conductors.

L. ENTRANCE SEALS

1. Provide and install OZ entrance seals on all conduits entering building below grade.

M. RACKS AND SUPPORTS

1. Conduit support racks, Unistrut supports and fittings, etc., shall be hot-dipped galvanized, except in corrosive areas where the supports and fittings must be PVC coated.
2. **Painted metal supports are not allowed**.

N. PULL BOXES

1. Pull boxes, which are required for proper conduit installation, shall be sized according to the requirements of Article 370 of the NEC.
2. Condulet type pull boxes shall be cast type with threaded hubs

O. OUTLET/JUNCTION BOXES

1. Boxes shall be provided in the wiring or raceway systems wherever required for routing/pulling of wires, making connections and mounting of devices or fixtures.
2. Boxes in exposed conduit runs shall be cast metal condulets with threaded hubs. **Non-metallic boxes are not allowed**.
3. Each box shall be metal and shall have the volume required by the National Electrical Code for the number of conductors enclosed in the box. Boxes for mounting lighting fixtures shall not be less that 4 inch octagonal or 4 inch square except that smaller boxes may be installed as required by fixture configuration, as approved. Boxes in the raceway system shall not be less than 1-1/2 inches deep, except where shallower boxes required by structural conditions are approved.
4. Boxes for other than lighting fixture outlets shall not be less than 4 inches square.
5. Boxes in concealed conduit runs shall be equipped with tile extension rings, device mounting straps and accessories required for the purpose of the outlet.

16010.2.6 A. CONDUCTORS

1. Shall be of the type, size, and locations as shown on the Drawings and meet the requirements of the latest addition of the National Electric Code (NEC).
2. Shall be soft-annealed coated copper in accordance with ASTM B33 or B189.
3. Conductors No. 10 and smaller shall be solid copper for lighting circuits only, all other circuits shall be stranded copper.
4. All conductors shall be THHN/THWN copper rated at 600 volts, unless otherwise noted.
5. **Aluminum conductors will not be allowed**.

B. GROUNDING CABLE

1. Shall be as called out on the drawings and per NEC. (Grounding lugs shall be the clamp type made of high conductivity copper alloy and shall be provided for all equipment to be grounded.)

16010.2.7 SPLICES, TAPS AND TERMINATIONS

A. Splices, taps and terminations made in interior damp or wet locations, corrosive atmosphere locations or exterior boxes above or below grade shall be covered with 3M heat shrinkable ITCSN series sleeves or end caps or Raychem equal as approved by the Engineer.

B. All splices shall require approval by the Engineer.

16050.2.1 SAFETY SWITCH DISCONNECTS

A. Provide disconnect switches where shown and required by NEC as specified herein.

B. Type: Heavy duty, manual, single throw, fusible or non-fusible as indicated.

C. Rating: 600 volt, ampere size as noted or as required for load served.

D. Enclosure: Nema 4, Gasketed stainless steel or as called out in equipment schedule on drawings.

E. Fuses: Switches shall be equipped with Type "R" fuse clips factory installed. Fuses shall

be dual element type RK5 of size as noted.

F. Non-Fusible Switches: For equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.

16050.2.2 JUNCTION BOXES

A. Junction or pull boxes, which are required but not shown, shall be sized according to requirement of the most current NEC.

B. Condulet type junction boxes shall be cast metal with threaded hubs, unless otherwise specified on the drawings.

16050.2.3 WIRE DEVICES

A. Switches: 20 ampere, 120/277 volt, toggle type. Single pole used as designation for entire series - double pole, 3-way, 4-way or lock type. Hubbell #1221, Bryant #1221, Leviton #1221. Switch and pilot shall be Hubbell #1221-PL or Leviton #1221-PL. Double pole toggle switch shall be Hubbell #1222-2.

B. Ground Fault Interrupter Receptacles: 20 ampere, 125 volt, NEMA 5-20R, gray color. Leviton #6398.

C. Receptacles: 20 ampere, 125 volt, NEMA 5-20R, gray color for locations where indicated. Hubbell #5352, Bryant #5352, or Leviton #5352.

D. All devices shall be gray in color.

E. Special receptacles other than those listed above shall be as designated on the drawings.

F. Device Plates:

1) For surface mounted boxes plates shall be stainless steel suitable for use on cast metal device boxes, condulet FS and FD types. Shall be complete with gaskets and approved for wet locations.

2) For flush boxes in finished areas, plates shall be stainless steel. Gang plates shall be one-piece.

16010.3 CONSTRUCTION REQUIREMENTS

Unless notified otherwise, the Contractor responsible for the electrical Work shall perform all electrical work in accordance with the Drawings and with these Specifications.

16010.3.1 CODES, PERMITS, LICENSES AND STANDARDS

A. PERMITS AND LICENSES – The Contractor shall secure all permits and licenses required in connection with this work.

B. CODES AND STANDARDS - All work, labor, and equipment shall conform to applicable State and Local Codes and Standards and the applicable sections of the latest revisions of the following:

- American Society for Testing and Materials (ASTM)

- National Fire Protection Association, National Electrical Code (NEC)
- Insulated Power Cable Engineers Association (IPCEA)
- Underwriters Laboratories Inc. (UL)
- American Steel and Iron Institute, "Design Manual on Steel Electrical Raceways"
- National Electrical Manufacturer's Association (NEMA)
- American National Standards Institute (ANSI)
- Institute of Electrical and Electronic Engineers (IEEE)
- International Building Code (IBC)
- International Fire Code (IFC)
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

Conflicts between any of the above referenced codes and standards and between any of them and these Specifications and/or the Project Drawings shall be resolved by complying with the more stringent requirements.

16010.3.2 SAFETY

A. REGULATIONS - The Contractor's work shall conform to the Associated General Contractors of America, Inc. *Manual of Accident Prevention in Construction* and shall comply with all current regulations of the Occupational Safety and Health Act (OSHA) as required for work identified on the Drawings or in these Specifications.

B. SAFETY GUARDS - All equipment, which the Contractor furnishes and installs, shall be provided with appropriate safety guards for prevention of accidents. The Contractor shall provide and maintain any other necessary construction required to secure safety of life or property, including the maintenance of sufficient lights to secure such protection.

16010.3.3 DIAGRAMMATIC DRAWINGS

A. The electrical drawings are diagrammatic, intended to indicate the general scope and locations of the work to be installed and are not to be considered as complete in every detail. The Contractor shall install all work indicated and/or specified herein, complete to perform the function intended without additional cost.

B. The electrical drawings are diagrammatic, however, they shall be followed as closely as actual construction and work of other contractors will permit. Runs to panels from outlets, referred to as "home runs", are indicated on the drawings by arrows pointing in the general direction of panels. Contractor shall continue such circuits to the panels as though the routes were completely indicated. Deviations from drawings required to make the work of this Contract conform to building as constructed, or as to work of other contractors, shall be made at the Contractor's expense. The Engineer reserves the right to make minor changes in the location of equipment and outlets without additional charges.

16010.3.4 SITE EXAMINATION

Examination of the site shall be made by the Contractor, who shall compare it with the drawings and specifications and satisfy himself as to the conditions under which the work is to be performed. The Contractor shall, at such time, ascertain and check all conditions which may affect its work. No allowance shall subsequently be made in the Contractor's behalf for any extra expenses to which the Contractor may be put due to failure or neglect on its part to make such examination and determination of the condition.

16010.3.5 SUPERVISION

A. A competent foreman or superintendent, approved by the Owner's Representative, shall be at the site at all times to receive instructions and shall have the proper authority to act on behalf of the Contractor. The Contractor shall verify dimensions given on the electrical drawings and report any errors or inconsistencies to the Engineer before commencing the work. The Engineer or its representative will interpret the meaning of the Drawings and Specifications where questions arise.

B. Contractor shall assign persons to be in direct charge of work who are thoroughly experienced in the types of construction work specified herein. All labor shall be performed in a workmanlike manner by skilled workmen under the supervision of competent foremen.

16010.3.6 WORKMANSHIP

Workmanship shall be in accordance with the best present-day construction methods and shall be neat and orderly throughout the project.

16010.3.7 COORDINATION OF CONSTRUCTION

A. The Contractor shall coordinate work with other contractors, subcontractors, the Owner, and the Engineer to assure orderly and expeditious progress of work. The Contractor shall select order/sequence of work and establish schedule of working hours for construction, all subject to review and direction by the Owner.

B. This Contractor shall be held solely responsible for the proper installation of its work. The Contractor shall arrange with the proper contractors for the installation of anchors and other embedded devices, and for the leaving of required chases, openings, etc., and shall do all cutting and patching made necessary by its failure or neglect to make such arrangements with others. Any cutting or patching done by this Contractor shall be subject to the directions of the Engineer and shall not be started until approval has been obtained.

C. All cutting, welding or drilling of concrete or structural members shall be properly reinforced and patched to match as nearly as possible the surrounding work. Before cutting, welding or drilling any concrete or structural member, the Contractor shall secure the approval of the Engineer. Where deemed appropriate by the Engineer, in the case of gross negligence pertaining to this issue, the Engineer reserves the right to back-charge the Contractor for the Engineers associated costs.

16010.3.8 **INSTALLATION**

<u>RACEWAY AND FITTINGS</u>

A. STANDARDS

1. All conduit to be installed in accordance with the requirements of the National Electrical Code, latest addition.
2. Steel conduit to be installed in accordance with recommendations of American Iron and Steel Institute “Design Manual on Steel Electrical Raceways”, latest addition.
3. PVC coated, “Plastic-Bond-Red”, conduit installed in accordance with instructions in Robroy Plastic –Bond installation manual.

B. ELECTRICAL CONTINUITY

All metallic conduit systems shall be electrically continuous throughout.

C. MOISTURE

1. All conduit raceway systems shall be essentially moisture tight.
2. Conduit drainage shall be accomplished by sloping conduits towards manholes or boxes.
3. Where pockets cannot be avoided in exposed conduits, provide drainage fittings or weep holes. Weep holes drilled through the walls of any conduit or fitting shall not produce burrs on the inside or outside surface.

D. ALIGNMENT OF EXPOSED CONDUIT

Install conduit runs parallel or at right angles to lines of structure.

E. FIELD CUTS AND THREADS

1. Field cuts shall be made square, threads clean and sharp.
2. Remove burrs, sharp or rough edges by reaming.
3. Before couplings or fittings are attached, apply a coat of red lead or zinc chromate to male threads of RGS or IMC conduit, also apply these coatings or other special compound recommended by the manufacturer of the conduit where the conduit protective coating is damaged.
4. PVC coated conduit system requires male threads on conduit, elbows and nipples and all female threads on fittings or conduit couplings to be protected by application of a urethane coating.
5. **Care must be taken to assure that concrete surfaces are protected from cutting oil, any/all damage will be the responsibility of the Contractor**.

F. BENDS

1. Uniform, whether job-fabricated or made with standard fittings or boxes.
2. Do not dent or flatten conduit
3. Conduit installation should be installed symmetrically insofar as practicable.
4. Unless approved otherwise, bends larger than 1-1/4 inch shall be factory made.
5. Bends in exposed conduit shall be symmetrical insofar as practicable.
6. Do not expose bends at floor or ceiling.

G. LOCATION

1. Conduit routing is generally shown in schematic fashion, unless dimensioned or noted to the contrary.
2. Contractor is responsible to route conduits as required to connect equipment or devises.
3. Vertical risers, equipment and device locations are approximately as indicated on the drawings. Contractor shall coordinate installation of conduit with structure and equipment.
4. Contractor is responsible to coordinate conduit installation with other contractors installations, in the event of conflict, field routed conduit shall be moved at the Contractors expense.
5. Conduit shall be located a minimum 6 inches away from steam, hot water, or other hot surface. Protect from heat, as Engineer approved, if the 6 inch separation is impracticable.
6. Diagonal installation is not permitted.

H. BURIED/EMBEDDED CONDUIT

1. Buried conduit shall be a minimum of 30 inches below finished grade, sloped toward manholes or pull boxes.
2. RGS conduit installed underground, or used in PVC runs for sweeps 22 degrees or larger, must be wrapped with 3M-50 10 mil pipe wrap, approved asphalt compound or approved equal.
3. Mid-run weep holes and gravel drainage pockets will not be permitted.
4. Conduits embedded in concrete or masonry shall be securely held in place during concrete placement and construction operations.
5. In concrete floors, conduit shall be set before pouring of concrete begins. Conduit shall be routed in a direct line, with bends as long as possible, with 2 inches minimum from conduit to bottom of slab and maximum conduit size of 2 inch, unless otherwise approved.
6. Non-metallic conduits above 600 Volts shall be encased in red concrete covered by a minimum of 2 inches on all sides.

I. WALL PENETRATIONS

1. Penetrations through exterior building walls to be by core drilling and providing appropriate conduit entrance seals.
2. Openings through existing partitions shall be provided at Contractor's expense. Holes through masonry construction shall be drilled with suitable core drilling machine.
3. All work is to be performed neatly.
4. Patches shall match original material in composition and appearance.
5. Provide fire seals as detailed or required by NEC where a fire rated wall or partition is penetrated.
6. A template shall be provided by the Contractor to hold conduit groups terminating together or passing through fire walls or floors.
7. In walls and partitions, conduit shall be installed vertically. If vertical installation is impracticable, the Engineer shall approve horizontal installation for each location.

J. EXPANSION FITTINGS

1. Install expansion fittings in all conduit runs crossing structural expansion joints and in all straight conduit runs exceeding 75 feet in length.

K. CONDUIT ENDS

1. Insulating bushings shall be installed at open conduit ends, terminating in panels, control centers, consoles or other similar locations.
2. Plug space around cables with oakum and/or an approved sealing compound where conduits enter switchboards, cabinets or similar locations.
3. Cap or plug all spare conduit ends to prevent the entrance of foreign material.

L. CONDUIT CONNECTIONS

1. At cabinets and boxes use double locknuts and insulating bushings for rigid conduit.
2. At cable tray securely clamp conduit to tray and install insulating bushings.
3. Install insulated grounding bushings with lay-in ground lugs where metallic conduit terminates in non-metallic manholes or pullboxes.
4. Flexible conduit for connection to movable/vibrating equipment shall be liquid-tight, sealtite as manufactured by Anaconda Metal Hose Company, or approved equal, utilizing approved liquid-tight fittings.

M. SUPPORTS

1. Hangers and supports shall be galvanized or PVC coated.
2. Hangars generally are not detailed, but must be adequate to support combined weight of conduit. Rigid fastenings are to spaced at a maximum of 6 feet.
3. Clamps will be galvanized malleable iron one-hole straps, beam clamps or other approved device with necessary bolts, washers and expansion shields.
4. **Perforated metal straps shall not be used**.
5. Adjustable hangers shall be used to support horizontal runs only, use trapeze hangers for parallel runs of conduit. Install u-bolts or other approved clamping device at each end and at each elbow. Install clamp every third intermediate hanger for each conduit.

N. CONDUIT CLEANING

1. Contractor is to clean and swab the inside of conduits, by mechanical means, to remove foreign materials and moisture before conductors are installed.

O. SPARE CONDUITS

1. Spare conduits shall have a nylon pulling line installed for future installation of cables.
2. Recessed panels shall have three 1 inch spare conduits in the wall space stubbed-out above ceiling and three 1 inch spare conduits stubbed under the floor.
3. Spare conduits shall be capped.

CONDUCTOR INSTALLATION

A. BENDING RADII

1. Not to be less than permitted by ICEA and/or NEC.

B. SUPPORTS IN VERTICAL RUNS

1. To be in accordance with NEC requirements.

C. SPLICING

1. Will be permitted only with Engineers approval, and will be held to an absolute minimum.
2. Permitted only in junction boxes or similar accessible locations.
3. Cover with heat shrinkable sleeves to make moisture proof and corrosive resistant.
4. No splicing of instrument or control wiring shall be allowed without specific approval, by the Engineer.

D. CONNECTORS

1. Solderless compression or mechanical type will be utilized where screw does not bear directly on the wire.
2. Apparatus lugs, conductor, and coat shall be thoroughly cleaned with suitable oxidation inhibiting compound prior to connection.
3. Retaining cup washers shall be used where solid wire is used at terminal blocks.
4. Compression type connectors shall be installed using ratchet type crimping tools that will not release until full compression has been achieved.
5. Dies for the crimping tools shall be matched to the connector and approved for use

by the Engineer and the connector manufacturer.

6. Twist on type, Scotch-lok or approved equal, connectors shall be restricted to the connection of lighting fixture wires only.

E. POWER CABLES

All power cables will be installed in strict accordance with the manufacturers instruction, and in conformance with NEC.

F. CONNECTIONS

All apparatus lugs shall be tandem single or multi-barrel lugs as detailed/required.

G. CONDUCTOR PULLING

1. Use pulling grips or eyes.
2. Firmly mount pulling reels on portable stand and secure against displacement
3. Use an approved by the Engineer commercial pulling compound for lubrication.
4. Monitor and do not exceed cable-pulling tension as specified by the cable manufacturer.

H. COLOR CODING

1. Single phase service – use white for neutral conductor, and black for ungrounded conductors.
2. Three phase service - feeder and branch conductors shall be color coded as follows

	120/208 Volt	277/480 Volt
a.	Phase A – Black	Brown
b.	Phase B – Red	Orange
c.	Phase C – Blue	Yellow
d.	Neutral – White	Grey
e.	Ground – Green or Bare	Green or Bare

3. Coding shall be by insulation color or minimum 1 inch band of colored tape.
4. Green covering of conductors shall be solely for grounding.

I. PHASING

1. Where common neutral is run for two or three circuits, phase conductors shall be connected to breakers in the panel, which are connected to different phase legs.
2. Home runs may be combined at the option of the Contractor, providing not more than three circuits are installed in one conduit, unless otherwise approved by the Engineer.

J. SERVICE SYSTEMS

1. Incoming service systems shall be grounded at two points with the main water service at the entrance point ground to the building and to driven ground rods as indicated on the Standard Detail Drawing.
2. Jumpers shall be provided around water meters and any dialectric sections of pipe.
3. Size shall be as indicated on the Drawings and/or as required by NEC.
4. Connections shall be accessible for inspection.
5. Neutral conductor connection to grounding electrode conductor shall be at the main

service enclosure only.

6. Type of equipment and details of installation shall be verified with Power Company representatives.
7. Metering equipment shall be provided as indicated on the Drawings or as required by these Specifications.

16010.3.9 INSTALLATION OF POWER AND CONTROLS TO EQUIPMENT

Contractor shall provide all power and control wiring required for the work of other trades as described on the drawings and in the specifications, except where the furnishing and installing of such wiring is specified elsewhere. Connect cord sets to Owner furnished equipment and make connections to all electric power consuming equipment whether furnished under contract or by Owner.

16010.3.8 TEMPORARY ELECTRIC SERVICE DURING CONSTRUCTION

A. The Project Contractor is responsible for all project electrical work unless otherwise noted. The Contractor shall be aware, however, that some or all of the project electrical work may be performed by the Owner and/or an independent electrical contractor. The division of work to be performed by others may be indicated on the drawings, or may be as called for by the Engineer. But, the Contractor shall be responsible to review the Drawings and consult with the Engineer, to determine if its scope is less than one hundred percent of all project electrical work. The Contractor shall also be responsible to coordinate and schedule its work with that of the Owner or independent electrical contractor, and to leave its installations ready, with the connecting wires coiled, for the Owner or independent contractor to connect to or to terminate as necessary, thereby ensuring the most efficient completion of the project by all parties.

B. The Contractor or electrical subcontractor doing the work shall provide temporary power, complete with metering and wiring, for lighting and power outlets for construction tools and equipment. This contractor will make arrangements with the local power company for temporary electrical service connections for construction power.

C. No attempt shall be made herein to specify construction power requirements for equipment in detail. However, all temporary wiring shall meet NEC, Article 305, requirements. The service shall be provided with a main disconnect, and all power receptacles shall be, or be protected by, appropriately rated GFI single-pole devices.

D. At completion of the Project, or sooner if directed, the temporary power supply shall be disconnected and removed from the construction site.

E. During construction, if it becomes necessary to shut down power to a critical item of equipment or process, the Contractor or electrical subcontractor shall provide the necessary wiring and a portable generator or other source of electric power to keep such critical equipment or process in operation.

16010.3.9 SEISMIC RESTRAINT

A. The appropriate Seismic Zone Classification will be provided on the Drawings or in the Special Provisions. All electrical equipment shall be securely anchored and seismically braced in accordance with the regulations contained in the most recently adopted edition of the IBC and with the SMACNA *Guidelines for Seismic Restraints of Electrical Systems* as they pertain to the Seismic Zone Classification given.

B. Units mounted and secured directly to structures shall be provided with connectors of

sufficient strength to meet the restraining criteria.

C. All electrical equipment which is to be securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than IBC requirements and SMACNA guidelines for the given seismic zone.

16010.3.10 LABELING OF J-BOX COVERS

All J-Box covers shall be labeled with information showing the voltage and the circuit number in reference to each home run pulled through that J-Box and a particular run of conduit.. The Contractor shall continue such circuits to the panels as though the routes were completely indicated.

16010.3.11 REPAIR OF WORK

A. The work shall be carefully laid out in advance and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support, or anchorage of the conduit raceways or other electrical work, this work shall be carefully done. Any damage to building, piping or equipment shall be repaired by skilled mechanics of the trades involved, at no additional cost to the Owner.

B. Penetrations within fire rated wall assemblies shall be appropriately repaired and replaced to full integrity of the designed fire resistance of the wall.

16010.3.12 TESTING

On completion of the work, the installation shall be tested free from all grounds and short circuits. Normal feeders, circuits, and service entrance conductors with wire size #2 and larger shall be tested for leakage phase-to-ground and phase-to-phase prior to energizing the electrical system. The Contractor shall submit a written report to the Engineer showing methods used and readings taken. Voltage applied for testing shall not exceed two times normal operating voltage.

16010.3.13 GUARANTEE/WARRANTY

A. The following guarantee is a part of the specification and shall be binding on the part of the Contractor:

"The Contractor guarantees that this installation is free from defects. The Contractor agrees to replace or repair, to the satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance."

B. Electrical systems and equipment shall not be considered acceptable for substantial completion until they have performed in service continuously without malfunction for at least ten (10) days.

16010.3.14 DEFECTIVE EQUIPMENT

If equipment fails to conform to the Specifications or to operate satisfactorily, the Owner will have the right to operate said equipment until defects are corrected. The Owner will have the right to operate rejected equipment until it is replaced, without cost for depreciation use or wear. The Contractor shall remove defective equipment from operation for examination, adjustment, alteration, or change only at times approved by Owner.

16010.3.15 CLEAN-UP

A. As the work progresses, and on a daily basis, the Contractor shall remove from the premises and surrounding streets, alleys, etc., all rubbish and debris resulting from its operations and shall leave all equipment and material furnished by the Contractor absolutely clean and ready for use.

B. In addition, the Contractor shall periodically remove all debris and waste in order to maintain safe working and operating conditions, and shall dispose of the same in an approved manner. At the completion of work, The Contractor shall remove all its rubbish, tools, scaffolds and surplus materials from and about the site, leaving its work clean and the areas ready for occupancy.

16010.3.16 AS-BUILT DRAWINGS

Blue line white prints of 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 such changes are made in the work. These drawings shall be reviewed with the Engineer on a timely basis, not to exceed at least once each month. Failure to keep as-built drawings up to date shall be cause for withholding monthly or final payment.

16010.3.17 FINAL INSPECTION AND ACCEPTANCE

The Contractor shall notify the Engineer when work is considered to be complete, in full operating condition, and ready for final inspection. The Engineer, after determining that the installation is ready for final inspection, will conduct the final inspection and tests as are deemed necessary to determine that the provisions of the specifications are satisfied. The Owner will not accept work nor make final payment to the Contractor until Engineer has certified that the work of the Contractor is complete and in conformance with the specifications and guarantees.

16010.4 METHOD OF MEASUREMENT

16010.4.1 NO SEPARATE MEASUREMENT

Separate measurement shall NOT be made for furnishing or installing electrical systems, components, materials required to be installed within the pay limits for a building or enclosure identified in the Bid schedule to be furnished by the Contractor.

16010.4.2 SEPARATE MEASUREMENT

A. NEW BUILDINGS – Separate measurement shall be made for installation of electrical systems, components, and materials, required for a building or enclosure shown on the Drawings and as called for in these Specifications and identified in the Bid Schedule, when such electrical systems, components, and materials are identified and listed in the Bid Schedule.

B. ALTERNATE POWER SYSTEMS – Provide standby generator, battery charger, block heater, remote start and operation, power plug/receptacle, automatic transfer switch, manual transfer switch, grounding, conduit, conductors, and fuel supply, as shown on the Drawings, and as defined in the applicable sections of the Specifications for a complete and functioning system.

C. EXISTING BUILDINGS – Separate measurement will be made for installation of electrical systems, components, and materials, required to be installed or replaced in an existing building or enclosure, as shown on the Drawings and as called for in these Specifications,

when such electrical systems, components, and materials are identified and listed in the Bid Schedule.

D. MOBILIZATION & EQUIPMENT – Provide mobilization and demobilization vehicles and equipment necessary to perform all electrical work as shown on Drawings and Specifications.

16010.5 BASIS OF PAYMENT

16010.5.1 No separate payment shall be made for furnishing or installing electrical systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the Contractor.

16010.5.2 When electrical systems, components, or materials are measured for a new building or enclosure as shown on the Bid Schedule, separate payment will be made as listed in specification 16400.

16010.5.3 When initial installation or replacement of electrical systems, components, or materials is made in an existing building as shown on the Bid Schedule, the accepted quantity will be paid for at the contract price listed below:

PAY ITEM	UNIT
New Buildings	Lump Sum
Alternate Power Systems	Lump Sum
Existing Building	Lump Sum
Mobilization & Equipment	Lump Sum

16150. 1 GENERAL

16150.1.1 QUALITY ASSURANCE

A. Comply with NFPA 70 requirements for electrical materials and installation.

B. Provide products and components which have been UL listed and labeled, including UL marks indicating special type usage whenever applicable.

16150.2 PRODUCTS

16150.2.1 MOTOR STARTERS

A. Acceptable Manufacturers:

1. Allen-Bradley Co.
2. Eaton Corp/Power Distribution Div.
3. Furnas Electric Co.
4. General Electric Co. (GE Supply)
5. Square D Co.

B. Provide factory fabricated starters complying with NEMA Standards Publication ICS 2 with NEMA Type enclosures as specified in Section 16050.

C. Provide starters with thermal overload protection on each phase utilizing interchangeable melting alloy, Class 20 (trip in 20 seconds or less when carrying a current equal to 600 percent of its current rating) overload heaters, sized in field for full load current rating indicated on each motor nameplate.

D. Manual Motor Starter: Quick-make, quick-break trip free toggle or pushbutton operating mechanism; provisions for positive padlocking in OFF position.

E. Magnetic Motor Starter: Non-reversing or reversing, as indicated; manual reset overload relay with reset button on face of enclosure; full voltage starting; control transformer of sufficient capacity to handle operating coil and associated controls, integral with each starter; 120 volts control circuit, fuse protected; equipped with pilot light.

16150.2.2 CONTACTORS

A. Acceptable Manufacturers:

1. Allen-Bradley Co.
2. Eaton Corp/Power Distribution Div.
3. Furnas Electric Co.
4. General Electric Co. (GE Supply)
5. Square D Co.

B. Provide contactors complying with NEMA Standards Publication ICS 2 with NEMA Type enclosures as specified in Section 16010, unless otherwise indicated.

16150.2.3 RELAYS

A. Acceptable Manufacturers:

1. Control Relays:
2. Allen-Bradley Co.
3. IDEC Systems & Controls Corp.
4. Omron Electronics, Inc./Control Components Div.
5. Potter & Brumfield
6. Square D Co.

B. Provide relays complying with NEMA Standards Publication ICS 2 with NEMA Type enclosures as specified in Section 16050, unless otherwise indicated.

16150.2.4 CONTROL PANELS

A. Acceptable Manufacturers:

1. Allen-Bradley Co.
2. Eaton Corp/Power Distribution Div.
3. Furnas Electric Co.
4. Square D Co.

B. Provide factory fabricated oiltight pushbuttons, selector switches, pilot (indicating) lights, and pushbutton stations complying with NEMA Standards Publication ICS 2, heavy duty, with NEMA Type enclosures as specified in Section 16050.

1. Fabricate pushbutton stations for vertical or horizontal mounting, as indicated, and with button and light arrangements, as indicated on drawings.

C. Pushbuttons: Momentary or maintained contacts, as indicated; contacts rated 10 amps continuous carrying current, 600 volts AC; quick-make, quick-break, snap action operating mechanism.

D. Selector Switches: Rotary type; two or three position control, as indicated; legend plate with markings as indicated.

E. Pilot Lights: Transformer type, 120 volts AC; glass or acrylic plastic prismatic lens, color as indicated; legend plate with markings as indicated.

16150.2.5 CIRCUIT AND MOTOR DISCONNECTS

A. Acceptable Manufacturers:

1. Eaton Corp/Power Distribution Div.
2. Allen-Bradley Co.
3. Siemens Corp/Electrical Appartus Div.
4. Square D Co.
5. General Electric Co. (GE Supply)

B. Provide factory fabricated switches complying with NEMA Standards Publication KS 1 with NEMA Type enclosures as specified in Section 16010.

C. Safety Switches: 3 pole, heavy-duty, horsepower rated disconnect; rated at 600 volts; quick-make, quick-break operating mechanism; integral operating handle provided with means for positive padlocking in OFF position; current carrying parts constructed of

high conductivity copper, with silver-tungsten type switch contacts; fusible or non-fusible as indicated; positive pressure type reinforced fuse clips for fusible switches.

D. Fuses: Dual element type, with time delay; non-renewable; current limiting where indicated.

16150.3 METHOD OF MEASUREMENT

16150.3.1 NO SEPARATE MEASUREMENT

Separate measurement shall NOT be made for furnishing or installing electrical systems, components, materials required to be installed within the pay limits for a building or enclosure identified in the Bid schedule to be furnished by the Contractor.

16150.4 BASIS OF PAYMENT

16150.4.1 No separate payment shall be made for furnishing or installing electrical systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the Contractor.

16150.4.2 When electrical systems, components, or materials are measured for a new building or enclosure as shown on the Bid Schedule, separate payment will be made as listed in specification 16400.

16210.1 DESCRIPTION

The Contractor shall provide and install all lighting systems for the Project, complete with lamps, brackets, hangers, mounting devices and all other miscellaneous components required to complete the lighting system as shown on the Drawings and in accordance with these Specifications.

16210.1.1 RELATED WORK

Section 16010 - Electrical General Requirements

16210.1.2 SUBMITTALS

Shop drawings shall be submitted for all light fixtures in accordance with Section 1300 of these Specifications.

16210.1.3 DEFINITIONS

Not used.

16210.2 MATERIALS

16210.2.1 LIGHTING FIXTURE TYPES AND SIZES

Shall be as designated on the Drawings or as otherwise required by the Special Provisions. All work, equipment, and materials shall be in accordance with UL "Standards for Electric Lighting Fixtures", No. 57, and the NEC (National Electric Code).

16210.2.2 INCANDESCENT FIXTURES

Shall be complete with medium base socket, all hardware required for installation, and lamps. Lamps shall be medium base, inside frosted, general purpose, or the project type as referenced in the electrical schedule.

16210.2.3 FLUORESCENT FIXTURES

Shall be provided complete with Class "P" high power factor, electronic type ballast with a -20°F temperature rating, together with all miscellaneous hardware and lamps. Ballast shall be CBM certified, ETL rated, with maximum sound level equivalent to General Electric Company Sound Rating "A". Lamps shall be cool white unless otherwise required on the Drawings.

16210.2.4 HIGH INTENSITY DISCHARGE FIXTURES

Shall be ballast type, complete with all miscellaneous hardware and lamps. Photocells shall be used as required on the Drawings. Ballast shall be constant wattage, high power factor type. Lamps shall be inside frosted and of the wattage indicated.

16210.2.5 HIGH PRESSURE SODIUM FIXTURES

High-pressure sodium and metal halide fixtures shall be suitable for all burning positions as specified for each type of luminaire.

16210.3 CONSTRUCTION REQUIREMENTS

16210.3.1 Fixtures and related materials shall be installed as nearly as possible in the locations shown on the Drawings. The Contractor shall coordinate the exact locations with structure, equipment, and other devices as approved by the Engineer and/or the Owner. Mounting heights shall be as indicated on the Drawings.

16210.3.2 Conductors serving grid ceiling fixtures shall be enclosed in 1/2 inch flex conduit from a junction box attached to the building structure. Fixture locations shall be coordinated with ceiling system. Fixtures shall be securely fastened to the ceiling framing members.

16210.4 METHOD OF MEASUREMENT

Provide all lighting fixtures, beacons, emergency lighting, conduit, sweeps, support members, enclosures, lamps, conductors, switches, and appurtenances as shown on the drawings and as defined in the applicable sections the specifications required for a complete and functioning system.

16210.5 BASIS OF PAYMENT

16210.5.1 No separate payment shall be made for furnishing or installing electrical systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the Contractor.

16210.5.2 When electrical systems, components, or materials are measured for a new building or enclosure as shown on the Bid Schedule, separate payment will be made as listed below.

16210.5.3 When initial installation or replacement of electrical systems, components, or materials is made in an existing building as shown on the Bid Schedule, the accepted quantity will be paid for at the contract price listed below:

PAY ITEM	UNIT
Light Fixtures	Lump Sum

SERVICE ENTRANCE RATED AUTOMATIC-MANUAL TRANSFER SWITCH

SECTION 16251SP

16251 SCOPE

This specification is intended for typical automatic transfer switches consisting of the following main characteristics:

- maximum voltage rating of 600VAC, 50/60Hz
- amperage rating of 100 - 4000Amps
- open transition (break-before-make) transfer logic
- Standard or Service Entrance Rated Automatic Transfer Switches

16251.1 AUTOMATIC TRANSFER SWITCH

16251.1.1 This Specification covers the supply of a complete operational service entrance rated automatic transfer switch rated 400 Amps, 480 Volts, 3 Phase, and 60Hz, 4 Pole, for installation by others.

16251.2 GENERAL REQUIREMENTS

16251.2.1 GENERAL

16251.2.2 The unit shall be manufactured in accordance with this specification and applicable UL, CSA, IEC, NEMA, and ANSI standards.

16251.2.3 The unit shall be manufactured in a facility, which is registered to an ISO 9001:2000 quality system.

16251.2.4 Supplier shall be responsible for ensuring the compatibility of all components of the unit.

16251.2.5 The unit shall be free of defects in material and workmanship.

16251.2.6 The unit shall be supplied with a 5 year warranty from the manufacturer at no additional cost.

16251.3 RELATED INDUSTRY STANDARDS

16251.3.1	**UL 1008**	Automatic Transfer Switches for Use in Emergency Systems
16251.3.2	**CSA C22.2 No.178-1978**	Automatic Transfer Switches
16251.3.3	**NEMA No. ICS 10**	Industrial Control and Systems AC Transfer Switch Equipment
16251.3.4	**EC 947-6-1**	Automatic Transfer Switching Equipment

16251.4 ENGINEERING SUBMITTALS

The following documentation shall be made available for submission to the project engineer for review/approval purposes on the automatic transfer switch:

A. Physical Layout Drawing
   1. Outline dimensions, cable entry/exit locations, interior/exterior component layouts, connection data

B. Electrical Schematic
   1. Internal wiring, customer connection terminals, optional components, controller settings

C. Product Data Sheets
1. Equipment Ratings

16251.5 ENVIRONMENTAL CONDITIONS

16251.5.1 The unit shall be installed with ambient temperatures between 5°and 122°Farenheit, relative humidity from 0-95% non-condensing.

16251.6 RATINGS & CONSTRUCTION

16251.6.1 AUTOMATIC TRANSFER SWITCH

16251.6.2 Rating of the automatic transfer switch shall be 400 AMP, 480 VAC, 60 Hz, 3 PHASE, 4 WIRE.

16251.6.3 The transfer switch shall comprise of 3 switching poles plus a switched neutral.

16251.6.4 The automatic transfer switch shall be rated for Service Entrance applications and shall contain an 400 Amp standard or 100% rated over current device for the utility power switching device as indicated on the drawings. The generator power switching device shall be rated for 100% continuous load without de-rating. The current rating shall be based on all classes of load including resistive, and motor loads. Fault withstand current rating of the complete assembly shall be 15 Kamps RMS. The interrupting and closing rating shall be equal to or exceed the required withstand rating. This rating shall be obtained with standard upstream over current protection devices.

16251.6.5 The automatic transfer switch must be listed or certified to the following safety standards:

UL 1008 Automatic Transfer Switches For Use in Emergency Systems
CSA C22.2 No.178-1978 Automatic Transfer Switches

16251.6.6 Enclosure: The completed assembly shall be mounted in a NEMA 3R enclosure suitable for outdoor application with controls mounted on an interior door. Exterior door shall provide additional protection against outside environment and vandalism.

162516.7 Finish: All steel parts shall be cleaned, sealed and painted with one coat rust resistant primer and two coats of ASA #61 gray enamel or polyester powder coat finish inside and out.

16251.6.8 Ground Lugs/Bus: Adequate size and quantity of ground lugs shall be provided and shall conform to NEC/CEC guidelines. Where a ground bus is provided, it shall be a full length copper ground bus bonded to the frame with adequate size and quantity of ground lugs and shall conform to NEC/CEC guidelines.

16251.6.9 Busbars: Where load bus bars are utilized, they shall be tin plated round-edge high conductivity copper and be sized for 100% continuous load rating of the transfer switch, in accordance with NEMA, CSA and UL guidelines. The short circuit withstand rating of the completed bus assembly shall be not less than the short circuit fault current of the system.

16251.6.10 Cable Connections: Provision shall be made to terminate all incoming and outgoing power cables and grounding conductors. Connections shall be via screw type cable lugs.

16251.6.11 The automatic transfer switch shall be constructed to accommodate top entry of incoming generator power cables, bottom entry incoming utility power cables and side exit of outgoing load cables.

16251.6.12 The Power Switching units shall be fix-mounted, utilize fully enclosed contacts and withstand and closing rating shall be equal to or exceed the required withstand rating of the complete mechanism.

16251.6.13 All materials and parts used in the unit shall be new, of current manufacture, of best industrial grade, and free from defects and imperfections.

16251.6.14 The transfer switch mechanism shall provide a simple means of manual operation using only components, which are permanently affixed, in the operating position.

16251.6.15 The unit shall permit manual operation of the transfer switch while the system is energized and carrying rated load.

16251.6.16 All internal control devices used in the automatic transfer switch shall be cable of being de-energized and isolated from the system by use of an accessible isolation plug for servicing procedures as required.

16251.6.17 The automatic transfer switch design shall provide front accessible components and wiring for easy serviceability. Power or control connections, which are not readily serviceable while the transfer switch is mounted in its enclosure, are not acceptable.

16251.6.18 All power contacts used shall operate in a quick-make / quick-break manner, the speed of which shall be independent of supply voltage and / or speed of operation by manual means.

16251.7 FUNCTIONAL REQUIREMENTS

16251.7.1 GENERAL DESCRIPTION

The service entrance rated automatic transfer switch shall automatically transfer the load to the generator supply in the event of a utility supply failure and return the load to the utility supply upon restoration. The transfer switch shall incorporate an isolating mechanism and over current protection on the utility supply to allow operation as the main service disconnect in accordance with NEC requirements. The transfer switch power switching devices shall be mechanically and electrically interlocked to prevent the utility and generator supplies from being interconnected.

16251.7.2 AUTOMATIC SEQUENCE OF OPERATION

Note: For specific device settings refer to *Section 4.3 "STANDARD "CONTROL FEATURES."*

16251.7.2.1 When the voltage on any phase of the utility supply is below preset levels of rated voltage for a preset time delay, a contact shall close to initiate starting of the generator set.

16251.7.2.2 The load shall transfer to the generator supply when the generator voltage and frequency have reached acceptable preset levels and the warm-up time delay has expired.

16251.7.2.3 When the utility supply is restored to above preset levels of rated voltage on all phases, load transfer from generator to utility supply shall be initiated following expiry of the utility return timer.

16251.7.2.4 Once the transfer mechanism operates and opens the generator power switching device, the transfer mechanism shall stop in the neutral position (i.e. with both power switching devices open) for the duration of the neutral delay timer setting to allow load voltage to decay prior to re-connecting the utility supply.

16251.7.2.5 The load shall be re-connected to the utility supply once the neutral delay timer expires and the transfer mechanism continues operation and closes the utility power switching device.

16251.7.2.6 The load shall immediately retransfer to the utility supply (if within acceptable limits) should the generator supply fail prior to expiry of the utility transfer delay.

16251.7.2.7 The generator set shall continue to operate following a load transfer for a cool down delay period, and then a contact shall open to stop the generator set.

16251.7.2.8 An "on load" test mode may be initiated which shall cause a simulated utility failure condition and transfer the load to the generator set. The transfer sequence shall be the same as for a utility power failure except a neutral delay sequence shall occur when transferring from utility to the generator source.

16251.7.2.9 The load shall immediately retransfer to the utility supply (if within acceptable limits) should the generator supply fail during a "on load" test mode.

16251.8 STANDARD CONTROL FEATURES

16251.8.1 The transfer switch shall be rated for use on multiple system voltages. The transfer switch shall be field configurable to operate on the following nominal system voltages; 208V, 240V, 380V, 480V, 600V.

16251.8.2 Transfer switch control power must be obtained from the source being transferred to. The controls shall not require any connection to external power sources. Transfer switches requiring power from the engine starting (or other) battery are not acceptable.

16251.8.3 A control circuit isolation plug shall be provided to isolate all control circuitry inside the transfer switch to facilitate maintenance procedures. When isolated, there shall be no voltage present on the control circuitry.

16251.8.4 The transfer switch controller shall be microprocessor based and shall contain all voltage and frequency sensing, timing functions, and metering.

16251.8.5 The transfer switch controller software program shall include a three (3) level security password system for access to all programming functions. Specific password levels shall be provided for "read only", "read/write" and "master". All programming set-points for voltage, frequency and time delays shall be software programmable from the front panel mounted keypad, and all parameters shall be displayed in alpha numeric format.

16251.8.6 The transfer switch controller shall include an operator interface liquid crystal display (LCD) which is door mounted. The LCD shall have an automatic scrolling display feature for all main system information. The following information shall be displayed:

System Time
Transfer switch position
Utility supply metering – 3 phase voltage and frequency
Generator supply metering – 3 phase voltage and frequency
Timer countdown display
Test mode operation indication
Data Logging of Events

16251.8.7 Digital metering provided by the transfer switch controller shall have an accuracy of +-0.5% for all voltage and frequency readings. Frequency shall be displayed to at least one decimal. Three phase line to line voltages shall be displayed for both generator and utility supplies.

16251.8.8 The transfer controller shall provide data logging and shall store the data in non-volatile EEPROM memory. The following events shall be recorded:

A. Total Number of Transfers

B. Total Number of Transfers due to source failureNumber of Hours Controller is energized Number of Hours Load is on UtilityNumber of Hours Load is on Generator.

16251.8.9 Three phase under voltage sensing shall be provided for the utility supply. The under voltage sensor shall be user adjustable from 70-100% of nominal and shall be based on a falling (i.e. drop-out) voltage. The under voltage sensor shall be factory set at 85% nominal voltage. The under voltage sensor shall reset (i.e. pick-up) 5% above the dropout setting and shall be adjustable. The under voltage sensor shall include a transient time delay feature set at 1 second.

16251.8.10 Three phase over voltage sensing shall be provided for both utility and generator supplies. The voltage sensing function shall be programmable as follows:

–over voltage pickup 100–130% of nominal, factory set at 110%.
–over voltage dropout 100–130% of nominal, factory set at 108%.
–over voltage time delay 0–10 seconds, factory set at 5 seconds.

16251.8.11 Three phase under voltage sensing shall be provided for the generator supply. The under voltage sensor shall be user adjustable from 70 -100% of nominal and shall be based on a falling (i.e. drop-out) voltage. The under voltage sensor shall be factory set at 85% nominal voltage. The under voltage sensor shall reset (i.e. pick-up) 5% above the dropout setting and shall be user adjustable. The under voltage sensor shall include a transient time delay feature set at 5 seconds.

16251.8.12 Voltage phase balance sensing shall be provided for the generator and utility supplies. The voltage phase balance sensor shall be user adjustable from 0 - 15% of nominal and shall be factory set at 5% nominal voltage. Activation of an abnormal utility phase balance condition shall cause the generator to start and to transfer on load. The voltage phase balance sensor shall include a transient time delay feature set at 5 seconds.

16251.8.13 Frequency sensing shall be provided for the utility supply to permit load transfer to the utility supply if within nominal limits. The utility frequency sensing function shall be programmable as follows:

–under frequency 40.0–60.0Hz, factory set at 57.0Hz
–under frequency time delay 0–10 seconds, factory set at 5 seconds.
–over frequency 50.0–70.0Hz, factory set at 63.0Hz
–over frequency time delay 0–10 seconds, factory set at 5 seconds.

16251.8.14 Frequency sensing shall be provided for the generator supply to permit load transfer to the generator supply if within nominal limits. The generator frequency sensing function shall be programmable as follows:

–under frequency 40.0–60.0Hz, factory set at 57.0Hz
–under frequency time delay 0–10 seconds, factory set at 5 seconds.
–over frequency 50.0–70.0Hz, factory set at 63.0Hz
–over frequency time delay 0–10 seconds, factory set at 5 seconds.

16251.8.15 An engine start contact shall be provided which shall close to initiate starting of the engine. The engine start contact shall be rated 5A, 120/240VAC, 5A, 28Vdc resistive.

16251.8.16 The following time delay functions shall be provided:

16251.8.16.1 Engine Start - A time delay on engine start shall be provided to delay the engine start signal after failure of the utility source. The time delay shall be user adjustable 0 - 60 seconds, factory set at three (3) seconds.

16251.8.16.2 Engine Warm-up - A time delay for engine warm-up shall be provided which permits transfer to the generator supply after generator voltage and frequency exceed acceptable limits. The time delay shall be user adjustable 0 - 60 minutes, factory set at 2 seconds.

16251.8.16.3 Utility Return - A time delay for return to utility shall be provided which permits transfer to the utility supply only after stable voltage conditions exist for the specified time period. The time delay shall be user adjustable 0 - 60 minutes, factory set at 2 minutes.

16251.8.16.4 Engine Cool-down - A time delay for engine cool-down shall be provided which delays the engine stop signal after load has retransferred to the utility source until the time delay period expires. The time delay shall be user adjustable 0 - 60 minutes, factory set at 2 minutes.

162518.16.5 Neutral Delay - A time delay for neutral position shall be provided to minimize the effect of out-of-phase transfer due to connected motor load. The time delay shall be user adjustable 0 - 120 seconds, factory set at three (3) seconds.

16251.8.17 The transfer controller shall provide a timer bypass function to automatically bypass unwanted delays during testing or maintenance procedures. The timers shall automatically reset on the next operation sequence to their original setting. The following time delays shall have a user initiated bypass feature:

- ❑ Engine Warmup Delay
- ❑ Utility Return Timer
- ❑ Engine Cooldown Timer
- ❑ Neutral Delay Timer

16251.8.18 The re-transfer to utility sequence of operation shall be user selectable for Automatic, or Manual re-transfer operation. When Manual re-transfer mode is selected, the user can initiate when the re-transfer to utility power shall occur.

16251.8.19 Provision for operator-initiated system test modes shall be provided. Test modes shall be programmable for "off load" testing (load does not transfer to generator) or "on load" testing (load does transfer to generator).

16251.8.20 All test modes shall have provisions to enable a programmable security access with password protection if required. A master level password shall be required to change user access passwords.

16251.8.21 Automatic timed test modes shall be provided to allow for tests to be manually initiated and automatically terminated. Timed test modes shall be user adjustable (0-240 minutes). The load shall automatically re-transfer back to the utility supply should the generator fail on load.

16251.8.22 An automatic exercise time function shall be provided for generator testing. A 7/14/21/28 day, programmable time clock shall be provided. The timer shall be fully programmable for; day, week, time of day, duration of the test and type of test mode (i.e. On-Load or Off-Load). The exercise timer shall utilize the transfer controller's internal time clock for referencing all timing functions. The time clock shall have a ten (10) minute power reserve feature to retain correct time settings during short duration utility power failures. The transfer switch shall automatically re-transfer back to the utility supply if the generator set fails during an exercise period.

16251.8.23 Control logic shall be provided for immediate transfer to the utility supply (if within acceptable limits) should the generator set fail during any activated test mode.

16251.8.24 Control logic shall be provided for sensing a transfer switch failure condition, and if the alarm condition is activated, the transfer controller shall automatically force a transfer to the alternate source if available.

16251.8.25 Programmable control logic shall be provided to select desired point at which a "commit to transfer" to the generator supply shall be given to prevent nuisance starts on fluctuating utility supply. The "commit to transfer" point shall be user selected as follows: following expiry of the engine start delay period or following expiry of the warm-up delay period.

16251.8.26 Pilot lights shall be provided to indicate load on utility status (green) and load on generator status (red). Pilot lights to be long life LED type.

16251.8.27 The transfer switch controller shall provide a lamp test function to test all LED lights.

16251.8.28 A programmable contact shall be provided for customer use. The contact shall be a Form **C** contact rated 5A, 120/240VAC resistive and shall have the following user programmable functions:

Utility available (within voltage, frequency & phase balance limits)
Generator source available (within voltage, frequency & phase balance limits)
ATS Control not in auto
Second engine start contact
Utility and Generator sources available
Transfer Fail
Load on Generator
Load on Utility

Load Shed

16251.8.29 Utility Supply Auxiliary Contact (AUX-U)

Three (3) auxiliary contacts shall be provided which operate when the utility source is on load. The auxiliary contacts shall be supplied with a rating of 10A, 120/240VAC, 5A, 28Vdc resistive, Form C.

16251.8.30 Generator Supply Auxiliary Contact (AUX-G)

Three (3) auxiliary contacts shall be provided which operate when the generator is on load. The auxiliary contacts shall be supplied with a rating of 10A, 120/240VAC, 5A, 28Vdc resistive, Form C.

16251.9 OPTIONAL CONTROL FEATURES

Provide the following options if specified on the drawings.

16251.9.1 Utility Supply Auxiliary Contacts (AUX-U)
Additional auxiliary contacts shall be provided which operate when the utility source is on load. A maximum of three (3) additional auxiliary contacts shall be supplied with a rating of 10A, 120VAC resistive Form C.

16251.9.2 Generator Supply Auxiliary Contacts (AUX-G)
Additional auxiliary contacts shall be provided which operate when the generator is on load. A maximum of three (3) additional auxiliary contacts shall be supplied with a rating of 10A, 120VAC resistive Form C.

16251.9.3 Utility Available Light (UAL)
A pilot light shall be provided to indicate the availability of the utility supply condition. Pilot light is to be green, LED type.

16251.9.4 Generator Available Light (GAL)
A pilot light shall be provided to indicate the availability of the generator supply condition. Pilot light is to be green, LED type.

16251.9.5 Utility Power Available Contacts (UPA)
Auxiliary contacts shall be provided which operate when utility power is available. A quantity of __ auxiliary contacts shall be supplied with a rating of 10A, 120VAC resistive Form C.

16251.9.6 Generator Power Available Contacts (GPA)
Auxiliary contacts shall be provided which operate when generator power is available. A quantity of __ auxiliary contacts shall be supplied with a rating of 10A, 120VAC resistive Form C.

16251.9.7 Load Disconnect Contact (LDC)
Control logic shall be provided to signal an external load (e.g. elevator) of an impending transfer to and from the generator supply. A single Form A output contact shall be supplied and shall be rated 10A, 120VAC resistive. The contact shall close prior to a transfer and remain closed until the transfer is completed and the post transfer delay time has expired. A pre-transfer delay function shall be provided, programmable 0 - 30 seconds, factory set at 10 seconds. A post transfer delay function shall be provided, programmable 0 - 30 seconds, factory set at 10 seconds.

16251.9.8 Fail to Transfer Contacts (FTT)

Auxiliary contacts shall be provided which shall activate when the transfer switch mechanism fails to operate within a specified time delay. The time delay shall be programmable 0–30 seconds, factory set at 15 seconds. A quantity of __ auxiliary contacts shall be supplied with a rating of 10A, 120VAC resistive Form C.

16251.9.9 Enclosure Strip Heater c/w Thermostat (TS-H1)

An enclosure strip heater shall be supplied inside the Transfer Switch enclosure and shall be controlled by an adjustable thermostat. An external power source rated 120VAC, single phase; 15A over current protected branch circuit is to be supplied by others.

16251.9.10 Enclosure Strip Heater c/w Thermostat (TS-H2)

An enclosure strip heater shall be supplied inside the Transfer Switch enclosure and shall be controlled by an adjustable thermostat. Power for the strip heater is to be connected to the transfer switch load bus via suitably sized power transfer.

16251.9.11 Shunt Trip Generator Switch (TS-STG)

A shunt trip device shall be provided in the Generator transfer power switching device to provide remote tripping capability for load shedding or load dumping purposes. Shunt trip device shall be rated for 24Vdc 10A control power, which is to be supplied by an external source with required logic and over current protection.

16251.9.12 Shunt Trip Utility Switch (TS-STU)

A shunt trip device shall be provided in the Utility transfer power-switching device to provide remote tripping capability for immediate load dumping purposes. Shunt trip device shall be rated for 24Vdc 10A control power, which is to be supplied by an external source with required logic and over current protection.

16251.9.13 Remote Communication Module (CIM)

A remote communication module shall be provided to remotely monitor and control the transfer switch with direct telephone system interconnection via internal modem or to communicate remotely via RS232 or RS 485 type signal. Communication module is to be provided with remote communication software operable on current version of Windows™ software. Communication module shall provide Modbus™ protocol for interface with external communication systems of same type.

16251.10 EXECUTION

16251.10.1 FACTORY TESTING

The automatic transfer switch shall be factory tested prior to delivery to the purchaser. The following tests shall be conducted by qualified factory personnel:

A. Visual Inspection: Electrical and mechanical inspections to verify installed components are of correct ratings; meet the requirements of the project specifications and to ensure regulatory and quality requirements are met.

B. Mechanical Tests: As a minimum, the following mechanical tests shall be performed

on the transfer switch:

1. Power conductor torque verification
2. Verification of mechanical interlock
3. Manual ATS mechanism operation/adjustment
4. All mechanical fasteners/wire connections tight
5. Electrical Tests: As a minimum, the following electrical tests shall be performed on the transfer switch:
6. Adjustment/setting all timers & voltage sensors
7. Verification of electrical interlock
8. Function test-normal operation- three (3) complete cycles
9. Mechanism adjustment
10. Dielectric test16251.4.1.4 Final Inspection: As a minimum, the following final inspection tasks shall be performed on the transfer switch:
11. Calibration label/equipment labels installed and correct
12. All safety/warning labels attached
13. All wiring straight, neatly bundled and adequately protected.
14. All options supplied as specified
15. Enclosure is clean, no paint imperfections
16. Final documentation is enclosed (Drawing, O&M Manual)
17. The transfer switch manufacturer shall provide upon request of the project engineer, four (4) copies of certified Factory Test Reports for the transfer switch supplied.

16251.11 FIELD TESTING/COMMISSIONING

The automatic transfer switch shall be tested once installed at the project site to confirm proper operation of the system. Schedule and witness testing activities shall be coordinated with the project engineer, site contractor, and owner as required in advance of the testing. Qualified local factory-trained field service representatives shall conduct the following tests:

A. Visual Inspection: Electrical and Mechanical inspection to verify the installation is correct as recommended by the transfer switch manufacturer and as per NEC/CEC requirements.

B. Mechanical Tests: As a minimum, the following mechanical tests shall be performed on the transfer switch:

1. Power conductor torque verification
2. Verification of mechanical interlock
3. Manual ATS mechanism operation
4. All mechanical fasteners/wire connections tight
5. Confirmation of correct transfer switch voltage, current and withstand ratings as is required for the application.

C. Electrical Tests: As a minimum, the following electrical tests shall be performed on the transfer switch:

1. Meggar testing the power cabling to the transfer switch.
2. Verification of correct power cabling phasing and phase rotation, prior to energization.
3. Confirmation of settings for all timers and voltage sensors.

D. Full function test - normal operation – three (3) complete cycles of failing the utility

supply, and transfer load to/from the generator set.

E. Verification of all test modes operates correctly.

F. Qualified factory-trained field service personnel shall provide upon request of the project engineer four (4) copies of field test reports noting any deficiencies that require corrective action.

Acceptable model shall be a **Thomson Technology TS 880** series service entrance rated automatic transfer switch or approved equal.

16251.12 METHOD OF MEASURMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 15010SP.

16251.13 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

PAY ITEM	UNIT
Automatic Transfer Switch	Each

16400.1 GENERAL

16400.1.1 APPLICABLE SECTIONS

The General Conditions, Supplementary General Conditions, Special Conditions, Alternates and addenda, applicable drawings and the technical specifications herein shall apply to all work under this Division 16.

16400.1.2 SCOPE

Provide all operations, methods, labor and equipment and provide and install all materials and incidentals necessary for the completion of the work as specified herein or included on the drawings.

16400.1.3 WORK INCLUDED

A. Electrical work required for this work is shown on the drawings and includes, but is not necessarily limited to:

1. Complete new electrical distribution system for power and lighting as shown.

2. Complete system of raceways and outlets for Control and all other auxiliary systems of this Division 16. Unless noted otherwise, the equipment and wiring of these auxiliary systems will be furnished and installed under their respective sections; however, the conduit raceway systems will be furnished and installed under this Section 16400.

3. All excavating, backfilling, compacting, and grading required for the installation of all work covered under this Division 16.

B. Shall furnish and install all component parts of all the systems required for their safe and proper operation, whether or not specifically mentioned or noted on the drawings, except those items or articles which are specifically noted hereinafter as being supplied otherwise.

C. Perform all trenching and backfilling required in connection with the work of this section in strict accordance with the provisions of Division 02000 of these specifications.

D. Provide all required electrical connections and service to items described in all other sections of these specifications. Provide all those services outlined in other divisions of the specifications as being done by the electrical sub-contractor.

16400.1.4 RELATED WORK SPECIFIED ELSEWHERE:

Section 16010 - Electrical General Requirements
Section 16050 - Basic Materials and Methods
Section 16410 - Fuses
Section 16500 - Lighting

16400.2 PRODUCTS

16400.2.1 DISTRIBUTION PANELBOARDS

A. Distribution panelboards shall be factory assembled dead front, wall mounted as scheduled and braced for the indicated ampere rms symmetrical with equipment, bussing

connections, circuit breakers and all similar components indicated on the drawings or required for proper completion. Each breaker shall have an etched micarta nameplate secured by two cadmium plated screws. Nameplates shall indicate equipment served as shown in schedule. Busses shall be copper of a maximum current density of 1000 amperes per inch and shall be equipped with uninsulated equipment ground bus. Three phase, 4-wire panels shall have full capacity neutral bus.

B. All floor mounted panels shall be mounted on a **4" housekeeping pad** and therefore to comply with NEC, the operating handles of switches and breakers shall be no more than 6'-2" above the bottom of the panel.

C. Distribution panel boards shall be wall mounted as indicated in schedules. For access to wiring gutters, panel shall be door within door construction. Shall be Square D, I-Line or equal of Siemens I.T.E., Cutler Hammer/Westinghouse or General Electric.

16400.2.2 BRANCH CIRCUIT PANELBOARDS

A. Branch circuit panelboards shall be Square D for the scheduled voltage, 3 phase, 4 wire operation or equal of Siemens, or General Electric. Shall be equipped with bolt-on breakers. Minimum width shall be 20 inches. Minimum depth shall be 5.75 inches. Panel trims shall be of the door within door construction.

B. Busses shall be copper.

C. Branch circuit breakers shall be provided per schedules on drawings. All multi-pole breakers shall be common trip.

D. Doors shall be complete with corrected circuit schedule on inside. Panels shall be NEMA 3R type construction.

16400.2.3 DRY TYPE TRANSFORMERS

A. General Purpose Dry-Type Transformers: (Under 600 volts)

1) General: Furnish and install at locations shown on the drawings dry-type two winding power transformers for general power and lighting applications indicated. Transformers shall be UL listed and bear the required Listing Mark.

2) Electrical Rating: Shall be 60 hertz of sizes, phases, high voltage and low voltage as scheduled on the drawings. Each transformer, unless specifically noted otherwise, shall have six (6) 2-1/2% full capacity taps, two above and four below nominal voltage in the high voltage winding.Temperature Classification: Each transformer shall utilize an insulation system that has been properly temperature classified and approved by Underwriters' Laboratories. Unless specifically noted otherwise, the insulation classification shall be 220 C with 150 C winding temperature rise in accordance with Underwriters' Laboratories specification UL506.

3) Load Rating:

a. Each transformer supplied to this specification shall be capable of operating at 100% of nameplate rating (NPR) continuously while in an ambient temperature not exceeding 40°C and shall be capable of meeting the daily overload requirements of ANSI Standard C57.96 as stated in the following chart:

PERMISSIBLE ONCE DAILY OVERLOADS WITH NORMAL LIFE MAINTAINED			
	Peak Load Following and Followed by a Constant Load of		
Peak Load Time (Hours)	90% NPR	70% NPR	50% NPR
1/2	162% NPR	185% NPR	200% NPR
1	138% NPR	148% NPR	152% NPR
2	123% NPR	128% NPR	133% NPR
4	113% NPR	115% NPR	118% NPR
8	106% NPR	107% NPR	108% NPR
NPR = Nameplate Rating			

b. Transformer loaded in accordance with this paragraph shall be capable of long service life under the thermal conditions specified. There shall be no need for derating.

4) Sound Rating: Each transformer shall have sound levels equal or lower than those established in the latest revision of ANSI Standard C89 as shown in the following chart:

Transformer Rating KVA	Maximum Sound Level Decibels
10-50	45
51-150	50
150-300	55

5) Other Requirements: The following requirements shall be in accordance with Underwriters' Laboratories specification UL506:

a. Enclosure:

(i) Ventilation openings
(ii) Corrosion resistance
(iii) Cable bending space
(iv) Grounding provisions
(v) Surface temperature rise
(vi) Wiring compartment temperature rise
(vii) Terminations

6) Test Requirements:

a. Each transformer furnished to this specification shall be subjected to the following production tests:

(i) Applied potential

(ii) Induced potential
(iii) No load losses
(iv) Voltage ratio
(v) Polarity
(vi) Continuity

b. The manufacturer shall have performed the following additional tests on units identical to the design type being furnished to this specification. Proof of performance of these lists in the form of test data sheets shall be provided as part of the shop drawing submittal.

(i) Sound levels
(ii) Temperature rise tests
(iii) Full-load losses
(iv) Regulation
(v) Impedance

7) Shop Drawings: Submit shop drawing for review prior to delivery to job site.

16400.3 EXECUTION

16400.3.1 INSTALLATION OF GROUNDING SYSTEM

A. The conduit system and neutral conductor of the wiring system shall be grounded to the cold water pipe having a continuous path to earth in compliance with grounding provisions as outlined in the NEC. Point of connection to the water system shall be as near as practicable to the service entrance. Provide bonding jumper same size as system ground to provide ground continuity from customer's side of metallic lines service entrance and street side of metallic mains. The neutral and ground shall be connected together at the main service switch only.

B. Where the water main is not metallic, delete water pipe ground requirements and provide a concrete encased electrode consisting of a 20-foot length of #3/0 bare copper conductor tied to the steel reinforcing bars and encased within a concrete footing. This footing shall be in direct contact with earth and located near the main panel.

C. The Contractor shall also install a made electrode ground system consisting of copperclad rods spaced not closer than six feet apart. Grounding conductors and connections to ground rods shall be protected from damage and shall be placed to avoid disconnect by unauthorized personnel. Interconnect with water pipe ground system.

D. The equipment grounding system shall be such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with the electrical circuits operate continuously at ground potential and provide a low impedance path for the possible ground fault currents. The system shall comply with the National Electrical Code, modified as indicated on the drawings or specifications and as hereinafter specified to incorporate a maximum 25 ohms ground resistance. Grounding connections shall be accessible for inspection.

E. The distributions system shall be provided with a separate equipment grounding conductor for each single or three-phase feeder, each branch circuit with a multi-pole protective device and each single phase receptacle and motor circuit as indicated. The required grounding conductor shall be installed in the common raceway with the related phase and/or neutral conductors. Single-phase branch circuits required for lighting, shall

consist of phase and neutral conductors installed in common metallic conduit which shall serve as the grounding conductor. Conduit equipment connections utilized in conjunction with the above single-phase branch circuits shall be provided with suitable bonding jumpers connected to approved grounding type bushings. Single-phase branch circuits and all branch circuits installed in flexible conduits shall be provided with a separate grounding conductors as hereinbefore specified for the multi-pole branch circuits.

16400.3.2 INSTALLATION OF PANELS

A. Installation: Unless otherwise indicated on the drawings, install wall panels with the top of the trim 6'-0" above the finished floor. Panels located in equipment rooms and wire closets shall be surface mounted. Floor mounted panels shall be provided with a 4" concrete housekeeping pad. Floor mounted panels shall be anchored to floor at all four corners and to wall or structural member at top for seismic restraint.

B. Directories: Mount a typewritten directory behind glass or plastic on the inside of each panel door. On the directory, show the circuit number and complete description of all outlets with specific locations on each circuit. In addition, provide a typewritten label inside door showing source of power to panel both as to feeder switch, panel designation and location within buildings.

16400.3.3 GENERAL PURPOSE DRY TYPE TRANSFORMERS

General purpose dry transformers shall be mounted on floor at locations shown on drawings. Each shall be anchored to floor by means of a minimum of four 1/2" x 6" anchor bolts grouted in existing concrete floor.

16400.3.4 TESTING

A. General: Upon completion of this portion of the work, test all parts of the electrical system in the presence of the Engineer Owner's Representative.

B. Test Requirements: All systems shall test free from short circuits and grounds, shall be free from mechanical and electrical defects, and shall show an insulation resistance between phase conductors and ground of not less than that required by the National Electrical Code.

16400.3.5 FINAL INSPECTION

A. This Division 16 contractor's job foreman shall be present at the final inspection of the work by the Owner.

B. Electrical job foreman shall have pad and pencil to list all deficient items noted. Corrections and adjustments of deficient items shall be done after the inspection, not during.

C. See Section 16050 for other requirements for final inspection.

16400.4 METHOD OF MEASUREMENT

16400.4.1 SERVICE ENTRANCE. Provide all conduit, sweeps, support members, transformer pads, grounding equipment, breakers, disconnects, enclosures, conductors, and appurtenances as required by the local utility, and as shown on the drawings and as defined in the applicable sections of the specifications required for a complete and fully functioning system.

16400.4.2 GROUNDING SYSTEM. Provide all grounding conductors, connections, ground rods, ground wells, and associated appurtenances and as shown on the drawings, and as defined in the applicable sections of the specifications.

16400.4.3 POWER PANEL (PP) OR MOTOR CONTROL CENTER (MCC). Provide all conduit, sweeps, pull boxes, power panels, motor starters, motor savers, motor control center, transient voltage surge suppressor (TVSS), support members, grounding equipment, breakers, disconnects, enclosures, conductors, and appurtenances as shown on the drawings and as defined in the applicable sections of the specifications required for a complete and functioning system.

16400.4.4 DRY TYPE TRANSFORMERS. Provide dry type transformer and appurtenances as shown on the drawings and as defined in the applicable sections of the specifications required for a complete and functioning system.

16400.4.5 LIGHTING PANEL (LP). Provide all conduit, sweeps, support members, grounding equipment, breakers, disconnects, enclosures, conductors, switches, receptacles, and appurtenances as shown on the drawings and as defined in the applicable sections the specifications required for a complete and functioning system.

16400.5 BASIS OF PAYMENT

16400.5.1 No separate payment shall be made for furnishing or installing electrical systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the Contractor.

16400.5.2 When electrical systems, components, or materials are measured for a new building or enclosure as shown on the Bid Schedule, separate payment will be made as listed below.

16400.5.3 When initial installation or replacement of electrical systems, components, or materials is made in an existing building as shown on the Bid Schedule, the accepted quantity will be paid for at the contract price listed below:

PAY ITEM	UNIT
Service Entrance	Lump Sum
Grounding System	Lump Sum
Power Panel or Motor Control Center	Lump Sum
Dry Type Transformers	Lump Sum
Lighting Panel (LP)	Lump Sum

16815 GENERAL

16815.1 INTENT

It is the intent of these specifications to procure for the owner a generator set, new and to the best industry standard of construction and design. The generator shall be of certified output by the manufacturer. Any major exception to this specification will be sufficient cause for rejection of bids.

16815.1.1 RATING: STANDBY

The generator shall deliver its rating continuously for the duration for any normal power failure. This rating is applicable for supplying emergency power for the duration of the utility power outage. No overload capability is available for this rating. The generator set shall be capable of being operated at rated power until the normal power is restored. The rating will be applied where reliable normal power is available. The standby rated engine shall be sized for a maximum of 80% average load factor and 200 hours of operation per year. The standby generator set shall be started and accelerated to rated speed immediately upon loss of normal power when equipped with cold starting aids such as a jacket water heater. The generator set shall accept load in one step up to the engine capability to recover to rated speed. Where load conditions are sensitive to voltage and frequency variations, the generator set must be sized accordingly.

16815.1.2 ENVIRONMENT

Altitude: 5000 feet
Minimum Temperature: -20 °F
Maximum Temperature: 104 °F

The engine generator set shall be capable of producing rated kW and kVA when operating at the above stated altitude and temperature range. The generator manufacturer shall provide data to verify the generator set will operate as required in the specified ambient conditions.

16815.1.3 SUBMITTAL INFORMATION

1. Current applicable literature completely describing the engine generator set.

2. Current applicable literature describing all accessories.

3. Complete dimensional and electrical drawings locating accessories, anchor bolt and mounting dimensions, fuel, exhaust and cooling piping connections. All information will be coordinated with the installing contractor.

4. Furnish the following information with the bid:
   - Engine manufacturer.
   - Number of cylinders/inline or vee.
   - Bore and stroke/piston speed @ rated rpm.
   - Brake Mean Effective Pressure (BMEP) @ rated capacity (kW).
   - Displacement in cubic inches.
   - Generator Capacity in kW, kVA and power factor.
   - NEMA MG1-22.40 temperature rise rating of insulation of generator.
   - Type of generator exciter.

Certified engine horsepower at the ambient temperature and elevation specified.

16815.2 ENGINE AND COMPONENTS

A. Starting System
The engine will be equipped with an electric, DC starting motor, positive engagement, of sufficient capacity to crank the engine at starting speed for one minute without overheating.

B. Fuel System: The fuel storage tank, fittings, gauges and piping shall be supplied and installed by the installing contractor, in accordance with NFPA and applicable local codes and as specified.

C. Cooling System: Unit Mounted
A unit mounted radiator will be furnished complete with a blower fan and glycol coolant. The maximum radiator airflow restriction of 0.5 inches. WC must be taken in account when sizing the cooling system. The cooling system will be sized to maintain a safe engine temperature at the appropriate ambient conditions. Proper ducting must be used to prevent overheating.

D. Exhaust System: Critical
The silencer shall attenuate exhaust noise to a Critical level. An Exhaust silencer shall be furnished of industrial standard construction, all welded, for stationary engine application. A seamless, stainless, convoluted flexible exhaust connector shall be provided. The entire exhaust system and silencer shall be supported independently of the generator set to prevent transmission of vibration and allow for thermal expansion. Long radius, low restriction fittings will be used throughout, and pipe size will be sufficiently large to handle the engine exhaust flow at full load without causing back pressure in excess of that allowed by the engine manufacturer.

E. Engine Lubrication System
The engine shall be furnished with a gear type lube pump that will furnish oil under pressure to moving parts. Full flow lube oil filters shall be provided in addition to a bypass valve that will allow lube oil circulation in the event of a failure of the filtering system.

F. Governing System: Isochronous Zero Speed Droop Governing System
The engine generator set shall be provided with a precision electronic governor of the constant speed type. The governor shall be capable of maintaining a steady state bandwidth of not more than ±0.25%, at any constant load, from no load to full load. The governor shall maintain governed speed at 60 Hertz at any load, from no load to full load.

G. Battery: Lead Acid
A lead-acid, heavy duty battery shall be furnished of sufficient capacity to provide a minimum of five full cycle starts for ten seconds crank with ten second rest periods between cranks. The lead acid battery will be 12 volt or 24 volt as required by the engine specification. The commercial type lead acid battery will include a manifold vent which eliminates corrosion gases away from the terminals and cables. The cells of the battery will be bonded and the partition inter-cell connectors will create a shorter current path to deliver more power to the terminals.

H. Battery Charger: NRG 22-10-RCLS
Battery Charger Design Guidelines:

Charger shall be designed for heavy-duty industrial service and capable of full-rated output indefinitely at temperatures between -20º C and +60º C. Charger shall be capable of recharging a fully discharged battery of the maintenance-free lead acid, conventional (wet) lead acid or nickel-cadmium type. Charger shall maintain the battery automatically and minimize the need for battery electrolyte replenishment. Conservatively rated SCRs

and diodes in full-wave bridge shall be used. A crank disconnect relay shall not be required to protect the charger from overload. Charger shall be unit mounted and natural convection cooled. The housing shall be constructed of rustproof metal (e.g. aluminum) and treated with a protective coating.

Battery Charger Standards:

Where required, the charger shall be listed by UL, ETL or another recognized testing authority to the most recent revision of UL specification 1236. The manufacturer shall maintain a comprehensive quality control system and shall be ISO 9001 or ISO 9002 registered.

Battery Charger Input:

Charger standard is 60 Hz (57 to 63 range). Nominal input voltage shall be (110-120 / 208-240 VAC, ± 10%, single phase, switch selectable). Charger shall incorporate a soft-start feature in which the output is gradually increased from zero to full, required output within 5 to 10 seconds. Input protection shall consist of fuses or circuit breakers. Proven surge suppression devices shall be fitted.

Battery Charger Output:

General Characteristics: Output voltage shall be (12 or 24) volts nominal. Float voltage shall be adjustable from 100% to 120% of nominal. Equalize voltage shall be adjustable up to 15% above float voltage. Output voltage adjustments shall be made from jumpers in the charger. Charger shall incorporate automatic current limiting with a rectangular current limit characteristic, and shall be capable of operating into a short circuit or dead battery indefinitely without damage or overheating. Charger shall be equipped with output fuses or circuit breakers.

Regulation and Temperature Compensation: Voltage regulation shall be within ± .5% of the correct temperature-compensated value from no load to full load with simultaneous variations of +10% input voltage and +5% input frequency. The DC output shall be constant voltage and current limited. The charger's current limit is 105% rated output. Input transient protection shall be provided. The charger shall be protected against damage by reverse connection of the battery.

The charger shall be equipped with an automatic high rate (equalize) charge facility operating in response to the battery's state of charge. Charger shall operate at the high rate until the battery is fully charged, then revert to float voltage to prevent overcharging. High rate operation shall be governed by the requirement of the battery. Mechanical or electronic timers shall not be used.

Charger shall incorporate automatic ambient temperature compensation to maximize battery performance and life. Temperature coefficient shall be (-0.18%) per degree C to assure correct charging in all temperatures.

Charger shall automatically compensate for voltage drop in the charging leads to prevent charging errors due to long cable runs.

Float/Equalize control: charger shall include an automatic equalize feature that is activated when the battery's state of charge is reduced. individual adjustment potentiometers shall be provided for float voltage, boost voltage and alarm voltages.

Optional features:

Input Frequency 50/60 Hz

Remote Temperature Compensation Sensor

Drip Shield

NEMA 3R Housing

The battery charger shall incorporate an alarm system (optional) providing indication of charger and battery status by LED displays and form C contacts. Separate contacts for AC fail, low-battery voltage, high-battery voltage, charger fail, and battery fault.

I. Engine Block Heater: Extreme Cold -20° F
A jacket water heater shall be provided which will be thermostatically controlled to maintain the engine block at a suitable temperature to assure rapid starting under the specified ambient temperature. The heater will be of the industrial tank type with thermo-syphon circulation.

16815.3 GENERATOR AND COMPONENTS

A. Generator Performance Rating
250 kW
312.50 kVA
480 Volts
3 Phase
.08 Power Factor
60 Hertz
1800 RPM

B. Mainline Circuit Breaker: Electronic Trip 100% rated
A molded case circuit breaker shall be provided for the protection of the generator.

All circuit breakers shall be listed by Underwriters' Laboratories, Inc., conform to applicable requirements of NEMA Standard Publication No. AB1 and meet appropriate classifications of Federal Specifications W C 37511/Gen.

All circuit breakers shall have a quick-make, quick-break over center toggle-type mechanism and the handle mechanism shall be trip-free to prevent holding contacts closed against a short circuit or sustained overload. All circuit breaker handles shall assume a position between on and off when tripped automatically. Multi-pole circuit breakers shall be common-trip such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Arc extinction is to be accomplished by magnetic arc chutes. All ratings are to be clearly visible.

Automatic operation of all circuit breakers shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. Circuit breakers shall be calibrated to carry 100% rated current in an ambient of 40 C. Circuit breakers shall be ambient compensation that, as the ambient temperature increases over 40 C the circuit breaker automatically derates itself so as to better protect its associated conductor. The instantaneous magnetic trip shall be adjustable and accessible from the front.

The interrupting rating of the circuit breakers shall be at least equal to the available short circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short circuit current rating specified.

The circuit breaker shall be sized to comply with UL2200.

C. Voltage Regulator: DVR (Digital Voltage Regulator)
The alternator shall be salient-pole, brushless, 12-lead reconnect able, self-ventilated of drip-proof construction with amortisseur rotor windings and skewed stator for smooth voltage waveform. The insulation shall meet the NEMA standard - MG1-22.40 and 16.40 - for Class H and be insulated with epoxy varnish to be fungus resistant per MIL 1-24092. Temperature rise of the rotor and stator shall be limited to NEMA Class F ratings. The excitation system shall be of brushless construction controlled by a solid- state voltage regulator capable of maintaining voltage within +/- 2% at any constant load from 0% to 100% of rating. The regulator must be isolated to prevent tracking when connected to SCR loads, and provide individual adjustments for voltage range, stability and volts-per-hertz operations; and be protected from the environment by conformal coating.

The generator set shall meet the transient performance requirements of ISO 8528-5, level G-2.

The generator, having a single maintenance-free bearing, shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.

The generator shall be inherently capable of sustaining at least 250% of rated current for at least 10 seconds under a 3-phase symmetrical short circuit without the addition of separate current support devices.

PMG Excitation System

The generator shall be equipped with a 300/250 Hz permanent magnet generator excitation system. Both the PMG and the rotating brushless exciter shall be mounted outboard of the bearing. The system shall supply a minimum short circuit support current of 300% of the rating for 10 seconds; or 250% for 50 hertz operation for 10 seconds. The rotating exciter shall use a three phase full wave rectifier assembly with hermetically sealed silicon diodes protected against abnormal transient conditions by a multi-plate selenium surge protector. The diodes shall be designed for safety factors of 5 times voltage and 3 times current.

VOLTAGE REGULATOR

The DVR2000E voltage regulator shall be a digital, microprocessor design with solid state voltage build-up. No voltage build-up relay or other relays are acceptable. The unit shall be encapsulated for humidity and abrasion protection. The regulator shall include 1/4% regulation, true volts per hertz operation with adjustable cut in, loss of sensing continuity shutdown, over excitation shutdown, three phase RMS sensing, over voltage protection, and provisions for parallel operation.

PERFORMANCE

The voltage regulation shall be 1/4% from no load to full load and 5% frequency variation. Regulator drift shall be less than 1/2% per 72°F /40°C ambient temperature change. The voltage regulator shall be a static-type using non-aging silicon controlled rectifiers, with electromagnetic interference suppression to MIL-STD-461 C, part 9, when mounted in the generator conduit box. The waveform harmonic distortion shall not exceed 5% total RMS measured line to line at full-rated load. The TIF factor shall not exceed 50. Construction will allow connection to the load through the top, bottom or either side of the conduit box. The conduit box shall be constructed of heavy gauge sheet steel, capable of supporting up to 240 pounds of accessory control equipment. The conduit box shall contain two compartments; one housing the rotating rectifier and PMG; and the other the connection area and regulator. This is to separate the

rotating elements from the load connection and voltage regulator adjustments. The regulator shall be mounted on the inside of the conduit box panel allowing access to adjust the regulator through a swinging dust cover from the outside of the conduit box, therefore avoiding the higher voltage generator terminals on the inside of the conduit box.

VERIFICATION OF PERFORMANCE

All certified performance and temperature rise test data submitted by the generator manufacturer are to be the result of the actual test of the same or duplicate generators. Temperature rise data shall be the result of loaded, rated power factor heat runs at the rated voltage and hertz. All performance testing shall be done in accordance with MIL-STD-705 and/or IEEE Standard-115.

16815.3.1 CONTROL PANEL: DGC 2020 (EXPANDED)

MTU Onsite Energy's Digital Genset Controller (DGC-2020) is a highly advanced integrated genset control system. The DGC-2020 is perfectly focused, combining rugged construction and microprocessor technology to offer a product that will hold up to almost any environment and flexible enough to meet your application's needs. This device provides genset control, transfer switch control, metering, protection and programmable logic in a simple, easy to use, reliable, rugged, and cost effective package.

Standard Features

- Generator Metering
- Engine Monitoring
- Genset Control
- Emergency Stop
- Engine Protection
- Windows-Based Software (BESTCOMSPlus)
- Automatic Transfer Switch Control
- Event Recording
- Suitable for use on rental gensets with Hi/Lo line sensing or single or three phase sensing override
- SAE J1939 Engine ECU Communications (Expandable I/O Capability)
- Modbus Communications via RS-485
- Multilingual Capability (English, Spanish, Chinese)
- Extremely Rugged, Fully Encapsulated Design
- 16 Programmable Contact Inputs
- 10 Programmable 2 Adc Form A Rated Contacts
- Wide Ambient Temperature Range
- NFPA110 Compatible
- HALT (Highly Accelerated Life Tests) Tested
- IP 54 Front Panel Rating with Integrated Gasket
- LCD Heater
- UL-508 Compatible
- UL Recognized, CSA Certified, CE Approved
- Current Sensing (5A CT Inputs)
- Generator Frequency - 50/60 Hz
- Battery Backup for Real Time Clock
- Generator Protection (27, 32, 40Q, 59, 81O, 81U)

Genset Protection

- Undervoltage (27)
- Reverse Power (32)
- Loss of Excitation (40Q)
- Overvoltage (59)
- Overfrequency (81O)
- Underfrequency (81U)

All Generator Protection features are programmable as alarms, pre-alarms, status or not used.

Engine:

Alarms (Shutdown)

- Low Oil Pressure
- High Coolant Temperature
- Low Coolant Level
- Low Fuel Level
- Overspeed
- Overcrank
- Engine Sender Unit Failure
- Fuel Leak/Fuel Sender Failure
- Emergency Stop
- Battery Charger Failure

Pre-Alarms (Warnings)

- Low Oil Pressure
- High Coolant Temperature
- Low Coolant Temperature
- Battery Overvoltage
- Weak Battery
- Battery Charger Failure
- Engine Sender Unit Failure
- Engine kW Overload (3 levels)
- Maintenance Interval Timer
- Low Coolant Level
- Low Fuel Level
- Fuel Leak Detect
- High Fuel Level
- Critical Low Fuel Shutdown

All alarms and pre-alarms can be enabled or disabled via the BESTCOMSPlus PC software or the front panel.

Genset Metering:

- Generator parameters consist of 8 standard parameters including, but not limited to voltage, current, Hz, real power (watts), apparent power (VA), and power factor. The view can be programmed to display up to 20 parameters using the scrolling and time delay feature.
- Engine parameters include oil pressure, coolant temperature, RPM, battery voltage, fuel level, engine runtime, and various J1939 supported parameters.

Engine Control:

- Cranking Control: Cycle or Continuous (Quantity and Duration Fully Programmable)
- Engine Cooldown: Smart Cooldown function saves fuel and engine life.
- Successful Start Counter: Counts and records successful engine starts
- Timers including, but not limited to:
  - Engine Cooldown Timer
  - Engine Maintenance Timer
  - Pre-Alarm Time Delays for Weak/Low Battery Voltage
  - Alarm Time Delay for Overspeed
  - Pre-Crank Delay
  - Continuous or Cycle Cranking Time Delay
  - Arming Time Delays after Crank Disconnect:
    - Low Oil Pressure
    - High Coolant Temperature

Event Recording:

The DGC-2020 has an event recorder that provides a record of alarms, pre-alarms, engine starts, engine runtime loaded, engine runtime unloaded, last run date, and many other events that are all date and time stamped to help the user determine the cause and effect of issues related to the generator set. Contains 30 event records each retaining up to 99 occurrences in memory. Time, date and engine hour detail is available for the most current 30 occurrences within each event record.

Specifications:

Metering:

- Generator Voltage (rms)
- Generator Current (rms)
- Generator Frequency
- Apparent Power
- Power Factor
- Real Power
- Oil Pressure
- Coolant Temperature
- Fuel Level
- Battery Voltage
- Engine RPM
- Engine Run Time
- Maintenance Timer

Operating Power:

- Nominal: 12 or 24 Vdc
- Range: 6 to 32 Vdc
- Power Consumption: - Sleep Mode: 5W with all relays non-energized
- Power Consumption: - Typical Operational Mode: 14.2W - Run mode, LCD heater on, 6 relays energize
- Battery Ride Through: Withstands cranking ride-through down to 0 V for 50 ms (typical)

Current Sensing:_____5 Amps AC Current Sensing

Continuous Rating .....0.1 to 5.0 Amps AC

1 Second Rating.....10 Amps AC
Burden .....1 VA

Voltage Sensing:

- Range: 12 to 576 V rms, line-to-line
- Frequency Range:10 to 72 Hz for 50/60 style
- Burden: 1 VA
- 1 Second Rating: 720 V rms

Contact Sensing/Input Contacts:

- Contact sensing inputs include 1 emergency stop input and 16 programmable inputs. The factory utilizes up to (3) of these inputs. The emergency stop input accepts normally closed, dry contacts. The remote emergency stop is limited to 75 ft. standard. Extended runs are available with optional relay. All programmable inputs accept normally open, dry contacts.

Engine System Inputs:

- Fuel Level Sensing Resistance Range: 33 to 240 Ω nominal
- Coolant Temperature Sensing Resistance Range: 62.6 to 637.5 Ω nominal
- Oil Pressure Sensing Resistance Range: 34 to 240 Ω nominal
- Engine Speed Sensing: Magnetic PickupVoltage Range: 3 to 35 V peak (6 to 70 V peak-peak)

Frequency Range: 32 to 10,000 HzGenerator Voltage Range: 12 to 576 V rms

Output Contacts:

- 15 Form A Total Programmable Outputs: (3) 30 Adc and (12) 2 Adc
  - The factory typically utilizes (5) on each gen-set which can be reprogrammed as needed:
    - (3) 30 Adc for Run, Start and Pre-Start
    - (2) 2 Adc for Audible Alarm and Alarm Output
  - (10) 2 Adc remain as user-defined outputs

Generator Protection Functions:

Overvoltage (59) and Undervoltage (27)

Pickup Range: 70 to 576 Vac
Activation Delay Range: 0 to 30 s

Underfrequency (81U) and Overfrequency (81O)

Pickup Range: 45 to 66 Hz (50/60 Hz nominal), 360 to 440 Hz (400 Hz nominal)
Pickup Increment: 0.1 Hz (50/60 Hz nominal), 0.1 Hz (400 Hz nominal)
Activation Delay Range: 0 to 30 s

Reverse Power (32)

Pickup Range: –50 to 5%
Pickup Increment: 0.1%
Hysteresis Range: 1 to 10%
Hysteresis Increment: 0.1%
Activation Delay Range: 0 to 30 s
Activation Delay Increment: 0.1 s

Loss of Excitation (40Q)

Pickup Range: –150 to 0%
Pickup Increment: 0.1%
Hysteresis Range: 1 to 10%
Hysteresis Increment: 0.1%
Activation Delay Range: 0 to 30 s
Activation Delay Increment: 0.1 s

Environmental:

Temperature: Operating: -40 to 70°C (-40 to 158°F), Storage: -40 to 85°C (-40 to 185°F)
Humidity: IEC 68-2-38
Salt Fog: ASTM B 17-73, IEC 68-2-11 (tested while operational)
Ingress Protection: IEC IP54 for front panel
Vibration:

5 to 29 to 5 Hz: 1.5 G peak for 5 min.
29 to 52 to 29 Hz: 0.036" DECS-A for 2.5 min.
52 to 500 to 52 Hz: 5 G peak for 7.5 min.

Swept over the above ranges for 12 sweeps in each of 3 mutually perpendicular planes with each 15-minute sweep.

Agency Approvals:

• UL/CSA Approvals: "cURus" approved to UL 508 R and CSA C22.2 No.14
• NFPA Compliance: Complies with NFPA Standard 110, Standard for Emergency and Standby Power.

CE Compliance:

This product complies with the requirements of the following EC Directives:

• Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
• Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC
• EN 50178:1997 - Electronic Equipment for use in Power Installations
• EN 61000-6-4:2001 - Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments
• EN 61000-6-2:2001 - Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments

ADDITIONAL SPECIFICATIONS

The DGC-2020 has been designed to provide maximum functionality at a minimum price. You only buy what you need. Below are options selected to help maximize the value provided by the DGC-2020.

Battery Backup for Real Time Clock

A ten-year (typical life) lithium battery is used to provide long-term maintenance of the real time clock setting. This battery is serviceable by removing the rear cover. The settings, programming, and event records are saved in nonvolatile memory and do not require battery backup.

Additional Control Panel Accessories:

4 Relay Package

16815.3.2 REMOTE ANNUNCIATOR: RDP-110 ANNUNCIATOR PANEL (FLUSH)

Analog and Digital Remote Annunciator Panels:

Meet NFPA-110 and NEC Section 700-12 requirements
Designed for use in harsh environments

PANEL COMPONENTS:

- Audible alarm horn rated at 80 db
- Surface or flush mounting
- Lamp test and alarm silence switches
- Analog panel requires 12, 24 volt DC; Digital panel requires 12, 24 volt DC or 120 volt AC power supply input
- Conduit box with knockouts on top, bottom, and either side

Pre-alarms that can be enabled:

- High coolant temperature
- Low coolant temperature
- Low oil pressure
- Low fuel level
- Battery over-voltage
- Weak battery
- Battery failure

Other safety features displayed on panel are display panel on and EPS supplying load.

16815.3.3 BASE DESIGN

The base shall be constructed of steel. The base shall be designed to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base shall permit skidding in any direction during installation and shall withstand and mitigate the effects of synchronous vibration of the engine and generator. The base shall be provided with suitable holes for anchor bolts.

16815.3.4 VIBRATION ISOLATION: SEISMIC SPRING

Unit shall be mounted on seismic vibration isolator sized to the weight of the set. These have horizontal and vertical restraints.

16815.3.5 FUEL STORAGE

SUB BASE TANK: 24 hours of operation

A Sub-Base skid mounted fuel tank will be supplied.

A. Sub Base Tank Construction

Sub base tank shall be Tramont or approved equivalent.
Be constructed in accordance with Underwriters Laboratories Standard UL-142.
Be constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; The Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and The Standard for Emergency and Standby Power Systems, NFPA 110.
Be rectangular in shape. Include reinforced steel box channel for generator support, with load rating of 5,000 lbs. per gen-set mounting hole location. Full height gussets shall be provided at gen-set mounting holes.

Be pressure washed with an iron phosphate solution. Interior shall be coated with a solvent-based film rust preventative, providing inter-operational protection.
Be shipped with a certificate of Structural/Mechanical Integrity, certifying that it has met standards through rigorous testing and has demonstrated specified capabilities.

B. Sub Base Tank Testing

Primary tank sections shall be pressurized at 3-5 psi and leak-checked to ensure integrity of sub base weld seams per UL-142 standards. Containment basin shall be leak-checked by means of weld penetrant and ultraviolet light.

C. Sub Base Tank Fittings

The sub base tank shall include the following fittings:

- Appropriately sized NPT fuel supply
- Fuel return fitting
- 1-1/4 inch NPT for normal vent
- NPT for emergency vent, sized as appropriate
- 2 inch NPT for manual fill
- NPT for level gauge, sized as appropriate
- 3/8 inch NPT basin drain - tank drain if single wall
- 2 inch NPT for level alarm
- NPT fitting for leak detection alarm

D. Fuel Level Gauge

The sub base tank shall include a direct-reading fuel level gauge.

E. Fuel Containment Basin

Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.

F. Leak Detection System

A fuel containment basin leak detector switch shall be provided.

G. Sub Base Tank Venting

Normal venting:

Normal venting shall be sized in accordance with the American Petroleum Institute Standard No. 2000, for venting atmospheric and low pressure storage tanks.
Tank shall be provided with atmospheric - normal - vent cap with screen.

Normal venting shall be sized as follows:

- 1-1/4 inches NPT for tanks through 2,499 gallons
- 1-1/2 inches NPT for 2,500 to 3,000 gallons
- 2 inches NPT for 3,001 to 10,000 gallons

Emergency venting:

The emergency vent NPT fitting shall be sized to accommodate the total capacity of both normal and emergency vents, and is not less than that derived from NFPA 30, Table 2-8, based on wetted surface area of the tank - calculated based on 100% of primary tank.

A zinc-plated emergency pressure relief vent cap shall be furnished. The vent shall be spring-pressure operated. Opening pressure shall be 0.5 psig; full opening pressure shall be

psig. Limits shall be marked on top of each vent.

A second emergency vent fitting shall be provided for the secondary containment portion of the tank if applicable.

16815.3.6 ENCLOSURE: CRYSTAL QUIET (STEEL)
The Crystal Quiet Enclosure or CQE, will be supplied and built with lockable and keyed alike hinged doors and flush mounted latches. The air intake consists of multiple baffles which help in reducing sound levels. There is a sound insulated air exhaust chamber for absorbing and redirecting noise and air flow upward. Sound attenuated foam of 1½ inch thick will be installed on the baffles, enclosure walls, and air exhaust chamber. Included is a critical grade silencer mounted in the air exhaust chamber.

16815.4 OPERATION AND MAINTENANCE

16815.4.1 FACTORY TESTING

The generator set shall be tested and performance assurance certification shall be completed at the factory on the unit. The test metering shall have an accuracy of 1% or better, and the metering used in testing shall be regularly calibrated and traceable to the National Bureau of Standards. The certified test of the engine-generator performance shall be provided. All tests shall be performed in accordance with the following test methods: IEEE 115 or MIL-STD-705.

Factory tests shall include but not be limited to the following:

Full load at rated power factor will be applied;
Full load at unity, 1.0 PF;
Recordings of the maximum load carrying capabilities of the engine generator set;
Maximum single block load pickup capability;
Kilowatts;
Amperes;
Voltage;
Kilovolt amperes;
Resistance of exciter field and stator;
Insulation test, generator field, exciter armature, exciter field, generator armature;
Dielectric test, generator armature, generator field, exciter armature, exciter field;
Lube oil pressure, if applicable;
Time;
Water temperature, if applicable;
Battery charge rate, if applicable;
Heaters, jacket water and/or lube oil;
Safety shutdowns and automatic controls;
Accessories - annunciator panel, charger, pumps as supplied;
Phase sequence on three phase;
Full load and .4PF to verify the motor starting capability of the engine generator set -optional;
Frequency;
Full rated load at rated PF and maximum load, to verify engine power, overload and maximum capability;
kVA, kilowatts, amperes, voltage, frequency and voltage transients at ½ and rated load

frequency at: no load, full load rated and maximum output;
Regulator range - adjust, phase sequence, phase voltage balance;
Stator and exciter field resistance;
Insulation test, generator field, exciter armature, exciter field, generator armature or stator;

Dielectric test, generator field, exciter armature, exciter field, generator armature or stator;
All safety shutdown and automatic controls.
Standard testing includes portions of MIL-STD-705:

301.1b: Insulation Resistance Test;
302.1a: High Potential Test;
401.1a: Winding Resistance Test;
410.1a: Open Circuit Saturation Curve Test;
503.1b: Start and Stop Test;
505.2a: Over speed Protective Device Test;
507.1c: Phase Sequence Test - Rotation;
508.1c: Phase Balance Test - Voltage;
510.1c: Rheostat Range Test;
511.1c: Regulator Range Test;
511.2b: Frequency Adjustment Range Test;
515.1a: Low Oil Pressure Protective Device Test;
515.2a: Over temperature Protective Device Test;
516.1: Controls, Direction of Rotation;
508.1c: Phase Balance Test - Voltage;
640.1c: Maximum Power Test.

16815.4.2 STARTUP AND WARRANTY VALIDATION
The start-up of engine generator set and Automatic Transfer Switch (if applicable) will be performed by an authorized service station of the manufacturer. The test will include instruction to personnel of normal maintenance and operation under existing load available.

16815.4.3 MANUFACTURER'S PRODUCT PERIOD OF WARRANTY: 2 YR - 3000 HR BASIC STDBY LIMITED
The standby electric generating system components, complete engine-generator and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge. The warranty period shall commence when the standby system is invoiced by the factory. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided.

16815.5 METHOD MEASUREMENT

16815.5.1 Measurement of the completed, functioning, and accepted standby generator will be made by the "Lump Sum" as shown on the BID schedule.

16815.5.2 BASIS OF PAYMENT

16815.5.2.1 The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Standby Generator	Lump Sum

16900 GENERAL

16900.1 SUMMARY

A. This specification describes a three-phase continuous duty, on-line, double conversion, solid-state uninterruptible power system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the existing building electrical system to provide power conditioning, back-up and distribution for critical electrical loads. The UPS shall consist of, as required by the project, the UPS module, battery cabinet(s), and accessory cabinet(s) for transformers, maintenance bypass, parallel tie, and distribution applications, and other features as described in this specification.

16900.1.2 UPS SYSTEM DESCRIPTION

A. UPS System Components: The UPS system shall consist of the following main components:

1. UPS module containing a Rectifier, Inverter, Battery Charger, Static Bypass, and associated Control and Monitor Panel.
2. Battery string(s) in Line-and-Match Battery Cabinets.
3. Line-and-Match accessory cabinets for transformer, maintenance bypass, parallel tie, and distribution applications.
4. Non-matching wall mounted or floor standing maintenance bypass cabinets or multi-module parallel tie cabinets.

B. UPS Module Modes of Operation: The UPS Module shall operate as an on-line, fully automatic system in the following modes:

1. Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while regulating both voltage and frequency. The Rectifier shall derive power from the commercial AC source and shall supply DC power to the Inverter. Simultaneously, the Battery Charger shall charge the battery.
2. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.
3. Recharge: Upon restoration of the AC source, the Charger shall recharge the batteries and simultaneously the Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load.
4. Bypass: If the UPS module must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode to Normal mode of operation shall be automatic. No-break transfer to and from Bypass mode shall be capable of being initiated manually from the front panel.

16900.1.3 REFERENCES

A. UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States.
B. CSA C22.2 No 107.1(Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.
C. NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.
D. IEC 62040-1-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-1: General and safety requirements for UPS used in operator access areas.
E. IEC 62040-1-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-2: General and safety requirements for UPS used in restricted access locations.
F. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.
G. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.
H. CISPR 22: FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) – Radio Frequency Devices (prior to Feb 16, 2006).
I. MIL-HDBK-217E (Military Handbook) – Reliability prediction of electronics equipment

16900.1.4 SUBMITTALS

A. The UPS shall be supplied with sufficient documentation, including the following manuals:

1 Installation and Operation Manual: One copy of the installation and operation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the UPS equipment and accessories. The manual shall include the following major items:

a. UPS description
b. UPS site planning and unpacking
c. UPS installation
d. Optional accessory installation
e. UPS theory of operation
f. Operating procedures
g. System events
h. UPS maintenance
i. Performance and technical specifications
j. Wiring requirements and recommendations
k. Physical features and requirements
l. Cabinet dimensions
m. Model # or serial # for ordering replacement parts.

16900.1.5 QUALIFICATIONS

A. The UPS manufacturer shall have a minimum of forty years experience in the design, manufacture and testing of solid-state UPS systems. A list of installed UPS systems of the same type as the manufacturer proposes to furnish for this application shall be supplied upon request.

B. The UPS manufacturer shall maintain a staffed 7x24x365 call center for technical and emergency support.

C. Field Engineering Support: The UPS manufacturer shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all field service offices must be submitted with the proposal. Third-party maintenance will not be accepted.

D. Spare Parts Support: Parts supplies shall be located in the field to provide 80% of all emergency needs. The factory shall serve as the central stocking facility where a dedicated supply of all parts shall be available within 24 hours.

E. Product Enhancement Program: The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These upgrades shall be available as optional field-installable kits.

F. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal. Under these contracts, the manufacturer shall maintain the user's equipment to the latest factory revisions.

16900.1.6 ENVIRONMENTAL REQUIREMENTS

A. The UPS shall withstand any combination of the following external environmental conditions without operational degradation.

1. Operating Temperature: 0 degrees C to + 40 degrees C (32 degrees F to 104 degrees F) without de-rating (excluding batteries).

2. Storage Temperature: - 25 degrees C to + 60 degrees C (-13 degrees F to 140 degrees F). Prolonged storage above + 40 degrees C (104 degrees F) will cause rapid battery self-discharge.

3. Relative Humidity (operating and storage): 95% maximum non-condensing.

4. Elevation:

(1) Operational: 4000 ft (2000 m) maximum without de-rating.

(2) Transportation: Capable of air transport.

16900.1.7 SAFETY

A. The UPS shall be certified by Underwriters Laboratories in accordance with UL 1778.

16900.2 PRODUCTS

16900.2.1 UPS MODULE STANDARD FEATURES

The UPS module shall consist of the following standard components:

A. Rectifier/Charger: The rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high-frequency PWM design, using Insulated Gate Bi-polar Transistors (IGBTs). The modular design of the UPS shall permit safe and fast removal and replacement of the rectifier/charger module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode. The rectifier/charger module shall also provide the following:

1. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
2. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
3. An option shall be provided to allow the rectifier to be capable of operating from a delta transformer output or high impedance grounded transformer (480V systems only).

B. Inverter: The inverter shall feature an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall also have the following features:

1. The inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the specified DC operating range.
2. The modular design of the UPS shall permit safe and fast removal and replacement of the inverter module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode.
3. The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.

C. Static Bypass: The bypass shall serve as an alternative source of power for the critical load when an abnormal condition prevents operation in normal mode. The bypass shall consist of a fully rated, continuous duty, naturally commutated static switch for high-speed transfers. The bypass shall feature the following transfer and operational characteristics.

1. Transfers to bypass shall be automatically initiated for the following conditions:
   a) Output overload period expired.
   b) Critical bus voltage out of limits.
   c) Internal over temperature period expired.
   d) Total battery discharge.
   e) UPS failure.
2. Uninterrupted automatic re-transfer shall take place whenever the inverter is capable of assuming the critical load.
3. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:
   a) When transfer to bypass is activated manually or remotely.

b) In the event of multiple transfers/re-transfer operations the control circuitry shall limit "cycling" to three (3) operations in any ten-minute period. The fourth transfer shall lock the critical load on the bypass source.

c) UPS failure.

4. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible with the inverter logic. During manual transfers to bypass mode, the inverter must verify proper bypass operations before transferring the critical load to the bypass.

5. All transfers to bypass shall be inhibited for the following conditions:

a) Bypass voltage out of limits (+/- 10% of nominal)

b) Bypass frequency out of limits (+/- 3 Hz, adjustable, factory set)

c) Bypass out of synchronization

d) Bypass phase rotation / installation error

6. Static transfer time: No break, complete in less than 4ms.

7. The bypass shall be manually energized using the control panel or remotely through a building alarm input.

D. Monitoring and control components: The following components shall provide monitor and control capability:

1. Control panel with status indicators.

2. Alarm and metering display.

3. Building alarm monitoring.

4. Communication ports.

E. Battery management system: The UPS shall contain a battery management system which has the following features:

1. The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.

2. The battery management system shall automatically test the battery string(s) to ensure that the battery is capable of providing greater that 80% of it's rated capacity. Testing the batteries shall not jeopardize the operation of the critical load. Upon detection of the battery string(s) not capable of providing 80%, the UPS system will alarm that the battery needs attention/replacement. The battery test shall be able to detect the following:

Open battery string
Shorted battery string
Battery capacity (runtime) less than 80% of "new" battery capacity

3. The UPS shall communicate battery test and monitoring data to the UPS manufacturer's remote monitoring site. Battery life remaining, capacity, and number of on-battery events shall be provided in a monthly report.

4. An optional temperature sensor shall be available to monitor the ambient temperature internal to the battery cabinet. If the ambient temperature increases, the UPS system charger shall automatically reduce the charging voltage to a level recommended by the battery manufacturer. If the ambient temperature is decreased the UPS shall automatically increase the battery charge voltage to that recommended by the battery manufacturer.

F. Wiring Terminals: For 208Vac 4-wire output configurations, the neutral output compression terminal shall be sized for 200% of UPS module rated current to accommodate higher neutral currents associated with non-linear loads. The UPS module shall contain mechanical compression terminals (adequately sized to accommodate 90°C wiring) for securing user wiring to the following locations:

1. Rectifier/charger input connections (3-wire plus ground)
2. Bypass input connections (3-wire plus ground for 3-wire plus ground output configuration (480Vac), or 4-wire plus ground for 4-wire plus ground output configuration)
3. DC link connections for battery cabinets (positive and negative).
4. AC output connections (3 or 4 wires plus ground).

16900.2.2 UPS MODULE OPTIONS AND ACCESSORIES

The UPS system shall consist of the following options and accessories as required:

A. Integrated Maintenance Bypass, Distribution, Tie, and Accessory Cabinet(s): Integrated Line-and-Match cabinet(s) shall be provided that include(s):

1. All hardware and interconnecting cable for connection to UPS module.
2. Manual maintenance bypass switch to isolate UPS module from commercial AC input and critical load. Switch shall provide complete isolation of UPS for servicing and, if necessary, complete removal and replacement of UPS while still providing bypass power to critical load. Switch shall be make-before-break, interlocked between UPS and bypass to prohibit improper operation.
3. K-1, K-13 or K20 rated output isolation transformer.
4. Qty two (2), 42 pole distribution panels with main disconnects for a total of 84 poles of distribution. Up to three (3) distribution circuit breakers may be substituted in lieu of each distribution panel.
5. Two (2)-module parallel redundant tie cabinet in a Line-and-Match configuration.

B. SNMP Network Adapter and UPS Power Monitoring Software: SNMP adapters shall provide a communications interface between the UPS module and SNMP-compatible network management systems. This capability shall allow the unit to be monitored remotely over an Ethernet network using a standard web browser.

1. UPS Power Monitoring Software: This system shall continuously monitor critical power elements associated with the UPS, using the communications port on each module and a customer furnished PC or phone dialer announcer. The

system shall automatically alarm if any problems arise and notify local or remote personnel of the alarm condition via email, page, or text message.

C. Battery Cabinet: The battery cabinet shall feature valve regulated, high-rate discharge, lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements. The battery cabinet shall have the following features:

1. The battery cabinet shall be the same depth and height as the UPS module.
2. The battery cabinet shall feature a mechanical enclosure of like appearance to the UPS module and shall feature casters. Each battery cabinet shall require front access only for installation, service and maintenance. The battery cabinet shall provide top and bottom cable entry.
3. Power wiring internal to each battery cabinet shall be factory provided. Each battery cabinet shall feature up to 10 battery trays which can be individually disconnected from the battery cabinet power wiring with quick disconnect devices. Each battery tray shall be firmly secured to the battery cabinet frame with fasteners. Each battery tray shall be removable from the front of the battery cabinet.
4. Each battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string within that battery cabinet. For battery configurations involving multiple battery cabinets, a battery string in one battery cabinet may be isolated from the DC link via its circuit breaker without removing other battery strings from the DC link and the UPS module.
5. The circuit breaker in each battery cabinet shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
6. The circuit breaker in each battery cabinet shall feature a 48VDC under voltage release device. The UV device shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
7. Power and Control wiring between the battery cabinet and the UPS shall be factory provided with compression type connectors between cabinets.
8. The batteries shall be configured with a ¼” spade type connector for attaching sense leads to each jar to facilitate the future addition of a battery monitoring system.
9. Expected battery life: 200 complete full load discharge cycles when operated and maintained within specifications.

D. Module Tie Cabinet. An external cabinet shall be available which shall allow connection of up to four (4) UPS modules to be connected for parallel operation. Module Tie Cabinet rating shall be in accordance with UPS module output ratings. This cabinet shall be utilized where individual UPS module output disconnect and isolation is desired, or when future expansion of a parallel system is planned. Cabinet shall also have the ability to house a optional main output breaker and a optional bypass breaker. Cabinet shall be designed for remote installation using customer-supplied wiring and conduit, and shall be capable of free-standing or wall-mounted installation.

16900.2.4 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING CHARACTERISTICS

A. UPS Continuous Ratings. The UPS shall be rated:

UPS Rating (max)	Optional Rating (1)	Optional Rating (2)	Optional Rating (3)
40kVA/36kW	n/a	n/a	n/a
80kVA/72kW	60kVA/54kW	50kVA/45kW	40kVA/36kW
120kVA/108kW	100kVA/90kW	n/a	n/a
160kVA/144kW	120kVA/108kW	100kVA/90kW	n/a

UPS Rating (max) is the maximum output possible from the UPS (for a load power factor range of 0.9 lagging to 0.9 leading). The UPS may be ordered with any of the three (3) optional ratings (where available) and later upgraded to its corresponding full UPS Rating (max).

B. Rectifier/charger input:

1. Nominal three phase input voltage: 208 or 480 VAC:

   3-wire plus ground for 3-wire plus ground output configuration

2. Operating input voltage range: +10%, -15% of average nominal input voltage without battery discharge.

3. For 60Hz systems, operating input frequency range shall be 55 to 65Hz.

4. Input power factor 0.99 lagging.

5. Normal input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode:

   a) Rectifier/charger input current limit shall be adjustable from 100 to 115% of full-load input current.

   b) Battery input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.

6. On generator input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode on generator:

   a) Rectifier/charger input current limit shall be adjustable from 100% to 115% of full-load input current.

   b) Battery recharge input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.

7. Input current total harmonic distortion (THD) shall be less than 4.5%.

8. Power walk-in: Ramp-up to full utility load adjustable from 3 seconds to 60 seconds.

C. Bypass input:

1. Synchronizing bypass voltage range shall be +/- 10% of average nominal input voltage.

2. Synchronizing bypass frequency range is centered on the nominal frequency.

3. Bypass and rectifier inputs can be supplied from out of phase sources if required.

4. Input surge withstand capability: The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV).

D. Rectifier/charger output:

1. Nominal DC voltage shall be variable between 384VDC to 480VDC for 208V input, and between 432VDC to 480VDC for 480V input.

2. Steady state voltage regulation shall be +/- 0.5%.

3. Voltage ripple shall be less that 0.5% (peak-to-peak).

4. Capacity: The rectifier/charger shall support a fully loaded inverter and recharge the battery to 90% of its full capacity within 10 times the discharge when input current limit is set at maximum.

5. Low line operation: The rectifier/charger shall be capable of sharing the DC load with the battery when the input voltage falls below the specified operation input voltage range, the on battery indicator shall enunciate operation in this mode.

6. DC sensing: Redundant DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.

7. Battery charger characteristics: The UPS battery charging system shall have the following characteristics:

a) The charger shall be capable of being configured for several charge modes including:

(1) A charging mode that increases battery life by allowing the battery to rest, reducing positive plate corrosion

(2) A charging mode floating the battery at a set level, which can be adjusted via software, used for flooded cell applications

(a) Nominal Float Voltage: 2.25 V per cell.

(b) Equalizing Voltage: 2.38 V maximum per cell (adjustable).

(c) Automatic (time based) or manual (user initiated) equalization available

b) UPS module will automatically adjust battery shutdown based upon loading and battery capacity.

(1) The UPS module shall automatically adjust the final discharge voltage between 1.67 and 1.75 Volts per cell based on the existing load and the rate and length of discharge.

(2) The absolute minimum operational voltage is 1.67 V per cell (adjustable).

8. The UPS module will automatically disconnect the battery system in case of full battery discharge followed by prolonged utility AC voltage failure. The time window before battery disconnection occurs shall be programmable for both time and voltage.

E. UPS output in normal mode

1. Nominal output voltage 208 VAC, 3-phase, 3 wire or 4-wire or 480V, 3-phase, 3-wire or 4-wire plus ground at the output of the Integrated Distribution and Bypass cabinet. Output wiring configuration is based upon input wiring configuration for systems without internal transformers.
2. Steady-state voltage regulation (in inverter) shall be within +/- 1% average from nominal output voltage.
3. Transient voltage response shall be < +/- 5% from nominal voltage for 100% load step, full load re-transfers and full load drop on battery.
4. Transient voltage recovery shall be 25ms to within +/- 1% of steady state.
5. Linear load harmonic distortion capability: Output voltage THD of less than 2% for 100% linear load.
6. Non-linear load harmonic distortion capability: Output voltage THD of less than 5% for 100% non-linear load when tested using the non-linear load described in IEC 62040-3 connected line to neutral.
7. Manual output voltage adjustment shall be +/- 3% from nominal.
8. Line synchronization range shall be +/- 3Hz, adjustable to +/- 5Hz.
9. Frequency regulation shall be +/- 0.01Hz free running.
10. Frequency slew rate shall be 1 Hz/second maximum (adjustable).
11. Phase angle control:
    a) Balanced linear load shall be +/- 1 degree from nominal 120 degrees
    b) Unbalanced linear loads shall less than +/- 5 degrees from average phase voltage for 100% load unbalance.
12. Phase voltage control:
    a) Balanced linear loads shall be +/- 1% from average phase voltage
    b) Unbalanced linear loads shall be less than +/- 5% for 100% load unbalanced
13. Overload current capability (with nominal line and fully charged battery): The unit shall maintain voltage regulation for up to 110% of resistive/inductive load for 10 minutes, up to 125% for 30 seconds, and up to 150% for 10 seconds.
14. Fault clearing current capability: 150% phase-to-phase for 10 cycles; 300% phase-to-neutral for up to 10 cycles
15. Static transfer time: No break, completed in less than 4ms.
16. Common mode noise attenuation:
    a) -65dB up to 20kHz, -40db up to 100kHz
    b) > 100dB with isolation transformer
17. Acoustical noise: Noise generated by the UPS under normal operation shall not exceed 65dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load.
18. EMI Suppression: The UPS shall meet FCC rules and regulation 47, part 15, for Class A devices prior to Feb 16, 2006, CISPR .

19. Electrostatic discharge (ESD): The UPS shall meet IEC 801-2 specifications. The UPS shall withstand a 25 kV pulse without damage and with no disturbance or adverse effect to the critical load.

20. Efficiency: The UPS efficiency shall be up to 94%.

F. UPS in Parallel Configurations:

UPS modules shall be capable of being paralleled to increase system power levels or to provide redundant power. A total of eight (8) UPS modules shall be capable of parallel operation, either for capacity or redundant systems. It shall be possible to parallel up to four (4) UPS modules without a central bypass cabinet. The parallel system shall have intelligence to automatically recognize the need for capacity and/or redundancy. Parallel systems shall utilize autonomous UPS power modules that do not rely on any control interconnections for synchronized operation. The individual modules shall operate in a peer-to-peer manner to provide automatic load sharing, synchronization, and selective tripping capabilities. "Master-slave" configurations are not acceptable.

The parallel system shall utilize a communications network to provide system information and status, such as operating mode and meter data. This network shall provide individual module information as well as total system information, and individual module information shall be available from any module's front panel display. The loss of this system information network shall not cause the parallel units to transfer to bypass or drop the critical load.

16900.2.5 MECHANICAL DESIGN

A. Enclosures: The UPS shall be housed in free-standing double front enclosures (safety shields behind doors) equipped with casters and leveling feet. The enclosures shall be designed for computer room applications. Front doors shall have locks to prevent unauthorized entry.

B. Ventilation: The UPS shall be designed for forced-air cooling. Air inlets shall be on the front of the unit. Air outlets shall be on the top. Eighteen inches of clearance over the UPS outlets shall be required for proper air circulation. Air filters shall be commonly available sizes.

C. No back or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall.

D. Cable entry: Standard cable entry for the UPS cabinet shall be through either the enclosure bottom or top. A dedicated wireway shall be provided within the UPS cabinet for routing user input and output wiring.

E. Front access: All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required.

F. Service area requirements: The 208Vac system shall require no more than thirty-six (36) inches of front service access room and shall not require side or rear access for service or installation. The 480Vac system shall require no more than forty-two (42) inches of front service access room and shall not require side or rear access for service or installation.

16900.2.6 CONTROLS AND INDICATORS

A. Microprocessor controlled circuitry: The UPS controls shall have the following design and operating characteristics:

1. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. DSP shall eliminate variances from component tolerance or drift, and provide consistent operational responses.

2. All operating and protection parameters shall be firmware controlled, thus eliminating a need for manual adjustments. The logic shall include system test capability to facilitate maintenance and troubleshooting. Printed circuit board replacement shall be possible without requiring calibration.

3. Start-up and transfers shall be automatic functions.

B. Digital Front Panel Display: The UPS control panel shall be a digital front panel display that features an 8x40 (8 lines, each with 40 characters) backlit LCD display. The LCD shall display UPS status, metering, battery status, alarm/event queue, active alarms and UPS configurations. The front panel display shall show a system mimic diagram with an outlined power path, current operating mode and event logs.

C. Control Panel Indicators: The UPS control panel shall provide the following monitoring functions with indicator LED's:

1. NORMAL: This shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load. A text message shall indicate if the bypass line is not within tolerance.

2. BYPASS: This shall indicate that the UPS has transferred the load to the bypass circuit.

3. BATTERY: This shall indicate that the commercial AC utility or generator source has failed and the battery is supplying power to the inverter, which is supporting the load. A text message shall indicate if the battery charge is low or if the battery is installed but disconnected.

4. ALARM: This shall indicate that the UPS detects an alarm condition, outlined in detail in the operator's manual.

D. Control Panel Controls: The UPS control panel shall provide the following functions from front panel push buttons:

1. EVENTS: Displays the list of Active System Events and a historical log of system events. Historical logs shall include a detailed time stamped list of the latest 128 events.

2. METERS: Displays performance meters for the system or critical load. When selected, the front display shall show individual screens of input parameters, output parameters or bypass parameters including; voltage, current and frequency. In addition, the battery display shall show runtime remaining.

3. CONTROLS: Displays a System Controls screen. Allows selection of operating mode, normal, bypass, charger on/off and Power Module on/off.

4. SETUP: Allows display contrast, date and time information serial communication port configuration and display of firmware revision numbers.

5. RETURN: Confirms selection or returns to previous screen.

E. Interface panel: The UPS shall be equipped with an interface panel, located behind a protective cover, which provides the following signals and communication features in a Class 2 environment:

1. Alarm contact: A dry contact for annunciating a summary alarm shall be provided for customer use. This contact shall be Form "C" capable of supplying both N/O and N/C contacts. Contact ratings shall be 5A max at a voltage not to exceed 28VDC or 277VAC.

2. RS232 (EIA / TIA-232) communications interface: Circuitry shall be provided for one RS232 (EIA / TIA-232) communication port for connection to automated service department diagnostic tools. This port may be used with simple ("dumb") terminals to gain remote access to all unit operation information.

3. Building alarms: Two inputs shall be provided for monitoring the status of external dry contacts. Building alarms shall be set up through the UPS configuration mode function on the RS232 (EIA / TIA-232) port.

4. External EPO contacts: Shall be provided to connect an external remote emergency power off switch to shutdown the UPS and de-energize the critical load.

5. Battery control contacts: Contacts shall be provided to connect the battery UVR and auxiliary signals from a battery breaker or battery disconnect switch.

6. External bypass indicator connection: A connection point shall be provided to acknowledge that an external maintenance bypass has been closed around the UPS, placing the critical load on utility power.

16900.2.7 COMMUNICATIONS

A. Communications Bay: The UPS shall be equipped with field configurable communications bays that will accommodate two (2) communication devices. A communication bay upgrade shall be available to increase the quantity of communication devices up to four (4).

B. Remote Monitoring:

1. Optional WEB/SNMP communication capabilities will be available for all systems.

2. The UPS shall be able to be monitored remotely via communications devices. UPS manufacturer shall provide optional communications devices capable of communicating via various industry standard protocols such as RS232 and ModBus. Monitoring of UPS status may also be performed through isolated dry contact Form C relays.

3. Remote monitoring of the UPS shall also be possible through status indicators elsewhere in the same facility through a device that replicates these indicators.

The UPS communication capability should be able to integrate into any industry standard Building Management System (BMS) and/or Network Management System (NMS). The UPS must also be able to be monitored via any standard Internet browser (i.e. Internet Explorer and Netscape).

All optional hardware interfaces shall be "Hot-swappable" (UPS maintains power to critical applications while changing interfaces).

C. Shutdown:

1. There shall be a mechanism that provides graceful, orderly, unattended, sequential shutdown of one or multiple computers powered by one UPS. This shutdown shall be performed via in-network or out-of-network means. The order of shutdown shall be user-defined, allowing the maximization of runtime on battery for more critical systems.

2. Shutdown of AS/400 computers shall be possible through open-collector relay contacts or isolated, dry contact, Form-C relays.

D. Notification:

1. There shall be a mechanism to send alerts to key personnel via email or SNMP traps. An alarm notification may also be sent by a network message.

2. Dial-out to a computer for alarm notification may be performed. The user may respond by dialing-in to retrieve alarm history and a summary of current meter status.

3. Management: A remote battery test may be performed via an Ethernet network. The UPS shall be tested through invoking a single command.

16900.2.8 UPS MODULE PROTECTION

A. Rectifier/Charger and Bypass protection shall be provided through individual fusing of each phase.

B. Battery protection shall be provided by thermal-magnetic molded-case circuit breakers in each battery cabinet (if standard battery pack is provided) or external protective device for an external battery.

C. Electronic current limiting circuitry and fuses in the Inverter circuit shall provide output protection.

D. To comply with agency safety requirements, the UPS module shall not rely upon any disconnect devices outside of the UPS module to isolate the battery cabinet from the UPS module.

16900.3 EXECUTION

16900.3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

16900.3.2 COMMISSIONING

A. Factory start-up shall be provided on a 5x8 basis (7 x 24 optional). Start-up service shall be provided at no extra charge and shall include one visit to perform all procedures and tests specified within UPS Installation and Operation manual. UPS manufacturer shall also offer the following optional services:

1. Pre-energize visit to inspect installation and provide guidance to installers as required.
2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.

B. The following procedures and tests shall be performed by Field Service personnel during the UPS startup:

1. Visual Inspection:
   a) Visually inspect all equipment for signs of damage or foreign materials.
   b) Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.
2. Mechanical Inspection:
   a) Check all the power connections for tightness.
   b) Check all the control wiring terminations and plugs for tightness or proper seating.
3. Electrical Pre-check:
   a) Check the DC bus for a possible short circuit.
   b) Check input and Bypass power for proper voltages and phase rotation.
   c) Check all lamp test functions.
4. Initial UPS Startup:
   a) Verify that all the alarms are in a “go” condition.
   b) Energize the UPS module and verify the proper DC, walkup, and AC phase on.
   c) Check the DC link holding voltage, AC output voltages, and output waveforms.
   d) Check the final DC link voltage and Inverter AC output. Adjust if required.
   e) Check for the proper synchronization.
   f) Check for the voltage difference between the Inverter output and the Bypass source.
   g) Optional on site full-load, step-load, and battery discharge tests using supplier furnished load bank, shall also be offered.
5. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

16900.3.3 WARRANTY

All components of the UPS system shall be covered by a standard one-year limited factory warranty and service protection package.

One-year limited factory warranty shall include replacement coverage for the UPS parts for a period of 18 months from shipment or 12 months from start-up, whichever occurs sooner.

One-year service protection package shall include 7x24 on-site repair/replacement labor for UPS parts and batteries; 7x24 technical support coverage; and 7x24 remote monitoring service (with monthly reports for UPS and battery performance). Standard response time shall be 8 hours from receipt of call. Manufacturer shall also offer, as an option, 7x24 on-site service support with guaranteed response times of 4, or 2 hours in certain major metropolitan areas. Additional preventive maintenance visits shall be available as an option for both UPS and battery components.

Manufacturer shall also include Start-up services consisting of: 5x8 Start-up service of UPS and batteries, with option for 7x24 Start-up. On-site user training, Site Audit, installation and commissioning of monitoring service, and validation of one-year limited factory warranty will be performed during the start-up.

Manufacturer shall also offer an optional service plan to provide 7x24 on-site coverage (preventive and corrective) for UPS and batteries, guaranteed response time, remote monitoring, Web access to service site history, annual Site Audit, UPS and battery preventive maintenance visit, and discounts on upgrade and modification kits. Manufacturer shall also provide an optional battery service plan to provide parts-and-labor coverage for partial and full battery strings, either with preventive maintenance or replacement coverage.

16900.4 METHOD OF MEASUREMENT

16900.4.1 Provide all components associated the UPS system as shown in the drawings and as defined in the applicable sections of the specifications required for a complete and functioning system.

16900.5 BASIS OF PAYMENT

16900.5.1 No separate payment shall be made for furnishing or installing electrical systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the Contractor.

16900.5.2 When electrical systems, components, or materials are measured for a new building or enclosure as shown on the Bid Schedule, separate payment will be made as listed below.

Pay Item	Unit
UPS System	Lump Sum

DIVISION 17

INSTRUMENTATION

SUNRISE
ENGINEERING

17000.1 SUMMARY

General requirements that apply to all process control and instrumentation systems for the entire project. Reference P&ID drawings and the Instrument List in SP17000

17000.1.1 RELATED SECTIONS:

17000.1.1.1 In addition to the responsibilities listed below, the System Supplier shall be responsible for all requirements of Section 16 and Section 17.

17000.1.1.2 The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

17000.1.1.3 Items involving electrical, control, and instrumentation construction may be shown on drawings or referred to in specifications that do not apply specifically to electrical, control and instrumentation systems. Because the Contract Documents are a single integrated document, it is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

17000.1.1.4 Items not involving electrical, control, and instrumentation construction may be shown on drawings or referred to in specifications that do apply specifically to electrical, control and instrumentation systems. Because the Contract Documents are a single integrated document, it is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

17000.1.2 The Contract Drawings, Documents, and overall design has been based on non-certified information furnished by various equipment manufacturers. It is incumbent on the part of the CONTRACTOR and Electrical & Controls Contractors to include in the bid all material and labor needed to install the actual equipment furnished.

17000.1.2.1 The CONTRACTOR and Electrical & Controls Contractors shall note that the instrument equipment specifications, ladder logic diagrams, and installation details are based on non-certified vendor information and indicate minimum scope of supply from the equipment manufacturer. The CONTRACTOR and Electrical & Controls Contractors shall include all costs in its bid to add additional instruments, wiring, computer inputs/outputs, controls, conduit, interlocks, electrical hardware, etc., into the design based on the equipment manufacturer's final certified vendor drawings. The CONTRACTOR and Electrical & Controls Contractors shall revise or produce new loop diagrams to meet the equipment manufacturer's wiring requirements. Such changes to instrumentation and electrical work shall be incorporated into the scope of work at no additional cost to the OWNER in light of the CONTRACTOR knowledge that non-certified vendor information has been used in the design.

17000.2 REFERENCES

17000.2.1 CODES AND REGULATORY COMPLIANCE.

17000.2.1.1 The equipment, materials, installation, and other work shall conform to all applicable regulations, standards, specifications, and codes which are current as of the date of the final inspection for this Contract.

17000.2.1.2 Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced documents to the extent that the requirements therein are not in conflict with the provisions of this Section; provided, that where such documents have been adopted as a code or ordinance by the public agency having jurisdiction, such code or ordinance shall take precedence.

17000.2.1.3 The equipment, materials, installation, and other work shall conform to all applicable regulations, standards, specifications, and codes which are current as of the date of bidding for this Contract, including, but not limited to, those which are established by the following sources:

A. Instrument Society of America (ISA).
B. National Electrical Manufacturers Association (NEMA).
C. Occupational Safety and Health Administration (OSHA).
D. American National Standards Institute (ANSI).
E. National Fire Protection Association (NFPA).
F. Institute of Electrical and Electronic Engineers (IEEE).
G. National Electrical Code (NEC).
H. Insulated Cable Engineers Association (ICEA).
I. Federal Communications Commission (FCC).
J. Underwriters Laboratory (UL).
K. Local Power and Telephone Companies.
L. Local Authorities having jurisdiction over the work.

17000.2.2 Where the requirements set forth in these Specifications or on the Drawings are greater or more rigid than the mandatory requirements referenced above, the applicable Specifications or Drawings shall govern.

17000.2.3 In the case of conflict between any mandatory requirements and Specifications or Drawings, the mandatory requirement shall be followed in each case, but only after submitting such proposed changes to the ENGINEER for approval.

17000.2.4 Nothing contained in these Specifications or shown on the Drawings will be so construed as to conflict with any national, state, municipal, or local laws or regulations governing the installation of work specified herein, and all such acts, ordinances, and regulations, including the National Electrical Code, are hereby incorporated and made a part of these Specifications. All such requirements will be satisfied by the CONTRACTOR at no additional expense to the OWNER.

17000.2.5 The Drawings and Specifications are complementary to each other; what is called for by one shall be as binding as if called for by both. If a conflict between Drawings and Specifications is discovered, this shall be referred to the ENGINEER as soon as possible for resolution. Should a conflict exist between the Drawings, Specifications, and/or mandatory requirements (i.e., codes, ordinances, etc.), it will be assumed that the more expensive method has been estimated, unless such alternate has been agreed to prior to submission of bids.

17000.2.6 SAFETY. The ENGINEER'S site responsibilities are limited solely to the activities of the ENGINEER and ENGINEER 'S employees on site. These responsibilities shall not be inferred by any party to mean that ENGINEER has responsibility for site safety. Safety in, on, or about the site is the sole and exclusive responsibility of the CONTRACTOR alone. The CONTRACTOR'S methods of work performance, superintendence of the CONTRACTOR'S employees, and sequencing of construction are also the sole and exclusive responsibilities of the CONTRACTOR alone. The OWNER warrants that: 1) The CONTRACTOR'S responsibilities will be made clear in the owner's agreement with the CONTRACTOR; 2) The owner's agreement with the CONTRACTOR shall require the CONTRACTOR to indemnify, defend, and hold OWNER and ENGINEER harmless from any claim or liability for injury or loss arising from owner's or engineer's alleged failure to exercise site safety responsibility; 3) owner's agreement with the CONTRACTOR shall require the CONTRACTOR to make OWNER and ENGINEER additional insured under the CONTRACTOR'S general liability insurance policy, which insurance protection shall be primary protection for OWNER and ENGINEER. Given the foregoing, OWNER also shall, to the fullest extent permitted by law, waive any claim against ENGINEER, and indemnify, defend, and hold ENGINEER harmless from any claim or liability for injury or loss arising from engineer's alleged failure to exercise site safety responsibility. OWNER shall also compensate ENGINEER for any time spent or expenses incurred by ENGINEER in defense of any such claim. Such compensation shall be based engineer's prevailing fee schedule and expense reimbursement policy.

17000.2.6.1 The term "any claim" used in this provision means "any claim in contract, tort, or statute alleging negligence, errors, omissions, strict liability, statutory liability, breach of contract, breach or warranty, negligent misrepresentation, or other acts giving rise to liability."

17000.2.6.2 The term ENGINEER used in this provision means the prime engineer and all sub-engineers, sub-consultants, Electrical Engineer, and the Instrumentation Engineer.

17000.3 DEFINITIONS

17000.3.1 DEFINITIONS: Definitions of terms and other electrical considerations as set forth in the:

National Electrical Code.
Institute of Electrical and Electronic Engineers.
Instrument Society of America.
National Fire Protection Association.
National Electrical Testing Association.

17000.3.2 SPECIFIC DEFINITIONS:

MTU: Master Terminal Unit.
RTU: Remote Terminal Unit.
FAT: Factory acceptance test.
HMI: Human Machine Interface.
LCP: Local Control Panel containing operator interface devices operators, etc. without a PLC.
LAN: Local Area Network.
WAN: Wide Area Network.
PC: Personal Computer.
PLC: Programmable Logic Controller.
RIO: Remote I/O.
SCADA: Supervisory Control and Data Acquisition system incorporating and including all parts of the PLCs, PCs, RIOs, MTUs, etc

17000.4 SYSTEM DESCRIPTION

In accordance with Section 17050 Control Strategies

17000.5 SUBMITTALS

In accordance with Section 01300 Submittals. In addition, CONTRACTOR will furnish the following:

17000.5.1 GENERAL. Submit shop drawings, product data, operating manuals and all other required submittals. Submittals shall show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers and all other pertinent details. Submittals shall be organized and delivered for review by specification section. There may be more than one submittal for an individual specification section.

A. Single submittals covering multiple specification sections will be returned without review. The ENGINEER will be reimbursed by the OWNER for all subsequent reviews and the OWNER will deduct the amount of the reimbursement from the CONTRACTORS' contract. The ENGINEER'S reimbursement will be on a time and expense basis and at the current billing rate of the ENGINEER. The ENGINEER will be the sole source for determining the suitability of any submittal.

B. Submittals shall be fully indexed with a tabbed divider for each and every component. Pages within the tabbed sections shall be sequentially numbered. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review. The ENGINEER will be reimbursed by the OWNER for all subsequent reviews and the OWNER will deduct the amount of the reimbursement from the CONTRACTOR's contract. The ENGINER's reimbursement will be on a time and expense basis and at the current billing rate of the ENGINEER. The ENGINEER will be the sole source for determining the suitability of any submittal.

C. Submittal Organization.

1. First Page.
   a. Specification Section Reference.
   b. Name and telephone number of individual who reviewed submittal prior to delivery to ENGINEER.
   c. Name and telephone number of individual who is primarily responsible for the development of the submittal.
   d. CONTRACTOR'S review stamp and comments.
2. Second Page.
   a. If a re-submittal, this page shall contain a response to each of the engineer's comments, and/or questions.
   b. In the order that the comments and/or questions were presented throughout the submittal.
   c. Referenced by index section and page number on which the comment appeared,
   d. Shall list any and all exceptions to the specifications, any items not excepted will be expected to be furnished as per the plans and specifications.

3. Remaining pages.
   a. Actual submittal data.
   b. Indexed.
   c. Pages sequentially numbered.
4. Submittal organization shall be in the exact same order as the items are referenced, listed, and/or organized in the specification section.

D. For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is intended to be used.

E. EXCEPTIONS TO SPECIFICATIONS. The CONTRACTOR shall include a list of proposed exceptions to the specifications and drawings along with a brief explanation of each. Acceptance of the exceptions is at the sole discretion of the ENGINEER. All items not listed as exceptions shall be furnished in accordance with the specifications and drawings. All items that do not meet the requirements of the specifications, and were not previously accepted as exceptions, shall be replaced by the CONTRACTOR at no additional cost to the OWNER, even if the submittals contained information indicating the failure to meet the requirements.

1. Any exceptions to the specifications must be noted, and the reason for the exception delineated. If there is no back up for the deviation the submittal will be returned requiring revision and re-submit.

17000.5.2 SHOP DRAWINGS: It is incumbent upon the CONTRACTOR to coordinate the work specified in these Sections so that a complete electrical power, instrumentation, computer and control system for the facility will be provided and will be supported by accurate shop and record drawings.

A. As a part of its responsibility the Electrical & Controls Contractors shall prepare and submit complete and organized shop drawings, as specified herein.

B. All drawings developed for the control system shall be generated utilizing AutoCAD by AutoDesk Version 2006 or later, shall be delivered on CDROM, as well as hard copies on 11 inch by 17 inch plain bond paper.

C. Manuals written specifically for this project shall be generated utilizing Microsoft Word or HTML and shall be delivered on CDROM, as well as hard copies on 8.5 inch by 11 inch plain bond paper.

D. The organization of the initial shop drawing submittal required above shall be compatible to eventual inclusion with the Technical Manuals submittal and shall include final alterations reflecting record conditions.

1. Accordingly, the initial multiple-copy shop drawing submittal shall be separately bound in a standard size, 3-ring, loose leaf, vinyl plastic, hard cover, binder suitable for bookshelf storage.
2. Binder ring size shall not exceed 2 inches.

E. Interface between instruments, vendor control panels, motor controls, motor starters, variable speed drives, control valves, flow meters and other equipment related to the CONTROL SYSTEM shall be included in the shop drawing submittal.

17000.5.3 During the period of preparation of this submittal, the CONTRACTOR shall authorize direct, informal liaison between the Electrical & Controls Contractors and the ENGINEER for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as specified may be authorized informally by the ENGINEER, but these shall not alter the scope of work or cause increase or decrease in the contract price. During this informal exchange, no oral statement by the ENGINEER shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant formal exception to, or variation from these Contract Documents.

17000.5.4 Should an error be found in a shop drawing during installation or startup of equipment, the correction, including any field changes found necessary, shall be noted on the drawing and submitted as final "RECORD DRAWINGS" prior to acceptance of the project.

17000.5.5 The CONTRACTOR shall submit detailed shop drawings and data prepared and organized by the Electrical & Controls Contractors.

A. All shop drawings shall include the letterhead and/or title block of the approved Electrical & Controls Contractors responsible for this project.

B. The title block shall include, as a minimum:

1. The Electrical & Controls Contractor's registered business name.
2. Address.
3. Project name.
4. Drawing name.
5. Revision level.
6. Personnel responsible for the content of the drawing.
7. Date.

17000.5.6 The Electrical & Controls Contractors shall respond to all comments on shop drawing re-submittals made by the ENGINEER either by making the noted correction or stating why it was not revised.

A. Any re-submittal received by the ENGINEER, which does not contain responses to the engineer's previous comments, shall be returned to the CONTRACTOR marked "REJECTED."

B. No further review by the ENGINEER shall be performed until a response for these comments has been received.

17000.5.7 The ENGINEER has allowed for up to and including two reviews of each submittal. The ENGINEER shall be reimbursed for all reviews after the first two reviews by the OWNER, and the OWNER will deduct the amount of the reimbursement from the contractor's contract. The engineer's reimbursement shall be on a time and expense basis and at the current billing rate of the ENGINEER. The ENGINEER shall be the sole source for determining the suitability of any submittal.

17000.5.8 The submittal shall be presented in nine distinct and complete parts in the following order, each in a separate bound set. Any incomplete submittal will be rejected and returned without comments.

A. Cost Loading and Cash Flow.
B. The complete system hardware items shall be submitted for review.
C. After successful review of the hardware items, the Loop Drawing submittal showing: control, interconnection, and loop drawings shall, be submitted for review.

D. Loop Description Submittal.
E. The Process Control and SCADA Software Submittal including, control system software, programming, and screen submittal shall follow the successful review of the drawings.
F. Testing and Start-up procedures.
G. Technical Manuals.
H. Training Submittals.
I. Record Drawings.

17000.5.9 COST LOADING AND CASH FLOW. The CONTRACTOR and the System Supplier shall develop a schedule, schedule of values, and cash flow summary for inclusion in the submittals. Failure to submit the schedule, schedule of values, or cash flow summary shall be cause for withholding any progress payment due for process control and instrumentation system work under sections in this Division.

A. Cash Flow Summary:

1. The cash flow summary shall be based on the submitted Schedule and equal in total to the contractor's process control and instrumentation system bid price plus approved contract modifications.
2. Expected payment requests for each month shall be included, as well as the cumulative payment requests to date for each month of the project.
3. The net payment requests for each month after deducting retainage and the cumulative payment requests to date shall also be shown.

17000.5.10 SYSTEM HARDWARE SUBMITTAL. This submittal shall be included in a singular, all-inclusive submittal which shall include but not be limited to:

A. A complete index appearing in the front of each bound submittal volume which lists each device by Tag and Loop number, type, and manufacturer. System groups shall be separated by labeled tags.

B. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and other control equipment.

C. Requirements for physical separation between control system components and 120 VAC and 480 VAC power cables.

D. UPS and battery calculations to show that the backup capacity and time meet the specified requirements.

E. Complete and detailed bills of materials:

1. A bill of material list, including quantity, description, manufacturer, and part number, shall be submitted for each field mounted device or assembly, RTU, MTU, LCP, cabinet assemblies and sub-assemblies.
2. A bill of material list identifying all items within an enclosure, including:
   a. Quantity.
   b. Description.
   c. Manufacturer.
   d. Part number.
3. Data sheets shall be included for each control system component together with a technical product brochure or bulletin. These data sheets shall show:
   a. The component name as used within the Contract Documents.

b. The manufacturer's model number or other identifying product designation.
c. The project tag number.
d. The project system of which it is a part.
e. The project site to which it applies.
f. The input and output characteristics.
g. The requirements for electric power.
h. The specifications for ambient operating conditions
i. Details on materials of construction.

4. Fully executed data sheets according to ISA-S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves, for each component, together with a technical product brochure or bulletin. The technical product brochures shall be complete enough to verify conformance to all Contract Document requirements, and shall be edited to reflect only those features supplied with the device. The data sheets shall show:

a. Component functional description used herein and on the Drawings.
b. Manufacturers model number or other product designation.
c. Project tag number used herein and on the Drawings.
d. Project system or loop of which the component is a part.
e. Project location or assembly at which the component is to be installed.
f. Input and output characteristics.
g. Scale range and units and multiplier.
h. Requirements for electric supply.
i. Materials of construction and of component parts to be in contact with, or otherwise exposed to, process media, and or corrosive ambient air.
j. Special requirements or features, such as specifications for ambient operating conditions.
k. Features and options which are furnished.

5. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by systems or loops, as a separate group for each system or loop. If, within a single system or loop, a single instrument is employed more than once, multiple data sheets, one per instrument, with one brochure or bulletin may cover all identical uses of that instrument in that system.
6. Control Panel Hardware Engineering submittal Refer to Section 17100.
7. A priced list of recommended spare parts covering items which are furnished under this Contract with the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts.

17000.5.11 SHOP DRAWINGS

A. A complete set of control system drawings which depict:

1. All PLCs, workstations, printers, communication devices, and communication links.
2. All PLCs shall be shown with their current I/O allocation, and future I/O allocation, current plus spares provided under this project, and maximum potential I/O based on available slots.
3. All cables required to support the communication requirements.
4. A separate diagram shall be submitted for each component fully annotated with conduit size and number associated with the power source.

B. Site-specific arrangement and construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, nameplates, and the like.

1. All drawings shall be scaled, and shall show the position of the equipment at its intended installation location.
2. All drawings must show a scaled representation of the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.
3. All required access and clearances associated with the equipment must be shown with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.

C. Loop Drawing Submittal: The Electrical & Controls Contractors shall furnish a Loop Drawing Submittal which completely defines and documents the contents of each monitoring, alarming, interlock, and control loop associated with equipment provided under Section 17, Section 16, as well as equipment provided under sections in other Divisions, existing, and OWNER furnished equipment which is to be incorporated into the control system.

1. The submittal shall be a singular complete bound package.
2. A complete index in the front of each bound volume.
3. The loop drawings shall be indexed by systems or process areas.
4. All loops shall be tagged in a manner consistent with the Contract Documents.
5. I/O shall be submitted for every analog and discrete monitoring and control loop.
6. Drawings showing definitive diagrams for every instrumentation loop system.
   a. These diagrams shall show and identify each component of each loop or system using legend and symbols from ANSI/ISA S5.4 -Instrument Loop Drawings, as defined by the most recent revision in ISA.
   b. Each system or loop diagram shall be drawn on a separate drawing sheet.
   c. Loop drawings shall be developed for all equipment associated with this project including vendor supplied packages, equipment provided under Divisions 16 & 17, and OWNER furnished equipment.
   d. The loop drawings shall also show all software modules and linkages.
7. In addition to the expanded ISA S5.4 requirements the loop diagrams shall also show the following details:
   a. Functional name of each loop
   b. Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
   c. MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.
   d. Designation, and if appropriate, terminal assignments associated with, every manhole, pullbox, junction box, conduit, and panel through which the loop circuits pass. a) Use conduit numbers as found in Division 16 for identification of conduits.
   e. Vendor panel, instrument panel, conduit, junction boxes, equipment and SCADA System terminations, termination identification wire numbers and colors, power circuits, and ground identifications.
8. A complete system block diagram.
9. Panel and cabinet layout drawings shall be prepared and they shall include the following information:
   a. Front, side, and plan views to scale.

b. Dimensions.
c. Arrangement (interior and exterior).
d. Mounting information, including conduit entrance location.
e. Finish data.
f. Tag number and functional name of items mounted in and on panel, console and cabinet.
g. Nameplate legend which includes text, letter size, and colors to be used.

10. Panel wiring and/or piping diagrams shall be prepared and integrated into the field wiring. They shall include the following information;
    a. Name of panel.
    b. Wiring and piping sizes and types.
    c. Terminal strip numbers.
    d. Functional name and manufacturer's designation for items to which wiring and piping are connected.
    e. Electrical control schematics in accordance with ANSI standards.
11. Field wiring and piping diagrams shall be prepared and be integrated with the panel wiring diagram. They shall include the following information:
    a. Wire and piping sizes and types.
    b. Conduits in which wiring is to be located.
    c. Panel (e.g., RTU, MTU, LCP, PLC, etc.) termination strip numbers.
    d. Location, functional name and manufacturer’s designation of items to which wiring and piping are connected.
12. Drawings showing schematic diagrams for control circuits. Complete details on the circuit interrelationship of all devices within and outside each control panel shall be submitted using schematic control diagrams. The diagrams shall show numbered terminals on components together with the unique number of the wire to be connected to each terminal. The diagrams shall also show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as samplers, pumps, valves and chemical feeders. The CONTRACTOR shall furnish all necessary equipment identified in the supplier's shop drawings to facilitate inclusion of this information by the System Supplier.
13. If necessary, interface with existing control and monitoring system. This shall include any and all modifications made to existing measurement and control circuits, equipment and wiring. It is the responsibility of the System Supplier to ascertain actual field conditions of the existing circuits, equipment and wiring. The OWNER will provide to the CONTRACTOR copies of all drawings and data that the OWNER can find that show such existing conditions.
    a. The OWNER makes no representation as to the completeness nor correctness of any such drawings and data and cannot guarantee that complete or partial data exists for any of the facilities included in this contract.
    b. Lack of such drawings shall not alleviate the contractual responsibility to ascertain and implement interfaces and modifications to existing measurement and control circuits, equipment and wiring.
14. Control Panel Wiring Diagram Submittal refer to Section 17100.

17000.5.12 LOOP DESCRIPTIONS. For all items specified by a functional description, the Electrical & Controls Contractors shall furnish, as a minimum, a functional description at least as detailed as a functional description in the Specifications, P&IDS, and elementary wiring drawings. The ENGINEER will review the functional description for conformance with the Specifications. Any additional costs which are caused by failure of the equipment to operate as stated in the functional description shall not be reason for a change in contract time or amount.

17000.5.13 PROCESS CONTROL & SCADA SOFTWARE SUBMITTAL. This submittal shall include but not be limited to:

A. Complete description of the standard application software programs, operating system and utility program to be furnished, including modifications and explanation of how the specific functional requirement will be met. A cross reference between the specification and the software submittal shall be provided in order to provide the ENGINEER the ability to identify how each specified section or function is being met by the System Supplier.

B. A complete description of all available software algorithms.

C. A complete set of control strategies and algorithms furnished under this contract which depicts all monitoring and control functions on a loop by loop basis.

D. An English language narrative of each control loop including its mission and anticipated action.

E. A complete listing of the SCADA System point I/O database.

1. This listing shall include for each data point relevant parameters such as range, active state, contact orientation, limits, incremental limits, I/O card byte, I/O hardware address and PLC assignment.

2. The list shall be divided and grouped on a site by site basis and divided into point type.

3. In addition to the active I/O's, the list shall also include the implemented spare I/O's and the available I/O's remaining on the I/O board, as well as other defined future points called for.

F. Detailed descriptions of procedures used to implement and modify control strategies and database construction.

G. Preliminary overview, screens, and preliminary reports.

17000.5.14 FACTORY ACCEPTANCE TEST PROCEDURES. The Electrical & Controls Contractors shall prepare and submit a factory test procedure which incorporates:

A. Test sequences.
B. Test forms.
C. Samples of database lists.
D. Control system testing block diagram.
E. Estimated test duration which complies with the requirements of the factory test specified herein.

17000.5.15 TESTING, CALIBRATION, AND START-UP SUBMITTAL. System test and start-up procedures and sequences shall be developed by the System Supplier and its Electrical & Controls Contractors in conjunction with the CONTRACTOR and other requirements as identified in these Contract Documents, and shall be submitted to the ENGINEER for review. An approved submittal shall be required prior to the commencement of system testing. Procedures shall be prepared for each process system.

A. The procedures shall, in narrative form, describe sequentially the operational steps to be followed in verifying the correct operation of each process system, including all features described in the control strategies contained in Specifications Section 17050, and those reflected in the P&IDs.

B. All equipment, constituting the complete control system and its various workstation displays, which function together to form a complete process system shall be tested together, including interlocks between devices. Test procedures for all process orientated systems shall be developed and performed.

C. Test Procedure Submittals. Submit the proposed procedures to be followed during tests of the control system and its components.

D. Preliminary Submittal: Outlines of the specific proposed tests and examples of proposed forms and checklists.

E. Detailed Submittal: After approval of the Preliminary Submittal, submit the proposed detailed test procedures, forms, and checklists. This submittal shall include a statement of test objectives with the test procedures.

F. Provide certified and witnessed test and calibration checklists for each of the following tests:
   1. Factory Acceptance Tests.
   2. Loop Validation Tests.
   3. Pre-commissioning Test.
   4. Performance Test.

17000.5.15 TECHNICAL MANUALS. Seven (7) final sets of technical manuals shall be supplied for the OWNER as a condition of acceptance of the project.

A. Information in the Technical Manuals shall be based upon the approved shop drawing submittals as modified for conditions encountered in the field during the work.

B. Each set shall consist of 1 or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl plastic hard cover binder suitable for bookshelf storage.

C. Binder ring size shall not exceed 2 inches.

D. Initially, 2 sets of these manuals shall be submitted to the ENGINEER for review after return of favorably reviewed shop drawings and data required herein.
   1. Following the engineer's review, one set will be returned to the CONTRACTOR with comments.
   2. The sets shall be revised and/or amended as required and the requisite final sets shall be submitted to the ENGINEER 15 days prior to startup of systems.
   3. The ENGINEER will distribute the copies.

E. The Technical Manuals shall have the following organization for each process:

   Section A - Process and Instrumentation Diagrams.
   Section B - Loop Descriptions.
   Section C – Loop/I/O Drawings.
   Section D - Instrument Summary.
   Section E - Instrument Data Sheets.
   Section F - Instrument Installation Details.

Section G - Test Results.
Section H - Control and SCADA System Software.
Section I - Control System Hardware

F. Signed results from Loop Testing, Pre-commissioning, and Performance Testing shall be included in Section H - Test Results.

G. In addition to updated shop drawing information reflecting actual installed conditions, each set of technical manuals shall include:

1. Installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance and overhaul instructions in complete detail.
2. This shall provide the OWNER with comprehensive information on all systems and components to enable operation, service, maintenance and repair.
3. Exploded or other detailed views of all instruments, assemblies and accessory components shall be included together with complete parts lists and ordering instructions.

H. Control and SCADA System Software. In addition to the information required under the specification section entitled "Contractor Submittals", this manual shall include complete documentation of all of the software programs provided for both the control and SCADA systems, including:

1. Listings of all application software on both hard copy and magnetic media.
2. Database both hard copy and CDROM.
3. Source codes.
4. Communication protocols.
5. All as necessary to maintain, troubleshoot, modify, or update the software system.

I. Control System Hardware. Technical manuals for the PLCs, workstations, printers, and all other control system hardware components.

17000.5.16 TRAINING SUBMITTALS. Operator and Maintenance Training plan which includes:

A. A submittal of the training plan overview along with prerequisites for the OWNER'S personnel.

B. Schedule of training courses including dates, durations, and locations of each class.

C. Proposed training material, including a resume, and a detailed outline of each lesson.

D. Resumes for the proposed instructors, indicating previous instructional experience.

E. Course Outline.

The ENGINEER will review the submitted data for suitability and provide comments that shall be incorporated into the course.

17000.5.17 RECORD DRAWINGS. The electrical & controls contractors shall keep current a set of complete loop and schematic diagrams which shall include all field and panel wiring, piping and tubing runs, routing mounting details, point-to-point diagrams with cable, wire, tube and termination numbers. These drawings shall include all instruments and instrument elements. Two hard copies shall be submitted after completion of all commissioning tasks but prior to performance testing. All such drawings shall be submitted for review prior to acceptance of the completed work by the OWNER.

17000.6 QUALIFICATION REQUIREMENTS OF SYSTEMS INTEGRATOR

The Electrical Contractor shall include as part of his submittals a Qualifications Submittal for the Systems Integrator. It shall include the following:

17000.6.1 Systems Integrator's office address, phone number and two office contacts.

17000.6.2 A list of at least five (5) successfully completed projects for a water and/or wastewater system of similar scope and complexity. The list shall include names and phone numbers for contact information.

17000.7 DELIVERY, STORAGE AND PROTECTION

17000.7.1 All equipment and materials delivered to the job site shall be stored in a location which will not interfere with the operations of the CONTRACTOR, other contractors on the site, or the OWNER.

17000.7.2 Storage and handling will be performed in manners which will afford maximum protection to the equipment and materials. Instruments shall be stored in complete conformance with the manufacturer's recommendations. Any instruments stored in variance with the manufacturer's recommendations shall be replaced at the engineer's discretion at no additional cost to the OWNER.

17000.7.3 It is the System Supplier's joint responsibility, with the CONTRACTOR to assure proper handling and on-site storage of instrumentation and control equipment.

17000.7.4 SHIPPING PRECAUTIONS: After completion of shop assembly, factory test, and approval, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.

A. Dehumidifiers shall be placed inside the polyethylene coverings.

B. The equipment shall then be skid-mounted for final transport.

C. Lifting rings shall be provided for moving without removing protective covering.

D. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

17000.7.5 SPECIAL INSTRUCTIONS. Special instructions for proper field handling, storage, and installation required by the Electrical & Controls Contractors shall be securely attached to each piece of equipment prior to packaging and shipment.

17000.7.6 TAGGING. Each component and/or instrument shall be tagged to identify its location, instrument tag number, and function in the system.

A. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the control system.

B. Instruments shall be tagged immediately upon receipt in the field.

C. Identification shall be prominently displayed on the outside of the package.

D. Tags shall utilize the Tag and Loop Number identifications shown of the P&IDs.

17000.7.7 STORAGE

A. Equipment shall not be stored outdoors.

B. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury.

C. If any apparatus has been damaged, such apparatus shall be replaced and/or repaired at no additional cost to the OWNER.

D. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the ENGINEER.

E. Such tests shall be at no additional cost to the OWNER, and if the equipment fails the tests, it shall be replaced at no additional cost to the OWNER.

17000.8 SEQUENCING AND SCHEDULING

17000.8.1 FACTORY ACCEPTANCE TEST (FAT). Prior to the delivery and installation of the SCADA system at the job site, but after the procurement, assembly, and configuration of all components, the System Supplier shall conduct a factory test.

A. The CONTRACTOR shall schedule the factory test after receiving approval of the factory test procedures submittal.

B. A copy of the test procedures shall be submitted to the ENGINEER at least 21 working days before the scheduled test date.

C. Notify the ENGINEER of scheduled tests a minimum of 15 working days prior to the date of the test.

D. Transmit completed PLC I/O Test Checklist forms 5 working days prior to the FAT.

17000.8.2 LOOP VALIDATION TEST. The CONTRACTOR shall notify the ENGINEER of scheduled tests a minimum of 30 working days prior to the estimated completion date of installation and wiring of the control system.

A. Testing shall be completed 5 working days prior to the Pre-commissioning phase of the project.

B. Loop Validation Certifications. After the field device loop tests have been successfully completed for all individual instruments, all separate analog control networks, all valves all motors, all local operator interface panels, all motor control centers etc. a certified copy of all test forms signed by the Electrical & Controls Contractors and the owner's representative as a witness, with test data entered, shall be submitted to the ENGINEER together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

17000.8.3 PRE-COMMISSIONING TEST. The CONTRACTOR through the System Supplier and Electrical & Controls Contractors shall furnish the services of an on-site commissioning engineer to supervise and coordinate installation, adjustment testing, pre-commissioning and start-up of the control system.

A. The commissioning engineer shall be present during the total period required to affect a complete operating system. The commissioning engineer must be the individual responsible for the programming of the PLCs.

B. A team supplied by the Electrical & Controls Contractors shall be on site for a minimum of 40 hours to check all equipment, perform the tests indicated, and furnish startup services. The team must include the actual individuals responsible for the programming of the PLCs and the SCADA screens.

C. Shall commence after acceptance of all training, wire test, calibration tests and loop validation tests, and all inspections have demonstrated that the instrumentation and control system complies with all Contract requirements.

D. Acceptance of the control system pre-commissioning testing must be provided in writing by the ENGINEER before the performance testing may begin.

17000.8.4 TRAINING. Training shall be completed before the pre-commissioning phase of the project may start. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The ENGINEER will review the course outline for suitability and provide comments that shall be incorporated.

A. Documentation. Training manuals shall be submitted to the ENGINEER a minimum of 10 working days prior to starting the training session. Within 10 days after the completion of each session the System Supplier shall submit through the CONTRACTOR the following:

1. A list of all OWNER personnel that attended the session.
2. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

17000.8.5 PERFORMANCE TESTING. Pre-commissioning test must be completed a minimum of 5 working days prior to the performance test.

17000.8.6 After pre-commissioning tests have been completed, the control system will be given a final 90-day performance test.

17000.8.7 ACCEPTANCE: For the purpose of this project, the following conditions shall be fulfilled before the WORK is considered substantially complete:

A. All submittals have been completed and approved.
B. The control system has been loop tested and pre-commissioned.

C. The OWNER training has been performed.
D. The performance test has been successfully completed.
E. All debris associated with installation of instrumentation has been removed.
F. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

17000.9 WARRANTY

17000.9.1 The System Supplier shall guarantee the performance and the hardware of all the instrumentation, control, telemetry and SCADA equipment and associated software and installation, as specified herein, for a period of one (1) year following the date of completion and formal acceptance of the WORK.

A. To fulfill this obligation, the System Supplier shall utilize technical service personnel designated by the Electrical & Controls Contractors.

B. Service shall be performed within 3 calendar days after notification by the OWNER.

17000.9.2 Equipment, software, and materials which do not achieve design requirements after installation shall be replaced or modified by the System Supplier to attain compliance, at no additional cost to the OWNER. Following replacement or modification, the Electrical & Controls Contractors shall retest the system and perform any additional procedures needed to place the complete system in satisfactory operation and attain design compliance approval from the ENGINEER.

17000.9.3 The Electrical & Controls Contractors shall install in the system the means to communicate with the control system from the Electrical & Controls Contractor's factory, including modems and other hardware as required, in order to diagnose system failures from the Electrical & Controls Contractor's facility.

17000.9.4 All parts, material, labor, travel, subsistence, or other expenses incurred in providing all the services and service visits during the warranty period shall be borne by the System Supplier under the guarantee.

17000.9.5 The warranty period shall start upon final acceptance of the complete control system work and successful completion of the performance test.

17000.9.6 The complete SCADA system (and associated software) included therein shall be guaranteed to meet or exceed the design requirements set forth in the Contract Documents.

17000.9.7 Equipment, software, and materials which do not achieve design requirements after installation shall be replaced or modified by the System Supplier to attain compliance, at no additional cost to the OWNER. Following replacement or modification, the System Supplier shall retest the system and perform any additional procedures needed to place the complete SCADA system in satisfactory operation and attain design compliance approval from the ENGINEER.

17000.9.8 The System Supplier through the CONTRACTOR warrants the materials and workmanship used for the SCADA system equipment and materials furnished under the Contract, and further guarantees the materials and workmanship used for any equipment and materials produced and furnished hereunder as a part of the work of this Contract to be as herein specified and agreed upon, free from injurious defects, and in all respects satisfactory for the service required.

17000.9.9 The System Supplier through the CONTRACTOR shall warrant/guarantee the satisfactory performance of the equipment and materials under operating conditions. In the event that tests and inspections disclose latent defects or failure to meet the specified requirements, the System Supplier upon notification by the ENGINEER shall proceed at once to correct or repair any such defects or non-conformance or to furnish, at the delivery point named in the Contract, such new equipment or parts as may be necessary for conformity to the specified requirements, and shall receive no additional compensation.

17000.9.10 The CONTRACTOR shall guarantee that the completed system shall perform all of the data acquisition, control, and reporting functions as shown and specified.

17000.10 MATERIALS

17000.10.1 All materials and equipment furnished under this contract shall be new, free from defects, and shall be standard products produced by manufacturers regularly engaged in the manufacturer of these products.

17000.10.2 Where there is more than one item of similar equipment being furnished under this contract, all such similar equipment shall be the product of a singular manufacturer.

17000.10.3 All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise specified to match existing equipment.

17000.10.4 SIGNAL LEVELS:

A. Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable.

B. Electrical signals outside control panels shall be 4 to 20 mA DC.

C. All electric signals shall be electrically or optically isolated from other signals.

D. Discrete input signal shall be 120 VAC, unless otherwise noted.

E. Discrete output signals shall be:

1. 120 VAC dry contact or TRIAC output as needed to coordinate with the field device, unless otherwise noted.
2. Pilot lights within PCMs may be 24 VDC and driven by 24 VDC discrete outputs or 120 VAC and driven by 120 VAC discrete outputs.
3. All discrete outputs without exception shall be routed through an external terminal block mounted fuse with blown fuse indication.

17000.10.5 All instrumentation shall be suitable for operation in the ambient conditions at the equipment installation locations.

17000.11 SOURCE QUALITY CONTROL

17000.11.1 The CONTRACTOR shall arrange with all Manufacturers of the equipment and fabricators of panels and cabinets, supplied under this project to allow the OWNER and ENGINEER to inspect and witness the testing of the equipment at the site of fabrication.

A. Equipment shall include the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices.

B. A minimum of 15 working days notification shall be provided to the ENGINEER prior to testing.

C. No shipments shall be made without the ENGINEER'S approval.

17000.11.2 FACTORY ACCEPTANCE TESTS (FAT): Prior to shipment, the complete control system including all MTUs, RTUs, PLCs, LCPs, peripherals, communications equipment, and other equipment, shall be assembled, connected, and all software loaded for a full functional test of the integrated system.

A. Test procedures shall be developed and submitted by the Electrical & Controls Contractors to show that the integrated system hardware and software is fully operational and in compliance with the requirements of the Contract Documents.

B. All hardware test procedures shall follow the guidelines of the applicable portions of Sections 3 through 8 in ISA's recommended practice ANSI/ ISA RP.1-1975(R1983).

C. A copy of the test procedures shall be submitted to the ENGINEER in conformance with Section 17000.5 of this section.

D. The factory test will be witnessed by the OWNER and ENGINEER.

E. The factory test shall make use of hardware simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, that shall be connected to the I/O points within the control system. All inputs and outputs shall be simulated and proper control system operation shall be validated. Each switch, pilot light, display, etc. shall be labeled in accordance with the P&IDs so that a timely and thorough test of the complete system can be conducted.

1. The use of jumper wires, terminal block mounted pilot lights, and loose meters to act as or supply the functionality of a simulator will not be allowed.
2. The hardware simulator may consist of a PLC, operating under a SCADA software package that has its I/O points hardwired to the control system PLC's I/O points. The SCADA software operating on a PC may then act as the switches, pilot lights, variable analog signal generators, and analog signal level displays.

F. Factory Acceptance Test.

1. PLC I/O Test:
   a. Test shall be conducted prior to the arrival of the OWNER and ENGINEER for the witness FAT.
   b. ENGINEER and OWNER shall review the test checklists.
   c. ENGINEER and OWNER shall at random pick points to be tested. a) If any of the randomly selected points fail the test the entire FAT shall be considered failed and all costs for the re-test, including engineer's and owner's time and travel expenses shall be borne by the CONTRACTOR.

d. PLC I/O Test Checklist Form:
   1) Forms shall be organized by:
      i) PLC.
      ii) I/O type.
   2) Test methodology:
      i) Discrete inputs: Apply appropriate input and panel terminal, observe input card indicator, observe data value at each indicated data address.
      ii) Discrete outputs: Toggle bit in output buffer, observe data point, output card indicator light and measure response at field wiring terminals.
      iii) Analog inputs: Apply appropriate analog input signal at panel terminals, observe data value at each indicated data address.
      iv) Analog outputs: Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response at panel wiring terminals.
   3) Test form shall identify:
      i) Panel.
      ii) I/O Type.
      iii) I/O tag name.
      iv) Panel terminal block number.
      v) I/O file.

17000.11.3 LOOP TEST

A. Test Forms will list:

1. Initial of individual performing test.
2. Date test was performed.

B. Loop Test:

1. Test shall be conducted by the individual responsible for the actual programming.
2. ENGINEER and OWNER shall witness the tests.
3. The submitted and approved system simulator shall be used for the test.
4. Any changes and/or corrections shall be noted on the test forms.
   a. Corrections shall be made after a complete system test.
   b. ENGINEER and OWNER shall witness the revisions and/or corrections prior to leaving the FAT.
   c. If the corrections and/or revisions are too extensive to made in a timely manner the FAT shall be considered failed and all costs for the re-test, including engineer's and owner's time and travel expenses shall be borne by the CONTRACTOR.
5. Changes and corrections shall be made at no additional cost to the OWNER.
6. Test methodology: Using the simulator prove the functional operation of each and every loop, based upon the approved Loop Descriptions.
7. Loop Test Checklist Form. Forms shall be organized by:
   a. Loop Number.
   b. First page in loop numbered group shall contain the appropriate portions of the P&IDs for the loop being tested.

c. Second page shall include the fully revised and approved Loop Description for the loop being tested.
d. Remaining pages shall identify the Cause and Effect as each I/O point is toggled through the simulator.
e. Check boxes shall be provided to track proper and/or improper operation of the loop.

17000.12 INSTALLATION

17000.12.1 GENERAL: Under the supervision of the System Supplier and as part of the role as Electrical Contractor, and in accordance with the manufacturer's instructions, and in coordination with the ENGINEER and the OWNER, all systems specified and/or required shall be:

A. Installed.

B. Connected

C. Tested.

D. Started to place the system in operation.

E. This shall include final calibration in concert with equipment specified elsewhere in these Contract Documents.

17000.12.2 It is the intent of these specifications that the Electrical & Controls Contractors shall accomplish the physical installation of all elements, instruments, accessories or assemblies specified in these contract documents.

A. The Electrical & Controls Contractors shall employ installers who are skilled and experienced in the installation and connection of all elements, instruments, accessories and assemblies.

B. Electrical work shall be performed as specified in the applicable sections of Division 16.

17000.12.3 The monitoring and control system configurations are diagrammatic. The locations of equipment are approximate unless dimensioned. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Where job conditions require reasonable changes in approximated locations and arrangements, the System Supplier shall make such changes without extra cost to the OWNER, in accordance with the requirements of Division 16.

17000.12.4 All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The OWNER reserves the right to require minor changes in location of equipment prior to roughing in without incurring any additional costs or charges.

17000.12.5 INSTALLATION AND CONNECTION. The System Supplier shall install and connect all field-mounted components and assemblies under the criteria imposed by these specifications. The installation personnel shall be provided with a final reviewed copy of the shop drawings and data.

17000.12.6 CONDUIT, CABLES, AND FIELD WIRING. All conduit shall be provided under Division 16 without delay to the WORK of Division 17. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, PLC input and output wiring and other field wiring and cables shall be provided under Division 16. All SCADA System equipment cables, and process LAN communication networks shall be provided under Division 17. All terminations and wire identification at control system equipment furnished under this or any other Division shall be provided as identified in Section 16.

17000.12.7 COMMUNICATIONS CABLES. Ethernet: Communications cables that will be used for Ethernet connectivity will meet Category 6 specifications as per EIA/TIA 568A. All Ethernet patch cables are to meet Category 6 specifications as well. In spaces with common air the cable needs to be plenum rated. Video: Camera cabling will be RG6 coax with 95% copper braid. In spaces with common air the cable needs to be plenum rated. Power conductors can be included within the jacket covering.

17000.12.8 EQUIPMENT TIE-DOWNS. All instruments, control panels, and equipment shall be anchored by methods which comply with seismic and wind bracing requirements which apply to the site. All control panels, VCPs, LCPs, etc., must be permanently mounted and tied down to structures.

17000.12.9 The ENGINEER has based the drawings and design on non-certified information furnished by various equipment manufacturers. It is incumbent on the part of the CONTRACTOR to include in the bid all material and labor needed to install the actual equipment furnished.

A. The instrument equipment specifications, ladder logic diagrams, and installation details are based on non-certified vendor information and indicate minimum scope of supply from the equipment manufacturer.

B. The System Supplier shall include all costs in its bid to add additional instruments, wiring, computer inputs/outputs, controls, conduit, interlocks, electrical hardware, etc., into the design based on the equipment manufacturer's final certified vendor drawings.

C. The Electrical & Controls Contractors shall revise or produce new loop diagrams to meet the equipment manufacturer's wiring requirements.

D. Such changes to instrumentation and electrical work shall be incorporated into the scope of work at no additional cost to the OWNER in light of the contractor's knowledge that non-certified vendor information has been used in the design.

E. The CONTRACTOR and System Supplier shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements at no additional cost to the OWNER.

F. All such additions and all such changes, including the proposed method of installation, shall be submitted to the ENGINEER for approval prior to commencing the work.

G. Such changes shall not be a basis of claims for extra work or delay.

17000.12.10 INSTALLATION CRITERIA AND VALIDATION. All field-mounted components and assemblies shall be installed and connected according to the requirements below:

A. Installation personnel have been instructed on installation requirements of the Contract Documents.

B. Technical assistance is available to installation personnel at least by telephone.

C. Installation personnel have at least one copy of the approved shop drawings and data.

D. All flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.

E. All power and signal wires have been properly terminated.

F. All connectors shall be, as a minimum, water tight.

G. All wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.

H. All wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the ENGINEER. All wiring shall be protected from sharp edges and corners.

I. All mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.

J. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. The System Supplier shall certify in writing that for each loop or system, all discrepancies have been corrected.

K. The OWNER will not be responsible for any additional cost of rework attributable to actions of the CONTRACTOR or the System Supplier.

17000.13 FIELD QUALITY CONTROL

17000.13.1 LOOP VALIDATION. All instruments, devices, valves, feeders, and systems shall be verified and adjusted after installation, in conformance with the component manufacturer's instructions.

A. Loop Validation Test. Each instrument shall be field verified and/or calibrated by the Electrical & Controls Contractors.

1. During the test procedure the instrument loop shall be validated. The output from the instrument shall be varied and the associated PLC register, HMI display, and/or SCADA screen value shall be observed to confirm output value, scale, range, and units from the device through the final control system element.
2. Instrument and Instrument Component Validation: Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance its Manufacturer's specifications and instructions.
3. Any instrument which fails to meet any Contract requirement, or, in the absence of a Contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the ENGINEER at no additional cost to the OWNER.

B. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA System. Actual signals shall be used wherever available.

C. Following any necessary corrections, the loops shall be retested.

D. Specified accuracy tolerances for each analog network are defined as the square root of the sum of the squares of individual component accuracy requirements.

17000.13.2 Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever Contract accuracy requirements are not indicated.

A. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network.

B. For networks which incorporate analog elements, simulated sensor inputs corresponding to 0, 10, 50, 90 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated network accuracy tolerance requirements.

C. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices.

D. Provisional settings shall be made on controllers and alarms during analog loop tests.

E. All analog loop test data shall be recorded on test forms which include calculated network system accuracy tolerance requirements for each output.

F. Each field device requiring an analog output shall be exercised through the control system. During this validation process the output from the PLC shall be varied and the end device position, speed, etc. shall be measured to confirm the proper operation of the device for the supplied analog signal from the control system.

G. Each field device providing a discrete input to the control system shall be exercised in the field and the proper operation shall be observed at the control system.

1. Limit switches shall be tested and limits set mechanically and then proper operation shall be observed as reported to the control system.
2. Starters, relay contacts, switch contacts shall be exercised and proper operation shall be observed as reported to the control system.
3. Instrument supplying discrete inputs to the control system shall be calibrated and tested, and the proper operation shall be observed as reported to the control system.

H. Each field device accepting a discrete output signal from the control system shall be exercised in the field and proper operation shall be confirmed by correlating the control system signal with the actual response in the field.

1. Valves shall be stroked through outputs from the control system and proper directional operation shall be field confirmed, as well as limits, and reports back the control system.
2. Motors starters shall be exercised from the control system and proper operation verified through direct field observation.
3. Solenoids and other field devices shall be exercised from the control system and proper operation verified through direct field observation.

I. Instrument validation sheets shall be completed for each and every field instrument and/or analyzer that provide the following information and a space for sign-off on individual items and on the completed unit:

1. Project name.
2. Loop number.
3. Tag number.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Analog input devices:
   a. Calibrated range
   b. Analog input associated PLC register address.
   c. Value in PLC register at 0, 10%, 50%, 90% and 100% of span.
   d. Value in SCADA database at 0, 10%, 50%, 90% and 100% of span.
8. Analog output devices:
   a. Calibration range.
   b. Analog output associated PLC register address.
   c. Control variable value at field device at 0, 10%, 50%, 90% and 100% of span.
   d. Physical device response 0, 10%, 50%, 90% and 100% of span. Response to be actual valve position, or motor speed, etc.
9. Discrete instrument input devices:
   a. Switch setting, contact action, and dead band.
   b. Valve position switches:
      1) Response in the PLC as the valve is stroked from the PLC.
      2) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
   c. Operator interface switches and associated response.
   d. Starter and drive auxiliary device contact response.
   e. Response of all other discrete inputs to the PLC.
10. Discrete output devices:
    Documented observed response of field device to the discrete output from the PLC.
    Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
11. Utilize the Factory Acceptance Test, PLC I/O Test form format modified to become the Loop Validation Test Checklist.
12. Space for sign-off by Electrical & Controls Contractors and date.
13. Test equipment used and associated serial numbers.

17000.13.3 PRE-COMMISSIONING TEST.

A. General. Pre-commissioning test shall commence as specified in paragraph 17000.8 of this Section. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

B. Pre-commissioning Procedures and Documentation. All pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the ENGINEER. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the ENGINEER, which include calculated tolerance limits for each step. Completion of all system pre-commissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the ENGINEER with a clear and unequivocal statement that all system pre-commissioning and test requirements have been satisfied.

C. Operational Validation. Where feasible, system pre-commissioning activities shall include the use of water or air as applicable to establish service conditions that simulate, to the greatest extent possible the normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

D. Loop Tuning. All electronic control stations incorporating proportional, integral or derivative control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response.

E. If excessive oscillations or system instability, as determined by the ENGINEER, occur the Electrical & Controls Contractors, in conjunction with the ENGINEER, shall develop and implement any additional control algorithms needed to achieve an optimal control loop operation, at no additional cost to the OWNER.

F. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 10, 50, 90 and 100% of span and the results checked against indicated accuracy tolerances.

G. Pre-commissioning Validation Sheets. Pre-commissioning shall be documented on one of two types of test forms as follows:

1. For functions which can be demonstrated on a loop-by-loop basis, the form shall include:
   a. Project name.
   b. Loop number.
   c. Loop description.
   d. Tag number, description, manufacturer and data sheet number for each component.
   e. Space for sign-off and date by both the Electrical & Controls Contractors and ENGINEER.

f. Use the FAT Loop Test Checklist forms modified to meet these specific testing conditions.

2. For functions which cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:
   a. Specification page and paragraph of function demonstrated.
   b. Description of function.
   c. Space for sign-off and date by both the Electrical & Controls Contractors and ENGINEER.
   d. Use the FAT Loop Test Checklist forms modified to meet these specific testing conditions.

F. Functional Performance

1. General. The complete control system including all SCADA screens, reports, trends, etc. shall be functional throughout the pre-commissioning test. The complete control system shall perform all specified functions within the time frames listed below, based on the ultimate system expansion. Tests or calculations shall be developed to extrapolate from the initial system measured performance to the expanded system performance.
2. Data Update Times. Data received from RTUs shall be displayed on the operator's console within 1 second of receipt of such data at the workstation, regardless of originating RTU, state of the data received, and the number of stations that require the data. Alarm printouts, when required, shall be initiated within the same 1 second time frame.
3. Screen Displays. Any specified screen display, except trend displays, shall be drawn complete on any furnished CRT, including all real-time data, within 3 seconds from an operator request for the displays.
4. Trend Displays. Any specified trend display containing up to three trend lines and any time interval, both real-time and historical, shall be drawn complete on any furnished CRT within 10 seconds from an operator request for the trend display.
5. Reports. Any specified report shall be compiled and printing initiated on any furnished printer within 30 seconds from an operator request for the report.

G. Pre-commissioning Certification. The Electrical & Controls Contractors shall submit an instrumentation and control system pre-commissioning completion report which shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing.

17000.13.4 PROOF OF CONFORMANCE. The burden of proof of conformance to specified accuracy and performance is on the Electrical & Controls Contractors. The Electrical & Controls Contractors shall supply necessary test equipment and technical personnel if called upon to prove accuracy and/or performance, at no separate additional cost to the OWNER, wherever reasonable doubt or evidence of malfunction or poor performance may appear.

17000.13.5 TESTING. All systems shall be exercised through functional and operational tests in the presence of the owner's representative in order to demonstrate achievement of the specified performance. Operational tests depend upon completion of work specified elsewhere in these Contract Documents. The scheduling of tests shall be coordinated by the CONTRACTOR among all parties involved so that the tests may proceed without delays or disruption by uncompleted work.

17000.13.6 ADJUSTING. At no separate additional cost to the OWNER, the System Supplier shall include the following services of qualified technical representatives of the Electrical & Controls Contractors, and the Electrical Contractor.

A. Make all necessary adjustments, calibrations and tests.

B. Control Valves: All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to insure that no changes have occurred since the bench calibration.

17000.13.7 CLEANING. All control panels and enclosures shall be vacuumed clean prior to start-up and again after final completion of the project. All panel surfaces shall be cleaned, any scratches and/or defects shall be repaired to "new" condition. If in the engineer's opinion the panel repairs do not constitute "new" condition, they shall be replaced with new panels at no additional cost to the OWNER.

A. All instrument faces and enclosures shall be wiped and/or vacuumed clean.

B. Removal of Abandoned Equipment: All existing instrumentation and control equipment that is no longer required after the new system has been put into service shall be removed and delivered to the OWNER by the CONTRACTOR.

17000.13.8 DEMONSTRATION

A. Performance Test. After successful completion of the pre-commissioning test as accepted by the ENGINEER and OWNER, the performance test and system startup by the OWNER'S operating personnel can follow.

B. General. Completed in conformance with this Section. The performance test is part of the work that must be completed as a condition of substantial completion for the entire project. The complete PLC control and SCADA system must run continuously for the duration of the performance test. During this period, all system functions shall be exercised, and any system interruption and accompanying component, subsystem, or program failure shall be logged for cause of failure, as well as time of occurrence and duration of each failure. The System Supplier and Instrumentation and Control System ' Contractor shall provide a competently trained technician or programmer on call for the project site during all normal working days and hours from the start of the performance test until final acceptance of the system. Response time to the project site shall be within 24 hours of a major failure.

C. Process Control System Testing. The entire process control system shall be tested and used under standard operating conditions.

D. SCADA System Testing. The systems to be tested on-line will include the Display Generator Programs, the Report Generator Programs, high level language Compiler, the Editor, the Debugging Program, and the PLC driver software.

1. Each system function, e.g., status report, alarms, logs, and displays shall be exercised several times at a minimum, and in a manner which approximates "normal" system operation.

2. At least four displays will be specified and generated during the test, which may also be specified as reports to be printed automatically, the programs generated, and the resulting data entered into the database.
3. Failure of the system during the above program testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications and corrective action shall be required before restarting the acceptance test.
4. Only those components, sub-systems, and systems covered in this specification and supplied under this contract shall be considered for this acceptance test.
5. Problems and failures of other systems shall not be considered as part of this test, except as they display the capabilities of this system to detect failures.

E. Failures. Failures shall be classified as either major or minor.

1. A minor failure would be a small and noncritical component failure or software problem which can be corrected by the owner's operators. This occurrence shall be logged but shall not be reason enough for stopping the test and shall not be grounds for non-acceptance. Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance. Failure of one printer, or CRT display shall be considered a minor failure providing all functions can be provided by backup equipment, ie. alternate printers and CRT's, and repairs can be made and equipment returned to service within 3 working days.
2. A major failure shall be considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
   a. A major failure shall cause termination of the performance test.
   b. When the causes of a major failure have been corrected, a new acceptance test shall be started.
   c. Failure of a control loop to maintain stability or function properly resulting in a process disturbance.
   d. Failure of any control system that results in an overflow, underflow, overdose, or underdose condition shall be considered as a major failure.

F. Technician Report. Each time a technician is required to respond to a system malfunction he or she must complete a report which shall include details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.

1. If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report shall be required or logged as specified above.
2. If a technician has performed work but no report is written, then a major failure shall be considered to have occurred.
3. Each report shall be submitted within 24 hours to the ENGINEER or its representative, and the OWNER.

17000.14 TRAINING

17000.14.1 GENERAL: The Electrical & Controls Contractors shall provide system maintenance and operator training courses by a qualified instructor for all the instrumentation, control, and computer monitoring and control systems furnished for this project.

A. All instruction training material shall be provided by the Electrical & Controls Contractors.

B. One of the individuals conducting the course must the same individual responsible for the majority of the programming that was performed for the instrumentation and control system.

17000.14.2 SCHEDULE: In conformance with the requirements of paragraph 17000.8 Sequencing and Scheduling of this Section.

17000.14.3 Agenda: The training shall include operation and maintenance procedures, trouble shooting with necessary test equipment, and changing set-points, and calibration for that specific piece of equipment.

17000.14.4 Maintenance/Operator Training. A maintenance/operator training course shall be provided for up to eight (8) designated personnel and representatives of the OWNER.

A. This course shall be designed to provide the operations, maintenance and supervisory personnel with training in routine and preventive maintenance of all items in the instrumentation, control and the computer monitoring and control systems.

B. The training course shall include instruction on the use of all maintenance equipment provided under Section 17.

C. During the course, hands-on experience with the system equipment shall be provided.

D. Course duration. PLC-based control system training shall be a minimum of 1 day with a total of 8 hours of training. SCADA system training shall be a minimum of 1 additional day with 8 hours of training.

E. Special emphasis shall be given to the following:

1. Locating of problems by software techniques and correcting the problems by replacement at the module level.
2. Use of the report generator program and display generator program with the object of making changes and additions to existing reports and displays as well as adding further reports and displays in the future.
3. Method to be used for scheduling and changing the scheduling of reports.
4. Conversion of engineering units.
5. Hardware and/or software of the PLCs, enabling adding or deleting analog and status points.

F. How to interpret the CRT displays, alarm reports, and other reports.

17000.15 METHOD OF MEASUREMENT

17000.15.1 RTU-01. RTU-01 will be installed in a professional and workmen like manner. The contractor shall demonstrate to the owner and engineer the functionality of the RTU-01.

16400.5 BASIS OF PAYMENT

16400.5.1 No separate payment shall be made for furnishing or installing control systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the Contractor.

16400.5.2 When control systems, components, or materials are measured for a new building or enclosure as shown on the Bid Schedule, separate payment will be made as listed below.

16400.5.3 When initial installation or replacement of control systems, components, or materials is made in an existing building as shown on the Bid Schedule, the accepted quantity will be paid for at the contract price listed below:

PAY ITEM	UNIT
RTU-01	Lump Sum

SECTION SP17000
INSTRUMENTATION & CONTROL, GENERAL
Attachment A - Instrument List

Tag	Service/Location	Description	Specification	Range	Setpoint	Drawing	Notes
ESL-101	Filtration	Utility Power OK Relay		DI		I-3.1	120Vac Relay mounted in RTU
LSH-103	Filtration	Flood Sensor	17321	DI		I-3.1	
YS-104	Filtration	Generator Running		DI		I-3.1	Dry Contact on Generator
Drum Filters							
YI-130	Drum #1	Run Status		DI		I-3.1	
YS-130	Drum #1	In Auto Status		DI		I-3.1	
YA-130	Drum #1	Fail/Overload		DI		I-3.1	
YI-131	Drum #2	Run Status		DI			Verify with PR Agua
YS-131	Drum #2	In Auto Status		DI			Verify with PR Agua
YA-131	Drum #2	Fail/Overload		DI			Verify with PR Agua
YI-132	Drum #3	Run Status		DI			Verify With PR Agua
YS-132	Drum #3	In Auto Status		DI			Verify With PR Agua
YA-132	Drum #3	Fail/Overload		DI			Verify With PR Agua
UV Disinfection							
TAH-210	Control Panel	Reactor Temperature		DI		I-3.2	
RI-210	Control Panel	UV Intensity		DI		I-3.2	
VL-210	Control Panel	Lamp Status		DI		I-3.2	
JIC-210	Control Panel	Lamp Power Level		DI		I-3.2	
JI-210	Control Panel	UV Reactor Offline		DI		I-3.2	
LT-211	UV Tank	Water Level Sensor		4-20mA		I-3.2	
FT-212	UV Exit Pipe	Magnetic Flow Meter		4-20mA		I-3.2	

Tag	Service/Location	Description	Specification	Range	Setpoint	Drawing	Notes
Recirculation Pump							
TAH-310	Fish Ponds	Temperature Alarm		DI		I-3.3	
MAH-310	Fish Ponds	Moisture Alarm		DI		I-3.3	
YI-310	Fish Ponds	Run Status		DI		I-3.3	
YS-310	Fish Ponds	In Auto Status		DI		I-3.3	
YA-310	Fish Ponds	Fail/Overload		DI		I-3.3	
YX-310	Fish Ponds	Run Command		DI		I-3.3	

17050.1 SUMMARY

A. This Section includes:
   1. General control strategies that shall apply to all control schemes.
   2. For specific control strategies as they apply to the specific control loops of this project see Section SP17050.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

17050.2 COMMON CONTROL FUNCTIONS

A. Common control functions are common to all control loops and devices and shall be incorporated into the control schemes for all devices.
   1. Common control schemes are identified on the P&IDs and reflected in the control schematics to some extent, but are not repeated in the individual loop descriptions and may not be shown on the P&IDs.
   2. By nature of the fact that these are common control functions they shall be incorporated into all control strategies, whether they are shown and/or described or not.

B. Common control functions are as follows:
   1. Alarm fail condition, unless otherwise specified, shall be logically derived under and of the following conditions:
      a) Device is commanded to start, and the starter auxiliary contact does not echo the command.
      b) Device is commanded to stop, and the starter auxiliary contact does not echo the command.
      c) Device is commanded to open, and the open limit switch does not echo the opened condition in two times the normal full travel time.
      d) Device is commanded to close, and the close limit switch does not echo the closed condition in two times the normal full travel time.
   2. Motor winding temperature switches, unless otherwise specified, shall only alarm a high temperature condition and not stop the motor.
   3. Motor overload switches shall always stop the motor, by de-energizing the motor starter.
   4. Motor winding heaters shall always be powered through the motor starter control power transformer, and a normally closed auxiliary contact on the starter.
      a) The ICSC and System Supplier shall verify that the auxiliary contact on the starter has sufficient capacity to energize and/or de-energize the motor winding heater. If the auxiliary contact is not rated for this load an interposing relay shall be added at no additional cost to the OWNER.
      b) The ICSC and System Supplier shall verify that the control power transformer has sufficient capacity for the motor winding heater. If the control power transformer is not rated for this load a larger transformer shall be used to replace the original at no additional cost to the OWNER.
   5. Elapsed run time shall be determined through an auxiliary contact on the starter which is an input to the PLC.
      a) Elapsed run time shall be displayed at the SCADA level for each and every motor controlled through the PLC system.

b) Individual elapsed run time accumulation shall be reset by the operator after entering a password if the proper security level is associated with said password.
c) Elapsed run time shall be displayed as 99,999.9 hours after which the elapsed run time registers shall recycle to 0.0 hours.
d) Provisions shall be made to allow the operator to enter a start value for runtime accumulation.
e) Elapsed run time shall be accumulated and stored in PLC registers and not in the SCADA system.

6. Status run shall be determined through an auxiliary contact on the starter which is an input to the PLC.
7. PID control algorithms.
   a) Each PID control algorithm shall have a face plate associated with the individual PID control algorithm that shall be displayed at its associated HMI and at the SCADA terminal. Said face plate shall have the following functions:
      (1) Display Output, CV.
      (2) Display Setpoint, SP.
      (3) Display Process Variable, PV.
      (4) Allow for operator selection of Automatic or Manual control of Output.
      (5) Under manual control of output allow the Operator to enter the desired output value.
      (6) Allow for input of the three PID tuning parameters.
8. Each panel, designated by a RTU or MTU number, shall contain a PLC and a HMI unless otherwise shown on the drawings. The HMI shall be used as the primary operator interface for entering parameters particular to the system.
   a) A main menu screen shall be developed that will allow the operator to access the system screens using software keys.
   b) There shall be a screen for each individual system within the panel that reflects or allows:
      (1) Tank level.
      (2) Line Pressure.
      (3) Flow Rate.
      (4) Others as needed and directed by the ENGINEER.
   c) Standard system HMI setpoints shall include but are not limited to:
      (1) Tank high and low levels
      (2) Line pressure high and low setpoints.
      (3) Flow rate high and low setpoints.
      (4) Others as needed and directed by the ENGINEER.
9. Status indication:
   a) The associated pilot light, HMI display, and SCADA display for each valve and pump shall indicate valve position by constantly illuminating the corresponding status indication and report this condition to the SCADA system.
   b) As previously described a fault condition shall flash the associated status indicator and alarm within the SCADA system.
   c) When a valve is in transition, not fully closed and not fully opened, then the valve open and valve closed status indicator shall:
      (1) For HMI and graphic displays state that the valve is in transition.
      (2) For pilot lights shall alternately flash on and off the valve fully opened and fully closed pilot lights.

10. When setpoints or actions are identified to occur on more than one HMI, or both the HMIs and SCADA, the last action or setpoint shall override the current condition, unless otherwise noted.
11. The manual control mode shall be completely manual and under operator control, there shall be no programmed interlocks requiring completion of a previous step before operating a device, unless specifically identified in the individual loop descriptions as occurring in the manual mode.

C. Alarm/Fault Indication/Acknowledgment
1. Furnish an alarm acknowledgment HMI pushbutton function at each HMI that Acknowledge Alarms.
2. In general any fault condition shall flash the appropriate graphic symbol and generate an audible alarm.
3. The individual alarm acknowledgment action shall function as follows:
   a) Shall change the flashing alarm indication to continuously ON if the alarm or fail condition persists after the acknowledgment action has been depressed.
   b) Shall turn OFF the alarm indication if the alarm or fail condition has been corrected and the alarming system has returned to normal.
4. All alarm and fail conditions shall flash their respective SCADA graphics, until the condition is acknowledged by the operator.
   a) Once the operator acknowledges the alarm or fail condition the SCADA graphic shall remain ON in a steady condition.
   b) Once the alarm has been cleared and the operator again acknowledges the alarm or fail condition the SCADA graphic shall turn OFF.
5. An alarm silence HMI pushbutton command shall silence an audible alarm but continue to show the visual alarm.
6. All valves, pumps, motors, and other process equipment shall have fail alarms displayed and reported at the HMI and SCADA level.
7. Any alarm that is not acknowledged after a setpoint period of time shall activate the auto dialer.

D. Tank and vessel levels.
1. All tank and vessel levels shall be displayed both in feet (XX.XX) and gallons, whether or not specifically identified in the P&IDs or Loop descriptions.
2. All identified tanks and/or vessels that have a level measurement shall include, whether or not identified, the following minimum functions that shall be displayed on the associated HMI and SCADA System.
   a) Numerical readout of process material level in the tank.
   b) Numerical readout of process material volume in the tank.
   c) Setpoint for high level and high level alarm.
   d) Setpoint for low level and low level alarm.
   e) Setpoints for high level and low level shall be entered as a level or volume as directed by the ENGINEER.

E. Power failure.
1. The control system upon sensing a power failure shall store, within, the PLC memory the current status of all devices, ie. ON or OFF.
2. Upon restoration of power the control system shall then sequence ON all equipment that was running prior to the power failure condition.
3. PLCs operating from UPS power shall monitor utility power status and differentiate between true alarm conditions and alarm conditions caused by power failure.

a) Conditions which are to be expected during power loss (ex. fail to run, open or close and some fail-safe equipment fault alarms) shall not be initiated due to loss of power, except for specific power loss alarms.
b) Other alarms (such as high and low level alarms) shall continue to function during power loss conditions.
c) A Power Loss Alarm shall be sent to the auto dialer.

F. PLC System Status
1. There shall be a minimum of one SCADA screen that shall show the status of all PLCs in the system.
2. There shall be a minimum of one SCADA screen that shall show the status of the PLC communications LAN.

17050.3 FORMAT

A. Based upon the information furnished in the Contract Documents, the CONTRACTOR shall develop detailed loop descriptions.

B. There shall be one loop description for each and every loop in the system.
1. Where there are similar loops, ie multiple loops for individual raw water pumps, only one loop description need be developed and the remaining loops may be referenced to said loop description.

C. The loop descriptions shall follow the format as outlined below:
1. Abstract
a) General description of how the loop works, what devices are involved, and how the process if to be controlled.
b) Process variable information including flow rates, level ranges, pH, turbidity, etc. shall be listed including measurement range, span, limits, setpoints, and units.
2. Local Level
a) Detailed description of the control functions at the Local Level.
b) Function of local operator interfaces.
c) Detailed explanation of the operation of system interlocks and hardwired permissive conditions.
3. PLC Level
a) Detail description of the control functions that are under control of the PLC.
b) Detailed description of the operator controls and automatic controls.
c) Detailed description of setpoints, alarms, etc.
d) Detailed description of the operation of system interlocks.
e) Detailed description of the control sequence.
4. HMI Level
a) Detailed description of the operator controls.
b) Detailed description of setpoints, alarms, etc.
5. SCADA Level
a) Detailed description of the operator controls.
b) Detailed description of setpoints, alarms, etc.

17051.1 GENERAL STRATEGY

Water level and flow need to be maintained to proved a healthy environment for the fish to grow. Water will flow from the spring/ponds to the filtration system. The water will flow through the drum filters across a weir and into the UV disinfectant system. The UV system is critical and cannot shut down at any time while water is flowing through the system. Water will flow from the UV system into the fish canals. If for some reason the Filtration and UV systems are down a back up recirculation pump shall provide water flow from the lower end of the fish canals back to the top. The critical nature of this system requires that there is an Uninterruptible Power Source (UPS) and a back-up generator.

17051.2 ALARMING

A Control Panel will be provided to collect the alarms from the different pieces of equipment. This central PLC will use digital inputs to collect outputs from the Drum Filter Control Panel, the UV System Control Panel, the UPS system, the generator and the Recirculation Pump Control Panel. A Human Machine Interface (HMI) shall be used to provide a means of operator interface and record keeping. A Sensafone or similar type device will be used to call out to at least 4 different numbers, to warn the operator of any problems. The operator will want to know if the drum filters motors are in a fault condition. The UV system is having power problems, and if the UPS system has been active. If the generator has come on due to a power outage or if the recirculation pump has had to come on due to low flow conditions.

17051.2.1 Potential alarm list:

1. Utility Power Off
2. Generator running
3. UPS system off
4. Drum filter motor fail x3
5. UV reactor off line
6. UV intensity alarm
7. UV reactor temp alarm
8. Recirculation pump fail alarm

17051.3 HVAC CONTROL

The Control Panel will be used to control the HVAC System also. The operator will have the ability to adjust temperature and humidity from the HMI. Analog inputs will continually monitor air temperature and moisture. Digital inputs and outputs from the PLC will be used to turn intake fans, exhaust fans and heater units on when required. The Control Panel will have 4 Operation Modes preprogrammed as follows:

1. COOLING MODE
2. HUMIDITY CONTROL MODE
3. FREEZE PROTECTION MODE
4. OCCUPANCY MODE

1. COOLING MODE

   CONDITIONS:

   Inside dry bulb temperature (TE-105) > 70°F

   Equipment Status:

   EF-1 = ON

IH-1 = ON
IR-1abc = OFF

2. HUMIDITY CONTROL MODE:
   CONDITIONS:
   Outside ambient dry bulb temperature (TE-206) > 32°F
   Inside relative humidity (MI-205) > 50%
   Equipment Status:
   EF-1 = ON
   IH-1 = ON
   IR-1abc= OFF

3. FREEZE PROTECTION MODE:
   CONDITIONS:
   Inside dry bulb temperature (TE-105) < 50°F
   Equipment Status:
   EF-1 = OFF
   IH-1 = OFF
   IR-1abc = ON

4. OCCUPANCY HEATING MODE:
   CONDITIONS:
   Occupancy Button: ON
   Inside dry air bulb temperature (TE-105) < 60°F

   Heating shall continue to 60°F for 3 hours and then return to Freeze Protection Mode.

   Equipment Status:
   EF-1 = OFF
   IH-1 = OFF
   IR-1abc = ON

17100 GENERAL

17100.1 SUMMARY

A. This section sets the general specifications and requirements for all the control panels and enclosures being provided under this contract.

1. Included but not limited to all:
   a. All custom built and designed control panels including RTU's, LCP's.
   b. Control panels furnished as part of equipment systems including VCP's.
2. The Electrical Contractor shall furnish, supply and install all custom control panels for this project in accordance CONTRACT documents.
3. This section also covers requirements for local control panels being supplied by the Equipment Manufacturers as part of the packaged equipment.
4. This specification covers the requirements for the fabrication of instrument boards, mounting, finishing, piping and wiring of instrument equipment.

B. RELATED SECTIONS

1. The contract Documents are a single integrated document, and as such Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

2. This section shall be used in conjunction with the following specification sections:
   a. General Electrical Requirements – Section 16010.
   b. Instrumentation & Control, General – Section 17000.
   c. Instrumentation & Control, General-Instrument List – Section SP17000.

17100.1.1 SYSTEM DESCRIPTION

A. Scope: The Electrical & Controls Contractors shall furnish the following custom control panels:

See Section SP17100 for Instrumentation Control Panels, General - Panel List

B. General requirements that apply to all control panels.

1. The control voltage within the control panel controls shall be 120 VAC. Where the electrical power supply to the control panel is 240 VAC single phase or 480 VAC 3-Phase, as shown on the electrical drawings, the control panel shall be provided with a control power transformer.

2. The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:
   a. Solenoid valves
   b. Instruments and transmitter both mounted in the control panel and remotely connected to the control panel.
3. Source power for control panels.
   a. All control panels shall be supplied with a maximum of 480 VAC, 3 phase, 60 Hz. power.

b. Each control panel that as supply power greater than 120VAC single phase, then the control panel shall have a flange mounted disconnect, interlocked with the enclosure door, to be used to isolate the control panel from the supply power.

c. Supply all transformers, protection, and power supplies needed to convert the supply voltage to the needed utilization voltage within each control panel.

d. If the control power transformer and primary circuit breaker is located in an adjacent motor control center or panel board, then the requirement for a flanged mounted disconnect is waived in lieu of a nameplate attached to the control panel identifying the location of the source of power for the control panel.

e. The panel must have a nameplate identifying this circuit breaker feeding the panel and a warning statement requiring that the feeder beaker be turned off before opening the door to the enclosure.

4. Enclosure general requirements.

a. Control panels shall have enclosures that meet the area classifications as specified on the drawings.

b. For those areas not specified:

1) Installed indoors NEMA 12 enclosures with gasketed doors shall be used.

2) Control panels installed outdoors shall be housed in NEMA 4X enclosures.

c. Control panels shall be either freestanding, pedestal-mounted, or equipment skid-mounted, as specified or shown.

d. Internal control components shall be mounted on an internal back-panel.

1) Devices may be mounted on the side-panel only by special permission from the Engineer.

5. Each source of foreign voltage shall be isolated by providing disconnecting or pull-apart terminal blocks or a disconnect operable from the control panel front.

6. Motor starters, where required, shall be provided to meet the requirements specified in Section 16150, “Electrical Control Devices”.

7. Discrete outputs from the control panel shall be provided by electrically isolated contacts rated for 5 amps at 120 VAC. Either through the use of an interposing relay or relay output card associated with the PLC.

8. Analog inputs and outputs shall be an isolated 4-20 mA 2-wire signal with power supply.

9. All control panel mounted operator interface devices shall be mounted between:

a. A minimum of 3 feet above finished floor elevation.

b. A maximum of 6 feet above finished floor elevation.

17100.1.2 SUBMITTALS

A. In accordance with Section 17000.5 Process Control & Instrumentation General Requirements.

B. Control Panel Engineering Submittals: Submit a control panel engineering submittal for each control panel and enclosure being provided for this project.

1. Control Panel Hardware submittal that shall include but not be limited to:

a. Enclosure construction details and NEMA type.

b. Finish, including color chart for ENGINEER selection of color.

c. Layout.
d. Power circuits.
e. Signal and safety grounding circuits.
f. Fuses.
g. Circuit breakers.
h. Signal circuits.
i. Internally mounted instrumentation.
j. PLC's.
k. Systems Integrator components.
l. Face plate mounted instrumentation components.
m. Internal panel arrangements.
n. External panel arrangements.
o. Construction drawings drawn to scale that define and quantify:
   1) The type and gauge of fabrication steel to be used for panel fabrication.
   2) The ASTM grade to be used for structural shapes and straps.
   3) Panel door locks and hinge mechanisms.
   4) Type of bolts and bolt locations for section joining and anchoring.
   5) Details on the utilization of "UNISTRUT" and proposed locations.
   6) Stiffener materials and locations.
   7) Electrical terminal box and outlet locations.
   8) Electrical access locations.
   9) Print pocket locations.
   10) Writing board locations.
   11) Lifting lug material and locations.
p. Physical arrangements drawings drawn to scale that define and quantify the physical groupings comprising:
   1) Control panel sections.
   2) Auxiliary panels.
   3) Sub-panels.
   4) Racks.
   5) Cutout locations with nameplate identifications shall be provided.
q. A bill of material that enumerates all devices associated with the control panel.

2. Control Panel Wiring Diagram submittal that shall include but not be limited to:
   a. Schematic/Elementary diagrams shall depict all control devices and circuits and their functions.
   b. Wiring/Connection diagrams shall locate and identify:
      1) Electrical devices.
      2) Terminals.
      3) Interconnecting wiring.
      4) These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.
   c. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.

d. Control sequence diagrams shall be submitted to portray the contact positions or connections required to be made for each successive step of the control action.

e. Input/Output (I/O) Diagrams for PLC I/O cards.

3. All panel drawings shall be 22" x 34" reduced to and fully legible at 11" x 17 submitted at 11" x 17" format size, with all data sheets and manufacturer specification sheets being 8.5" x 11".

4. The submittal shall be in conformance with NEMA Standard ICS-1-1.01, and each phase shall be submitted as a singular complete bound volume or multi-volume package and shall have the following contents.

a. A complete index shall appear in the front of each bound volume.

1) All drawings and data sheets associated with a panel shall be grouped together with the panels being indexed by systems or process areas.

2) All panel tagging and nameplate nomenclature shall be consistent with the requirements of the Contract Documents.

b. A listing of spare parts as specified in the drawings.

17100.1.3 QUALITY ASSURANCE

A. All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents.

B. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices to within a range equal to 20% above the minimum and 20% below the maximum of the rated environmental operating ranges.

C. Provide all power wiring for these devices.

D. Enclosures suitable for the environment shall be furnished.

E. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

F. All control panels and assemblies shall be labeled and listed by a nationally recognized testing laboratory.

1. U.L. 508 or approved equal.

17100.1.4 DELIVERY, STORAGE AND HANDLING

A. All panels are to be crated for shipment using a heavy framework and skids. The panel sections shall further be cushioned satisfactorily to protect the finish of the instruments and panel during shipment. All instruments that are shipped with the panel shall further have suitable shipping stops and cushioning material installed in a manner to protect instrument parts that could be damaged due to mechanical shock during shipment. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.

B. All shipments shall be by dedicated air ride van, unless otherwise specified or approved.

17100.1.5 WARRANTY

All equipment in control panels shall be under warranty for a period of one year from the date of completion of the control system start up.

17100.2 PRODUCTS

17100.2.1 MANUFACTURERS

A. Standard manufactured panel shall be used, whenever, possible.

1. As manufactured by:
   a. Hoffman Engineering.
   b. Rob Roy.
   c. Control Engineering.
   d. Saftronics of Utah, built to Hoffman Specifications.

B. Stainless steel control panels shall be standard manufactured panels whenever possible.

1. As manufactured by:
   a. Hoffman Engineering.
   b. Stalin.
   c. Saftronics of Utah, built to Hoffman Specifications.

C. Water tight corrosion resistant non-metallic enclosures shall be standard manufactured panels whenever possible.

1. As manufactured by:
   a. Hoffman Engineering.
   b. Stalin.

17100.2.2 MATERIALS

A. Materials:

1. Panel section faces shall be:
   a. No. 10 gauge minimum thickness steel for custom built freestanding panels.
   b. No 14 gauge minimum thickness steel for smaller panels.
   c. All materials shall be selected for levelness and smoothness.
2. Relay rack high density type panels shall:
   a. Utilize standard relay racks.
   b. With No. 14 gauge steel frame and supports.

3. Structural Shapes and Strap Steel:
   a. ASTM A-283.

4. Bolting Material:
   a. Commercial quality carbon steel bolts, nuts and washers, shall all be ½ inch diameter with UNC threads.
   b. Carriage bolts shall be used for attaching end plates.
   c. All other bolts shall be hex head machine bolts.
   d. All nuts shall be hot pressed hex, American Standard, heavy.
   e. Standard wrought washers shall be used for foundation bolts and attachments to building structures.
   f. All other bolted joints shall have S.A.E. standard lock washers.

5. Dimension:
   a. It is the responsibility of the ISCS and/or VCP manufacture to design and size all panels based upon:
      1) Available space in area as shown on the plans.
      2) Device and equipment requirements for component located within the control panel.

   b. The ENGINEER has based the size of the control panels as reflected on the plans on non-certified information and as such these sizes are to be uses as a general guideline.
      1) Panel sizes that substantially deviate (+3 inches) from the sizes shown on the plans, must be approved by the ENGINEER.

17100.2.3 MANUFACTURED UNITS

A. Enclosure

1. NEMA 12
   a. Enclosure designed to house electrical controls, terminals, and instruments, providing protection from:
      1) Dust
      2) Dirt.
      3) Oil.
      4) Water.
   b. Seams continuously welded and ground smooth.
   c. Door and body stiffeners as needed to make a rigid enclosure.
   d. Heavy gauge continuous hinge.
   e. Rolled lip around three sides of the door and all sides of the enclosure opening to prevent migration of liquids and contaminants into enclosure.
   f. Oil-resistant gasket attached to door with oil-resistant adhesive. Gasket to seal against roll lip on the enclosure opening.
   g. Internal mounting panel held in place by collar studs welded to enclosure.
   h. Door window when shown on the drawings.
      1) Safety plate glass.
      2) Held in place by rubber locking seal.
      3) To allow full view of numeric display, PLC I/O, LED display, and keyboard, etc.
   i. When shown on the plans a lockable door latching and handle mechanism to allow easy access to interior of enclosure and keyboard.
   j. Panel cutouts for instruments, devices, and windows shall be cut, punched, or drilled and smoothly finished with rounded edges. Reinforce around all cutouts with steel angles or flat bars.
   k. Finish.
      1) Interior, smooth, white polyester powder coating.
      2) Exterior polyester powder coating color to be determined by ENGINEER.
      3) Exterior brushed stainless for stainless steel panels.
   l. Manufacturer's standard gauge steel.

m. Each door to have a three-point latching mechanism and padlocking handle, with rollers on the ends of the latch rods.
n. With print pocket inside door.
o. With heavy duty lifting eyes.
p. With 15" floor stands or legs when shown on the drawings.
q. With flange mounted disconnect.
r. Conform to:
   1) NEMA Type 12.
   2) JIC EGP-1-1967.
   3) JIC EMP-1-1967.
   4) U.L. Listed.
s. Hinges: steel piano-type running full length of doors.
t. Mounting panel.
   1) 10 gauge steel.
   2) With stiffeners.

2. Water tight corrosion resistant stainless steel.
   a. NEMA 4X in design, dust tight, water tight, and corrosion-resistant.
   b. Minimum 14 gauge, Type 304 Stainless Steel.
   c. Captive stainless steel cover screws threaded into sealed wells.
   d. Oil resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
   e. Finish. Cover surface and sides, unpainted, brushed finish.
   f. Door fronts ground smooth.
   g. Specifically designed for use with flange mounted disconnect switches.
3. Watertight corrosion resistant non-metallic.
   a. Shall meet the applicable requirements of the stainless steel enclosures plus the following additional requirements.
   b. When specifically indicated on the plans and in the specifications, molded fiberglass reinforced polyester resin with 10 gauge plate steel reinforcing on the sides, top and bottom. Meeting the following minimum standards:

Physical Properties	Value	ASTM METHOD
Flexural Strength	29,000 PSI	D-790
Water Absorption	.07%	D-570
Tensile Strength	17,500	D651
Heat distortion	400 Deg. F	D-648
Specific Gravity	1.35	D-792
Dielectric Strength	400 V.PM.	D-149
Arc resistance	180 Sec	D-495
Flammability	94V-O	UL-94

   c. All seams sealed
   d. Hinges fiberglass with no exposed metal parts.
   e. Only exposed metal parts are to be captive stainless steel door screws that are easily replaced.
   f. Provisions for mounting panels must be an integral part of the enclosure whether by way of internal mounting channels welded to the interior or by way of spot-welded collar studs.
   g. Mounting panels to be constructed of aluminum plate.
   h. Panel finish.
      1) Gray exterior.
      2) White interior.
      3) White enamel aluminum mounting plate.

17100.2.4 ACCESSORIES

A. Flange Mounted Main Disconnect.

1. The control panels shall have an integrally mounted main disconnect switch consisting of a thermal magnetic circuit breaker when specified on the drawings.
   a. Minimum 22 KAIC.
   b. If the control panel is supplied at 120 VAC or less then the disconnect requirement may be waived: however, a nameplate must be furnished on the cover of the control panel identifying all sources of supply and foreign voltages within the control panel.
2. The main disconnect shall disconnect all power sources within the control panel.
3. The main disconnect shall be lockable in the off position.
4. The main disconnect shall be interlocked with the door of the control panel so that the door of the panel cannot be opened with the disconnect switch in the closed position.
   a. With defeater.
5. Flange mounted disconnects shall be used, door mounted disconnects are not acceptable.
6. Flange mounted disconnects as manufactured by:
   a. Allen Bradley 1494
   b. Cutler Hammer C361/C371
   c. ITE FH011
   d. Square D Class 94222

17100.2.5 FABRICATION

A. FRAMEWORKS AND SUPPORTS:

1. The rear of each panel section shall have a steel framework assembled to it for supporting conduit, wire ways, switches, piping and all instrument accessory items such as relay or terminal enclosures, transducers, pressure switches, valves and air relays.
   a. The mainframe work shall be constructed of standard structural shapes.
   b. Special shapes such as “UNISTRUT” may be used for secondary supports.
   c. Framework must neither interfere with instrument connections nor interfere with access needed for maintenance or adjustments.

2. Steel framework shall extend 2-feet 4-inches back from he panel face, or as shown on the drawings.
   a. Where specified, individual adjustable leg supports shall be provided at the back of the framework so that the entire panel shall be self-supporting.

B. PREPARATION OF PANEL SURFACE:

1. The surface of the panel shall be prepared for finishing in a manner equal to that described below. The entire surface shall comprise the front and rear face of the panel, both sides and the edges of all flanges, and the periphery of all holes or cutouts.
   a. All high spots, burrs, and rough spots shall be ground smooth.
   b. The surfaces shall be sanded or sandblasted to a smooth clean bright finish.

c. All traces of oil shall be removed with a solvent.
d. The first coat of primer shall be applied immediately.

C. PANEL FINISHING:

1. A thin coat primer surface shall be applied over the entire panel surface.
2. Wet sand, dry, then quick glaze spot putty on the front of the panel only. Dry, then wet sand again and dry.
3. A primer surface shall be applied on the front of the panel only.
4. Wet sand to smooth clear finish, and then dry.
5. At least 2 coats of polyester powder coating shall be applied over the entire surface.
6. Supply 2 one-pint containers of air-drying, matching paint for field touch-up of the panel face.

D. INSTRUMENT FINISHING:

1. The final coats applied to painted surface of instrument cases, doors, or bezels that are visible from the front of panels shall be manufacturer's standard unless otherwise specified.
2. Black Japan or "crinkle" finishes on instrument cases are not acceptable.

E. MOUNTING OF INSTRUMENTS:

1. Provide cut-outs, and mount all instrument items shown or specified to be panel mounted, including any instruments specified to be furnished by other vendors but installed in panel (if applicable).
2. Mount, behind the panels, other instrument accessory items as required and/or specified.
3. The rear of panel mounted equipment shall be installed with due regard to commissioning adjustments, servicing requirements and cover removal.
4. Spare space shall be kept clear of wiring, etc., to give maximum space for future additions.

F. ELECTRICAL REQUIREMENTS

1. Each terminal connection shall have a plastic plate with a terminal and instrument tag number.
2. All wiring shall be identified with permanent machine imprinted wire markers.
3. Freestanding panels shall be provided with switched fluorescent back-of-panel lights. One light shall be provided for every 4-feet of panel width and shall be mounted inside and in the top of the back-of-panel area.
4. Freestanding panels shall be provided with a 15-amp, 120-volt service outlet circuit within the back-of-panel area. The circuit shall be provided with 3-wire, 120-volt, 15-ampere, GFCI duplex receptacles one for every 4 feet of panel width (1 minimum per panel) and spaced evenly along the back-of-panel area.
5. Smaller panels shall be so sized as to adequately dissipate heat generated by equipment mounted in or on the panel.
6. Panel mounted outdoors, or in shaded areas, or in high humidity areas shall have the following accessories:
   a. Thermostatically controlled heaters that shall maintain the inside temperature above 40 Deg. F min or 10 Deg. F above ambient which ever is greater.

7. Smaller panels shall have the following accessory devices:
   a. Thermostatically controlled heaters that shall maintain the inside temperature above 40 Deg. F min or 10 Deg. F above ambient which ever is greater.
8. Smaller panels shall have the following accessory devices:
   a. Hand switch controlled 50-watt incandescent light.
   b. Breaker protected 120-volt, 15-amp duplex, GFCI receptacle.
9. Wiring Methods: Wiring methods and materials for all panels shall be in accordance with the N.E.C. requirements for General Purpose (no open wiring) unless otherwise specified. Open wiring in close cabinet type panels is allowed when specified in the material specifications.
10. Signal and Control Circuit Wiring:
    a. Wire type and sizes:
       1) Conductor shall be flexible stranded copper machine tool wire.
       2) These shall be UL listed Type MTW flexible or type SIS and shall be rated 600-volts.
       3) Wires for instrument signal circuits and alarm input circuits shall be No. 14 AWG.
       4) Wires connecting to PLC wiring arms shall be multi-conductor No. 20 AWG.
       5) All other wires, including shielded cables, shall be No. 16 AWG, minimum.
    b. Wire Insulation Colors:
       1) Conductors supplying 120-volts AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor.
       2) 120VAC grounded circuit conductors shall have white insulation.
       3) Insulation for ungrounded 120-volt AC control circuit conductors shall be red.
       4) 120VAC switched legs shall also have white or black color 'tick' on the insulation.
       5) Insulation for all positive DC conductors shall be blue.
       6) Insulation for all negative DC conductors shall be yellow.
       7) All switched DC legs shall also have white or black color 'tick' on the insulation.
       8) All wires energized by a voltage source external to the control panels shall conform to the above standards, but shall also be wrapped with purple electrical tape.
    c. Wire Marking:
       1) Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number, preferably the instrument loop number, which shall be shown on all shop drawings.
       2) These numbers shall be marked on all conductors at every terminal.
    d. Fused disconnect:
       1) Each signal and control circuit to have a fused disconnect.
11. For case grounding, panels shall be furnished with a ¼ - inch by 1 – inch copper ground bus complete with solderless connectors for all equipment ground conductors.
12. Electrical Locations:

a. Terminal boxes for incoming and outgoing signal leads shall be located at the top or bottom of the panel.

13. Power Supply Wiring:
    a. Unless otherwise specified, all instruments, alarm systems and motor controls shall operate on 115 VAC.
    b. At a location near the top of the panel, or bottom, furnish terminal box connections for the main power supply entry.
        1) Unless the main power connection can be made directly to the control panel disconnect behind a barrier.
    c. Each and every loop and instrument requiring 120 VAC shall be protected by individual DIN rail-mounted circuit breakers.
        1) The number of circuits depends on the circuit load as noted herein.
        2) A 15 amp, 2 pole circuit breaker shall be provided in each branch circuit.
        3) The circuit load shall not exceed 10 amps.
        4) Different panel sections or different process units must not use common branch circuits.
        5) Furnish and install DIN rail mounted circuit breakers for all individual instruments.
            a) Circuit breakers shall be mounted on the back of the panel.
            b) Identified by a service nametag.
            c) Each potentiometer type instrument, electronic transducer, controller or analyzer shall have an individual DIN rail mounted circuit breaker located within the control panel.
                i. Circuit breakers shall have plastic tags indicating instrument tag numbers.
                ii. Individual plug and cord set power supply connections require DIN rail mounted circuit breakers ahead of the receptacle.

14. Alarm Wiring:
    a. Install and wire all alarms including light cabinets, audible signal units, test and acknowledge switches and remote logic units as specified.
    b. Interconnecting wiring to panel mounted initiating devices shall also be wired.
    c. Where plug and cord sets are provided for component interconnection, harness and support the cables in neat and orderly fashion. Where separate wire is required, install No. 16 AWG with MTW or TFFN insulation between all components.

15. Signal Wiring:
    a. Signal Wire – Non Computer or PLC Use
        1) Signal wire shall be twisted pair or triads in conduit or troughs. Cable shall be constructed of No. 16 AWG copper signal wires with 90 Deg. C, 600 V insulation.
        2) Color code for instrument signal wiring shall be as follows:
            i. Positive (+) – Black.
            ii. Negative (-) – White.
        3) Multi-conductor cables where specified shall consist of No. 18 AWG copper signal wires twisted in pairs, pairs, with 90 Deg. C, 600 V insulation.

i. A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield. The overall bundle jacket shall be PVC.

4) Use for connections between field terminal blocks and the PLC wiring arms for analog inputs and outputs.

b. Signal Wire – Computer or PLC Use

1) Signal wires shall be similar to those for non-computer use but each pair shall be triplexed with a copper drain wire and aluminum polyester tape shall be applied over the triplexed group.

2) All cable shields, including thermocouple extension leads shall be terminated at a single point within the control panel.

3) Continuity of the shield is to be maintained throughout the cable runs.

c. Multi-conductor cables, wire ways and conduit shall be sized to allow for 20 percent spare signal wire.

16. Wiring Installation:

a. All wires shall be run in plastic wire ways.

b. Exception:

1) Field wiring.

2) Wiring run between mating blocks in adjacent sections.

3) Wiring runs from components on a swing-out panel to components on a part of the fixed structure.

i. Wiring run from components on a swing-out or front panel to other components on a fixed panel shall be made up in tied bundles.

ii. These bundles shall be tied with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals.

c. Signal and low voltage wiring shall be run separately from power and 120 VAC control wiring.

1) 120 VAC circuits shall be run through gray colored plastic wire ways.

2) 24 VDC circuits shall be run through white colored plastic wire ways.

d. Wiring to rear terminals on panel-mount instruments shall be run in plastic wire ways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

e. Provide an empty wire way for all field-wiring connections.

1) 120 VAC circuits shall be run through gray colored plastic wire ways.

2) 24 VDC circuits shall be run through white colored plastic wire ways.

3) Wire ways shall be no more than 50% full.

4) The distance from the terminals to the wire way shall be at least 3.0 inches.

f. Conformance to the above wiring installation requirements shall be reflected by details shown on the shop drawings for the ENGINEER's review.

17. Wire Terminal Configuration. All panels shall be provided with one terminal per field wire including shield wire. PLC panels shall have each PLC I/O card wires bundled and routed to terminal blocks that are grouped and labeled for each I/O card, including spare cards.

18. Grounding. Furnish equipment ground bus with lugs for connection of all equipment grounding wires.

17100.2.6 SOURCE QUALITY CONTROL

A. LABOR AND WORKMANSHIP: All panels shall be fabricated, piped and wired by fully qualified workmen who are properly trained, experienced and supervised.

B. GENERAL: Verification, testing, and instruction shall be provided in accordance with the applicable requirements of Section 17000, "Process Control & Instrumentation General Requirements."

C. TESTING:

1. The systems integrator shall conduct the following tests prior to arrival of the OWNER and/or OWNER's representative:
   a. All alarm circuits rung out to determine their operability.
   b. All electrical circuits checked for continuity and where applicable, operability.
   c. All nameplates checked for correct spelling and size of letters.
   d. The PLC I/O test.
2. It shall be the responsibility of the systems integrator to furnish all necessary testing devices and sufficient manpower to perform the tests required by the OWNER and/or OWNER's representative.
3. If the above tests have not been performed prior to the arrival of the OWNER and/or OWNER's representative, the CONTRACTOR shall be liable for back charges by the OWNER for the extra time required for the witnessing services.

17100.3 EXECUTION

17100.3.1 EXAMINATION. Control Panel fabricator shall notify Engineer two weeks before shipment of panel to jobsite for testing and inspection.

17100.3.2 INSTALLATION

A. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers by the Electrical Contractor, using wire ways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the conduit schedule, but will be shown on the loop drawings.

B. Control panels that are not adjacent to motor control centers shall be fully wired to the motor control centers by the Electrical Contractor. The Electrical Contractor shall furnish and install all necessary conduits and wire between the control panel and MCC based on the contract drawings.

17100.3.3 FIELD QUALITY CONTROL

A. In accordance with Section 17000 Instrumentation & Control, General.

B. The Electrical Contractor shall install control panels. Termination wiring shall be done in accordance with the drawings and under the supervision of the Engineer's on site inspector.

C. All holes for field conduits, etc. shall be cut in the field, there shall be no additional holes, factory cut holes, or holes closer allowed. Incorrect holes, additional holes, or miss-cut holes shall require that the entire enclosure be replaced.

17100.3.4 ADJUSTING

All enclosures shall be mounted so that their surfaces are plumb and level to within ± 1/16" over the entire surface of the panel.

17100.3.5 CLEANING

In accordance with Section 17000 Instrumentation & Control, General.

17100.3.6 DEMONSTRATION

In accordance with Section 17000 Instrumentation & Control, General.

17100.3.7 PROTECTION

Protect all surfaces from damage, any surface damage, shall be repaired and/or replaced as directed by the ENGINEER.

17100.3.8 SCHEDULES

All control panel testing shall be performed prior to shipping.

17100.3.9 TRAINING

In accordance with Section 17000 Process Control & Instrumentation General Requirements.

17100.4 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000.

17100.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

17210.1 DESCRIPTION

The Contractor shall furnish, test, install, and place into satisfactory operation the magnetic flowmeters (mag meters) with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

17210.1.1 RELATED WORK

Section 17000 – Instrumentation & Control, General

17210.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300.

17210.2 MATERIALS

17210.2.1 MAGNETIC FLOWMETERS

1. Device identification: See Section SP17000.
2. The Flow meter system shall consist of a flow element and an indicating signal converter remotely mounted. The flow meter shall be of the low frequency electromagnetic induction type and shall produce a pulsed DC signal directly proportional to and linear with the liquid flow rate.
3. The system shall be accurate to within +/-0.5% of flow rate for velocities between 1 and 20 feet per second.
4. Meter Body:
    a) Carbon Steel tube with welded flanged ends. Provide lifting lugs on the meter body. Laying length of meter shall be a minimum of 1.5 times the nominal meter size to minimize inaccuracies caused by the effects of liner wall conductivity to adjacent piping.
    b) Flanges shall conform to ANSI B16.5, Class 150 or ANSI B16.1, Class 125. All flanges shall be without raised face. Coordinate mating flanges with Contractor to ensure drilling patterns match.
    c) Electrodes shall be Hastelloy C and self-cleaning.
    d) Liner shall be Teflon.
    e) The meter housing shall be NEMA 4X construction and be capable of accidental submergence in up to 30 feet of water for 48 hours without damage to the instrument or interruption of the flow measurement.
5. Signal Converter/Transmitter:
    a) The signal converter/transmitter shall include the magnet driver and the converter electronics. The flow converter shall be remote mounted for all sizes with cabling furnished by the magnetic flow meter manufacturer without splicing. The signal converter shall be supplied in a NEMA 4X housing. The converter shall operate on a 120 VAC input.
    b) The electronics shall be of the solid state design, feedback type, utilize integrated circuitry and be microprocessor controlled. All operational parameters shall be user configurable locally. When in the configuration mode, normal meter output shall be maintained. The display shall have two rows of 16 digit alphanumeric characters for simultaneous viewing rate of flow and totalization. Both parameters shall be in direct reading of engineering units, field selectable.
    c) Input and output signals shall be fully isolated. The converter shall output 4-20

mA DC into a load range from 0-750 ohms at 24 VDC. The flow converter shall incorporate an integral positive zero return circuit. Empty pipe detection to drive output to zero when electrodes become uncovered is required. All data shall be stored in a non-volatile memory. The converter shall also output an active 24VDC with pulse output for a totalizer pulse.

d) Provide stainless steel grounding rings on the inlet and outlet. Grounding electrodes that penetrate the liner are not acceptable.

6. Operating range and other specifications as stipulated in SP17000.
7. Manufacturers:
    a) Toshiba LF434 w/ LF424
    b) Endress + Hauser 50W1H-UL01RC2B4AA
    c) ABB Mag X w/ Remote Transmitter
    d) or approved equal.

17210.3 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

17210.4 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000.

17210.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

SUBMERSIBLE PRESSURE TRANSMITTERS — SECTION 17310

17310.1 DESCRIPTION

The Contractor shall furnish, test, install, and place into satisfactory operation the submersible pressure transmitter (level transducer) with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

17310.1.1 RELATED WORK

Section 17000 – Instrumentation & Control, General

17310.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300.

17310.2 MATERIALS

17310.2.1 SUBMERSIBLE PESSURE TRANSMITTERS

1. Device identification: See Section SP17000.
2. The level transmitter shall be a two-wire type and have an accuracy of 0.5% of full scale.
3. The transmitter shall produce a 4-20 mA DC signal proportionate to the span range of the transmitter.
4. The span range shall exceed the static water level of the water well.
5. An integral electrical cable shall be supplied with strain relief that shall have the capability of suspending the transmitter to the proper depth and reaching the local RTU <u>without cable splicing</u>.
6. The cable shall be of vented polyurethane capable of supporting 220 pounds of strain with strain relief.
7. Operating range and other specifications as stipulated in Section SP17000.
8. Manufacturers:
   a) Instrumentation Northwest PS98i
   b) Wika Tronic LS-10
   c) or approved equal.

17310.3 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

17310.4 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000.

17310.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

17500.1 DESCRIPTION

The CONTRACTOR, through the use of a qualified System Supplier and integrator, shall furnish, supervise installation, assemble, configure, program, and place into service a complete and functional PLC based control systems.

17500.1.1 RELATED WORK

Section 17000 – Instrumentation & Control, General
Section 17100 – Instrumentation Control Panels, General

17500.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300.

17500.2 MATERIALS

17500.2.1 PLC HARDWARE

A. Device identification: See Section SP17100.

B. All PLC Hardware, CPUs, I/O devices, communication devices and PLC Software shall be new, free from defects, of first quality and produced by manufacturers regularly engaged in the manufacture of these products.

C. General: The SCADA controller shall be intelligent, modular unit, capable of both data acquisition and local data processing. It shall monitor and control local equipment in a stand-alone mode as well as being an intelligent node in a distributed system. It shall be based on multiprocessor architecture, in which a co-processor is used for handling on-board input/output channels. To facilitate initial installation, maintenance and future expansion, all external input/output modules shall connect to the basic controller using a high-speed internal bus.

The SCADA controller shall be configured and programmed with standard programming languages such as Relay Ladder Logic (RLL) and/or IEC 61131-3. Programs shall be developed and downloaded either directly to the controller using an RS-232 interface cable, or remotely through the communication network media such as phone lines, dedicated lines, or wireless radios.

The controller must be supplied with the number and type of input/output modules and communication ports as indicated elsewhere in the specifications. Future expansion may be made by simply plugging in additional input/output modules to the I/O bus.

1. SCADA controller hardware specifications: The controller shall include the following:
   a. Central Processing Unit (CPU):
      i. The CPU shall be equipped with at least 1 Mb CMOS SRAM for application programs, 512 KB Flash ROM for firmware and application programs.

ii. The CPU shall include a real time clock/calendar, accurate to within one minute per month, with lithium battery backup. The battery will maintain the memory and clock/calendar for two years of power off time.

iii. Diagnostic LEDs shall be included for the following:

(i) Power supply.

(ii) Program Run/Stop.

(iii) Communication parameters such as transmit, receive, clear to send, request to send, and carrier detect.

(iv) CPU Status.

(v) Forcing.

iv. The controller shall be capable of processing up to 32 PID loops with individual execution time bases from 0.1 to 25.5 seconds.

b. Input/output (I/O):

i. Digital inputs must be available for 12/24 Vrms/DC, and shall tolerate 150% over-voltage.

ii. Digital output must be rated for up to 28 VDC @ 1 Amp.

iii. Analog inputs shall be 0-20mA or 4-20mA, 15 bit resolution, ±0.2% accuracy over the operating temperature range, ±0.1% accuracy at 77°F (25°C) with 1500W transient suppresser on each input. Inputs shall be single ended and isolated from logic circuitry.

iv. Analog outputs will support 12 bit resolution, 4-20mA, ±0.2% accuracy over the operating temperature range, ±0.05% accuracy at 77°F (25°C) with 600W transient suppresser on each output.

v. The state of digital and/or analog output shall be configurable to hold last output value or go to off condition when the application program is stopped.

vi. Terminal blocks shall be removable and can accommodate solid or standard wires from 22 to 12 AWG. This allows module replacement without disturbing the field wring.

vii. The controller must be capable of supporting minimum of 600 input/output points in total.

c. Communication:

i. The RTU shall possess a minimum of two built-in communication ports with the following characteristics:

(i) RS-232, software controlled with full DCE/DTE operation to 38,400 baud.

ii. The RTU shall support asynchronous operating mode, half and full duplex transmission.

d. Mechanical Design:

i. The controller shall have front access to all controls, indicators, lithium battery, communication ports and power supply shall be provided. Communication ports shall be standard RJ-45, RS-232 and RS-485 to allow easy access.

ii. The controller shall operate over an ambient temperature range of -40°F to 158°F (-40°C to 70°C) with a relative humidity 5% to 95%, non-condensing. The RTU shall operate from 16 Vrms, 50/60Hz or 12-24 VDC. 115/240 Vrms operation shall be provided through the use of an optional transformer.

iii. Certifications and Standards:

(i) All inputs and outputs (except the serial communication ports) must survive ANSI/IEEE C37.90 surge withstand capability (SWC) tests without damage.

(ii) The controller must be certified for electrical safety by UL as conforming to UL 508 or CSA as conforming to CSA C22.2/142.

(iii) The controller shall meet or exceed the following standards:

1. Surge withstand capability: ANSI/IEEE C37.90
2. RF emission compatibility: FCC part 15, Subpart J, Class A
3. Electrical safety classification: UL 508/CSA C22.2/142
4. Hazardous area classification: CSA Class 1, Division 2, Group A,B,C,D
5. CE standards: EN55011, EN55022, EN60082-1, EN60082-2 and EMC directive 89/336/EEC
6. GOST standards: 8.009-84, 12997-84, 22261-92, 26203-80, 291125-91, PR 50-2-009-94

e. Communication Protocol:

i. The RTU shall support an industry standard protocol, such as Modbus and/or Modbus/TCP, with the following minimum features:

(i) Allows up to 65,535 stations in one system.

(ii) Ability to transfer complete programs and data over the communication network.

(iii) Support high data security techniques such as Cyclic Redundancy Check CRC16.

(iv) Proprietary protocols will not be allowed.

ii. The controller shall be able to receive information from other sites and retransmit the message to another site, using the same communication port.

iii. The controller shall allow flexible communication algorithms on all communication ports. Any of the ports can act as Master, Slave or Store-and-Forward at any time during the execution of the application program.

iv. The RTU shall be able to function as an interconnection point between different communication systems such as radio, leased lines, and radios with different frequencies.

v. The RTU shall be able to send broadcasting messages to a number of locations.

vi. The RTU shall be able to perform report-by-exception (event driven communications) under the control of the application program.

vii. The RTU shall be capable of supporting other protocols, such as Allen-Bradley DF1, DNP 3.0, Enron Modbus on any of the communication ports.

viii. Each communication port shall be configurable with a unique station number when used with the standard protocol.

ix. Any port running the standard communications protocol shall allow for programming via local or remote communications.

D. Warranty: The manufacturer shall warrant the hardware specified above against all defects in material and workmanship for a period of three years.

E. Manufacturers:
1. Control Microsystems, SCADAPack 32
2. or approved equal.

17500.2.2 PLC SOFTWARE

A. The programming software shall allow downloading of Relay Ladder Logic and/or IEC 61131-3 programs. The software shall allow the user to develop and download the application and system configuration over the communication network via radios, leased and dial-up lines.

B. The Relay Ladder Logic shall include the following functions:
1. PID feedback control.
2. Modem dialing and control.
3. Timers, counters, mathematical functions, memory functions.
4. Standard Ladder Logic functions such as coils and contacts.
5. Boolean logic functions.
6. Bit transfer functions.
7. Block transfer functions.

C. On-line monitoring of Relay Ladder Logic power flow shall be included to facilitate start-up and debugging of programs.

D. Relay Ladder Logic program shall be up to 12K words in size, with no fixed limit on the number of networks. The programming software shall support on-line monitoring and forcing of any register in the protocol database when utilizing the built-in protocol. Forcing shall write a value to the register and prevent modification of the register content by the communication protocol or the application software. A global command to remove all forcing must be included.

E. In addition to forcing, the software shall be capable of writing a value to any register in the protocol database but continue to allow the protocol or application software to modify the contents of the register.

F. The software communication settings must allow configurable number of retries in addition to message time-out of up to 99 seconds.

G. Operating System: The software shall be based on a multi-tasking executive system optimized for real-time environment.

H. 256 I/O variables.

I. Software key.

J. Manufacturers:
1. Workbench for IEC61131-3 (ISAGraf) Programming Software
2. or approved equal

17500.2.3 PLC PROGRAMMING CABLE

A. Cable length: Minimum 10 feet.

B. Manufacturers:
   1. Control Microsystems
   2. or approved equal.

17500.3 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

17500.4 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000.

17500.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

17710.1 SUMMARY

A. This Section includes HMI software.

B. Related Sections: The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

17710.2 REFERENCES

In accordance with Section 17000 "Process Control & Instrumentation General Requirements."

17710.3 DEFINITIONS

In accordance with Section 17000 "Process Control & Instrumentation General Requirements."

17710.4 SYSTEM DESCPRITION

A. The CONTRACTOR, through the use of a qualified Electrical & Controls Contractors, shall furnish, supervise installation, assemble, configure, program, and place into service a complete and functional HMI based control systems.

B. In accordance with Section 17000 "Process Control & Instrumentation General Requirements."

C. Furnish standard and customized software fully installed and configured for the control system specified herein.

1. It is the intent of this specification to have the Electrical & Controls Contractors furnish the latest generation, standard, field proven, fully debugged and supported PLC, PC & HMI software package for this application with a minimum of additions or changes.
2. Customized or specially written software shall be furnished to meet all of the functional requirements specified herein. Any custom applications software required shall be fully integrated into the basic software and shall not require unique command structures.
3. No attempt has been made to list all software or list all characteristics of software required by the Electrical & Controls Contractors to meet the functional requirements specified herein.
4. Software specified herein is described in broad, functional categories. The Electrical & Controls Contractors shall furnish a complete software package including the functional requirements specified herein along with whatever additional software is required for proper and efficient operation of the complete control system.
5. The software package shall provide a system capable of controlling system level activities and a higher level process control language allowing the operator to monitor and control the process through an interactive human interface. The software environment shall support a multi-programming atmosphere allowing concurrent execution of more than one program in a background/foreground mode or multi-tasking mode.

6. Throughout the execution of all software modules, the operator shall be presented with all of the command or operation choices available at that point in the program using sufficient verbiage or symbols to make the choices self-explanatory and unambiguous. Question and answer or fill-in-the-blank requests shall only be permitted where file names, tag names, or other unique text or numerical information is required.

D. Software Configuration: The software package, including the database, control functions, displays, reports, etc., shall be furnished fully configured as detailed in the specifications and must meet the functional requirements of the integrated system.

E. Operator Interface Graphics Generation:

1. It is the sole responsibility of the Electrical & Controls Contractors to configure the operator interfaces and to develop, design, engineer, configure and test all of the graphic displays required for this project.
2. All of this work shall take into account the specific needs of the end user.
3. In order to facilitate this work the Electrical & Controls Contractors shall conduct meetings with user groups.

F. Control Functions:

1. The Control System shall be capable of performing control and logic functions both at the PLCs, and at the Operator interface.
2. Control, logic, and interlock functions shall be performed at the PLCs.

G. Tagging Convention. The Electrical & Controls Contractors must use the Tag and Loop identifications found in the P&IDs for all:

1. PLC device tags.
2. HMI tags.
3. Data Acquisition and Graphic Display System Tags.

17710.5 SUBMITTALS

In accordance with Section 17000 “Process Control & Instrumentation General Requirements.”

17710.6 QUALIFICATION REQUIREMENTS OF SYSTEMS INTEGRATOR

In accordance with Section 17000 “Process Control & Instrumentation General Requirements.”

17710.7 DELIVERY, STORAGE AND PROTECTION

In accordance with Section 17000 “Process Control & Instrumentation General Requirements.”

17710.8 SEQUENCING AND SCHEDULING

In accordance with Section 17000 “Process Control & Instrumentation General Requirements.”

17710.9 WARRANTY

In accordance with Section 17000 “Process Control & Instrumentation General Requirements.”

17710.10 PRODUCTS

17710.10.1 HMI SOFTWARE

A. DATA HANDLING CAPABILITIES

1. No programming, compiling or linking shall be required to configure the system.
   a. The database tags must be configurable on-line.
   b. New function and database tag assignments shall be added while the system is performing data acquisition and control operations.
2. The process database containing the current value of the data, or tag list, shall be memory-resident and of a design that is appropriate for real-time monitoring and control functions.
   a. Its design shall be optimized for speed, memory usage, data integrity and system security.
   b. Floating-point arithmetic shall be used in all calculations.
   c. This database shall be stored as a standard Windows file on the local or network hard disk and, upon starting the system, this database is loaded into the computer's memory.
   d. Only computers physically connected to control system LAN shall require a database.
3. The actual application of monitoring and control functions shall be dictated by the definition of the contents of this memory-resident database. Configuration of this database shall be done by the Electrical & Controls Contractors.
4. Data integrity. The software shall provide pre-emptive multitasking to ensure that common Windows actions do not interfere with 1/0 communications, processing of data, alarming, and the integrity of the real-time and historical data.
   a. These common Windows actions include moving a window with a mouse, opening a file, accessing the hard disk, or printing a graphic display.
   b. The software shall be written fully 32-bit so that it runs native in the Windows operating system.
   c. Emulation using 16-bit software code is not permitted.

5. Database tag configuration
   a. Various input/output hardware assignments, as well as processing functions, shall be assigned to named tags or "function blocks".
      1) Multiple tags shall be tied together to perform more complex functions.
      2) During the configuration process, the program shall be capable of checking the tag structures for correct linkages, appropriate names, and so on.
      3) The program shall also be capable of detecting and handling configuration errors at run-time.
      4) Any errors encountered shall generate messages to the user.
   b. The program shall be able to perform tag configuration (adding, modifying, deleting, viewing) in several ways, as follows:
      1) Directly from the graphics editor, so that tags shall be configured as graphics are developed.
      2) Via an interactive spreadsheet-style database builder program that uses a fill-in-the-blank menu methodology.

3) The database builder program shall provide the following editing functions:
   a) Cut/Copy/Paste tags
   b) Duplicate tags
   c) Generate multiple tags from a given pattern
   d) Sort tags
   e) Query tags
   f) Display tags in user-configurable formats

c. Via the importation of a CSV text file developed in another program as input for tag creation. The database builder program shall also be able to export the current tag listing for modification by the external program.

d. Development of the database tags shall be completely independent of the creation of graphics displays. Use of a programming language, such as Visual Basic, C or a C-like language, shall not be required.

e. Database verification.
   1) The software must also allow for database configuration verification.
   2) This task shall allow for verification of configuration errors on a local database or a database on another node.
   3) Errors shall be reported in a dialog box and a user must be able to make the corrections from this dialog box.

f. Tag Database Editing
   1) The database shall allow for editing from a graphic editor, from within the building of a graphic operator screen, or from within a VBA script.
   2) The database editing shall be able to be accessed locally or across the network.
   3) A node shall edit a database on another node while online.

6. Database tag types. Functions shall be available in the database to support the following tag types:

a. Analog Input. This tag type shall read an analog value (time, temperature, speed, pressure, level, etc.) either directly from an A/D converter or from a register within an I/O device such as a programmable controller, and automatically scales the raw data to engineering units (seconds, revolutions/minute, pounds/sq. in., degrees, etc.). An Analog Input tag must also support write outs.

b. Analog Alarm. This tag type shall provide enhanced alarming capabilities to the Analog Input, including alarm suspension, remote acknowledgment, delay time, re-alarm time, close a contact based on an alarm condition, etc. An Analog Alarm tag must also support write outs.

c. Analog Output. This tag type shall write an analog value (setpoint, output, speed, etc.) either directly to a D/A converter or to a register within an I/O device, such as a programmable controller.

d. Analog Register. This tag type shall access multiple analog I/O points for read or write functions with a single I/O tag. The number of addresses shall be dependent upon the I/O device used.

e. Boolean Logic. This tag type shall take up to eight (8) inputs, typically logical or digital values, and performs Boolean arithmetic on them. The result shall then be passed to or used by other tags or applications within the system.
   1) The operators must include:
      a) OR
      b) AND
      c) EQUAL
      d) NOT EQUAL
      e) NOT
      f) XOR
      g) NAND
      h) Parentheses

f. Calculation. This tag type shall take up to 8 variables or constants and performs an arithmetic calculation on them. The result shall then be passed to or used by other tags or applications within the system.
   1) The operators must include:
      a) Add
      b) Subtract
      c) Multiply
      d) Divide
      e) Parentheses
      f) Absolute value
      g) Square root
      h) Exponentiation
      i) Natural log
      j) Base-10 log
      k) Relational operations (greater than, less than)
      l) Change floating point values to integers

g. Device Control. This tag type shall support 16 digital inputs and 8 digital outputs, each with random (i.e. not necessarily contiguous) addresses. A set of statements within the tag shall provide the ability to perform pattern checking, interlocking, and timing.

h. Digital Input. This tag type shall sense the logical on/off state of a switch, relay, pushbutton, etc. either directly from the I/O hardware or from a bit within the memory of an I/O device, such as a programmable controller.
   1) The value shall be displayed in a user-selected format (0/1, open/close, false/true, etc.)
   2) A Digital Input tag must also support write outs.

i. Digital Alarm. This tag type shall provide enhanced alarming capabilities to the Digital Input, including alarm suspension, remote alarm acknowledgment, delay time, re-alarm time, close a contact based on an alarm condition, etc. A Digital Alarm tag must also support write outs.

j. Digital Output. This tag type shall set a logical on/off state in an output relay either directly in the I/O hardware or in a bit within the memory of an I/O device, such as a programmable controller.
   1) The value shall be accepted in a user-selected format (0/1, open/close, false/true, etc.)
   2) The Digital Output tag must also provide output-reverse handling and the ability to specify an initial cold-start position.

k. Digital Register. This tag type shall access multiple digital I/O points for read or write functions with a single I/O tag. The number of addresses shall be dependent upon the I/O device used.

l. Event Action. This tag type shall monitor the value or alarm conditions of an I/O point and, based upon TRUE/FALSE conditions, performs one of two operations. These operations include starting or stopping the processing of another tag or opening or closing a digital point.

m. Fanout. This tag type shall pass the value it receives to up to five tags within the same database.

n. Multi-state Digital Input. This tag type shall combine up to three (3) digital values and outputs a value of 0-7 based upon the status of the values in sequence (000 = 0, 001 = 1, 010=2,011 =3,100=4, 101 =5,110=6,111 =7).

o. Program. This tag type shall provide the user with a procedural language for sequencing, monitoring, and controlling typical process operations, including:

1) If/Then go to another step
2) Wait until a process condition occurs
3) If time-out go to another step
4) Go to another step
5) Set a tag to a value or the value of another tag
6) Open/Close a digital tag .
7) Set Auto/Manual status of a tag
8) Set On/Off status of a tag
9) Add/Subtract a value to/from a tag
10) Print a message
11) Call other program blocks as subroutines
12) Run other program blocks in parallel
13) Stop other program blocks
14) Pause or delay a number of seconds
15) Play a .WAV sound file
16) Run an executable program
17) The current step being processed must be capable of being displayed on the operator's CRT. In addition, a debug mode shall be provided to facilitate program checkout.

p. Real-time Trend. This tag type shall take as its input an analog or calculated value and save up to eighty (80) values. Averaging of accumulated input values shall be provided to extend the amount of time represented by the trend block. The data within the tag shall be graphically depicted on operator displays.

q. Text. This tag type shall read or write text of up to eighty (80) characters from or to a device.

r. Timer. This tag type shall perform a counting operation.

1) It counts in either the up or down direction, from a pre-set value to a target value.
2) Upon reaching the target or time-out condition, a contact may be closed. This tag shall also support conditional next block processing.
3) It shall time up to one (1) year.
4) The timer may be started, stopped, reset or resumed based on a sensed condition or operator command.

s. Totalizer. This tag type shall maintain a floating point total for values passed to it from other database tags.

7. Tag attributes. Each tag shall have an instrumentation tag name of up to 30 characters.
   a. The name shall be alphanumeric.
   b. All other application programs shall use this tagname as their sole reference to the data element assigned.
   c. The name shall match the Tag and Loop identifications as found on the P&IDs.
   d. For tags assigned to actual hardware points, they shall also contain fields for:
      1) Hardware device name
      2) Hardware address
      3) Hardware specific parameters
      4) Signal conditioning requirements
   e. Simulation tags shall also be created that receive their values from the operator's keyboard, other internal calculations, or other programs. These tags shall conform to the conventions and corresponding Loop numbers as found on the P&IDs.
   f. Tags shall be processed periodically.
      1) The fastest rate shall be fifty (50) milliseconds.
      2) Rates shall be able to be set independently for each appropriate tag.
      3) Longer rates of up to once per twenty-four (24) hours shall also be supported.
   g. Alternatively, the system shall provide the ability to have tags processed on an exception basis. This choice shall be allowed on a tag-by-tag basis.
   h. Input tag shall also be able to be configured as a "one-shot". This shall cause the system to retrieve the value from the I/C device just one time when the system is started or the tag is brought on.
   i. All tags must have completed description fields.
   j. Each tag associated with a hardware address or capable of causing an alarm condition shall have a means of displaying a descriptive message on the alarm printer. The descriptor shall be at least 40 characters in length.
   k. The system shall provide built-in signal generators, including sine curves and random numbers, which shall be used for process simulation purposes.
   l. Any output or control block must be able to log a "time stamp" where an operator changes a value.
   m. Counting of tags in sized systems

8. For the smaller systems with a limited number of tags, only the following primary blocks shall be counted towards the I/O limit:
   a. Analog Input
   b. Digital Input
   c. Analog Alarm
   d. Digital Alarm
   e. Analog Output
   f. Digital Output
   g. Analog Register
   h. Digital Register
   i. On-Off Control
   j. Device Control

k. Text Block
l. Multi-state Digital Input Block
m. Custom written Tags that address I/O points
n. Only the blocks listed above are to be counted. There shall be no need to include tags located in other nodes or tags that are calculated points.

B. I/O DEVICE COMMUNICATIONS

1. The system must support communication with programmable logic controllers (PLCs — interfaced via serial communications or PLC manufacturer interface cards).
2. The system must be capable of supporting up to four (4) different types of device communications drivers and up to eight (8) serial ports simultaneously.
3. Driver configuration
   a. The communications driver shall be configurable on-line
   b. When supported by the I/O device (typically programmable controllers), block transfers (the ability to acquire multiple variables in one communications request) must be provided. The block sizes and poll times must be individually adjustable.
   c. Supported block transfer times vary depending upon the I/O device, but shall be able to run as fast as the I/O device can transfer data.
   d. Alternatively, exception-based processing may be optionally selected.
   e. In some cases, the manufacturer may provide support for the use of unsolicited messages, if supported by the I/O device.
   f. For serial or complex devices, the configuration process shall be interactive and use menus to select (depending on the device):
      1) Baud rate (if applicable)
      2) Reply time-out time (with 0.1 second resolution)
      3) Station address of device (if applicable)
      4) Block transfer base address and size (if applicable)
      5) Block interrogation rate
   g. The hardware address format shall be entered at configuration time shall correspond with the address format employed by the I/O hardware manufacturer.
   h. The use of Microsoft Windows Dynamic Data Exchange (DDE) for device communications shall be supported by the manufacturer. However, the use of DDE shall not be permitted for use with PLCs or other similar devices.
4. Display-only communications. To facilitate more efficient communications with programmable controllers, the system must be able to provide display-only communications.
   a. Communications to read or write tags (Analog Registers and Digital Registers) shall only be established when a graphics display containing these tags is open.
   b. When the display is closed, communications shall cease.
5. Error detection and recovery. Wherever possible, the device communications program shall perform error checking on messages. These error checks shall include lost response (time-out) and data error (checksum, LRC, CRC, etc.).
   a. Should communications errors be detected, the software shall automatically indicate that the data (on graphic displays, in historical files, etc.) is no longer valid.
      1) The invalid data should be replaced with any operator defined characters or have the ability to alter the color, or font to let the operator know the data may be invalid.

2) The system shall automatically attempt to re-establish communications, and, if successful, shall then replace the characters with valid data.
3) These capabilities shall be built-in to the software and shall not require any programming or other actions to implement.

b. Fail-over to a user-configurable back-up port shall be provided as a standard function of the driver. This capability shall, for example, cause the software to automatically attempt to establish communications between the computer and the I/O device via COM2 when it has determined that the connection via COM1 has failed.

6. OPC server connection. In addition to I/O drivers, the process database must be able to send and receive data with an OLE for Process Control (OPC) server.
   a. Any database block should be able to receive or send OPC data by supplying an OPC address. The OPC address should be the following syntax:
      a. ProglD;GroupName;ltemlD;AccessPath
      b. ProgID is the name of the OPC server
      c. GroupName is the name of the OPC group
      d. ItemID is the name of the OPC item AccessPath is optional, however must be support, and shall instruct the server how to access the data.
      e. The system must also be capable of severing OPC information to any OPC complaint database.
7. Diagnostics. The system shall provide a diagnostic program capable of running on-line or off-line that shall monitor message rates from the communication program. The diagnostic shall display the number of new messages, retries, time-outs, and any occurrences of error.
   a. For serial drivers, a built-in datascope shall be provided. This datascope function shall provide the ability to observe the messages being sent between the computer and the I/O device.
8. Stand-alone operation. Without Networking. In non-networked applications, the software shall be capable of performing all desired functions, data acquisition, graphics, trending, reporting, etc. within a single computer.
   a. Adding a Network. In networked application all that shall be required is to connect each computer to the local area network, and enable the networking functions within the software. Neither reconfiguration nor duplication of database tags shall be required to make data available to other nodes that require access to it.
9. Operator control. All programming commands related to changing system configuration or controlling field devices shall be performed only through the operator interface system and shall require more than one keystroke to protect against inadvertent operations.
   a. Control system configuration commands shall require operator confirmation of a requested action before any change is made. This shall apply to changes in the algorithms, control sequences, and similar configuration related actions, as well as file copy and file delete commands.
   b. If any sequence requires operator confirmation, the operator shall be able to cancel the operation at any point prior to executing the command.

C. GRAPHICS CAPABILITIES

1. The graphics package must provide a means of creating and displaying color object-oriented graphic displays that shall be used by the operator to monitor and control the process. Real-time values being read from the field devices shall be capable of being displayed in a variety of user-configurable formats.
2. Graphic displays shall be standard Microsoft Windows files and shall be able to be stored on the system disk, a floppy diskette, virtual (RAM) disk or file server, based on user-entered selections. There shall be no limit (other than physical disk size) to the number of displays that shall be developed and accessed on-line.
3. The development and runtime graphics packages must both be multi-document architecture applications.
4. Support for displays larger than the size of the monitor shall be provided. Scroll bars shall be provided to allow the operator to move to other areas of the display.
5. The graphic screens shall be based on objects and not individual pixels. The object graphics shall consist of an image and image attributes, such as size, color, and position that shall define the properties of the object. The operator shall use tools; menus and dialog boxes to change object properties.
   a. An object is defined as anything that shall be created with drawing tools from within the package or an image imported into the package.
   b. All properties, events, and methods of the object must be exposed to the system.
6. Graphic creation. The system shall provide an interactive object-oriented editor or workspace that allows creation of graphic displays using a pointing device (for example, a mouse).
   a. A facility shall be provided that quickly toggles, via a mouse click or hot-key, between the graphic building and graphic runtime modes to speed display animation verification during the development process.
   b. The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system shall not be required to make changes.
   c. Properties Window. A properties window, exposing all properties for an object must live on the workspace. The properties window must support edit functions for any object selected.
   d. Object Duplication. Object properties must be passed when an object is copied. Copying shall occur from the tree browser or workspace. All properties must be passed on to the duplicated object and the name properties shall automatically be changed.
      1) Example: When an object with the following properties Name: OVAL; Foreground Color: RED 024 gets duplicated the new objects properties are Name: OVAL1; Foreground Color: RED 024.
   e. Tile & Cascade. Graphic screens that are opened in configuration mode must support tiling and cascading. Tiling must have horizontal and vertical support and no overlapping when the graphic screens are viewed in this manor. The only limit on the number of graphic screens opened at one time shall be determined by the amount of RAM in the workstation. Cascading is defined as a method to stagger pictures so they can be selected from their title bar.

f. Graphic Sizing. Size shall be based on logical units; not pixels and any logical unit may be used. Graphic screen design at one resolution must be able to run at a different resolution. A full screen option as well as the ability to add sizing borders to any graphic screen must be supported. Also graphic screens must have an option to enable the screen to always be on top and a title bar enabled/disabled option.

g. Active X Support. The graphic screens must be an Active X document and have the ability to have third party Active X, OCX, controls dropped in. The system shall be capable of containing any control that is placed onto a graphic screen.

h. If a third party control crashes or misbehaves the system must be able to shut down the control while the graphic screen, system and workstation remains running. Running third party controls out of the process is not a suitable requirement for the protection.

7. Color support

a. The graphics package shall provide support for an unlimited choice of colors with at least 256 colors supported at any one time. The system shall have the ability to create, save, and restore custom color palettes. Each color must have an associated name so that colors may be selected by color name.

b. Color Palettes. The system must come with a standard, rainbow color palette as well as several standard shades of color palettes.

1) Each shade palette must have 256 shades.

2) The following standard shade palettes must be supplied.

a) Cyan

b) Gray

c) Green

d) Magenta

e) Red

f) Yellow

g) Blue

c. Color Changes. Color changes shall be selectable from editing the individual foreground, background, or edge color property for each object. In addition color changes must be selected from a "Modeless" color box. The "modeless" color box must float on the workspace and allow for the changing of colors on as many objects needed and choose which property of an object or objects is to be changed.

d. Global Colors. The system must allow for a global or universal color table selections.

1) This table shall be based on exact match, or range compression or a value.

2) The colors in the tables shall appear on any graphic screen when the value for the data source of the object matches the table.

3) Changes to color tables must be independent of the graphic screens and not require the system to compile or pass the graphic screen through the graphic configuration program or mode for changes to take place.

4) Changes to global color tables shall be supported in runtime mode.

8. Graphic toolbox. The system shall provide configurable toolboxes that the shall allow selection and customization as to what tools it contains and their position in the toolboxes. The Toolboxes shall be a Window where its shape, size and location shall easily be changed with the mouse. Toolboxes shall contain a method, like the ToolTips within Microsoft Word, to describe the function of each tool when the mouse cursor is positioned on a particular tool. Once configured, the state of the toolboxes shall be automatically saved when the drawing session is completed. It shall be returned to that same condition when the next drawing session is started.
   a. The system shall have the ability to define buttons.
   b. Graphic objects. At a minimum, the following object drawing tools must be supported:
      1) Rectangle/Square
      2) Rounded Rectangle/Rounded Square
      3) Oval/Circle
      4) Straight Line
      5) Polylines (two or more connected line segments)
      6) Polygons
      7) Arcs (curved line segments)
      8) Chords (a curved line connecting a line segment)
      9) Pie Shapes (wedges of a circle)
      10) Text
   c. Graphic development operations. Operations that may be performed on objects or groups of objects must include the following:
      1) Select/Select All
      2) Deselect/Deselect All
      3) Change Color
      4) Move
      5) Nudge (move a single pixel at a time)
      6) Cut
      7) Copy
      8) Paste
      9) Clear
      10) Duplicate
      11) Group/Un-group (objects within a group must be selectable without un-grouping)
      12) Align (left, right, top, bottom, vertical center, horizontal center)
      13) Space Vertically/Space Horizontally
      14) Grid
      15) Snap-to-Grid
      16) Reshape
      17) Zoom In/Zoom Out (50%, 100%, 150%, 200 %)
      18) Send to Back/Bring to Front
      19) Choice of line and fill styles
      20) Reshape (add/delete/move points)
      21) Flip horizontally/Flip vertically (mirror image)
      22) Search and Replace tagnames (including the use of wildcards)
      23) Undo (the number of levels shall be configurable up to 50)
      24) Cursor position (optionally on the display for exact object placement)
      25) Rotation (center of rotation selectable from any part of the screen)
      26) Space objects evenly (vertical & horizontal)

27) Make objects same size (height, width and both)
28) Layers (for building and viewing, up to 30 layers supported)

d. Graphic Animation. Each display shall have the ability to dynamically update elements in the picture. Defining the method for dynamic update shall be determined by a point and click operation.
   1) A pre-defined list of dynamic link elements that shall include the following:
      a) Data Link. Displays alphanumeric values (numeric values may be displayed in whole number/decimal or scientific notation)
      b) Time Link. Displays current time
      c) Date Link. Displays current date
      d) System Information Link. Displays diagnostic information
      e) Alarm Summary Link. Displays current alarm information
      f) Pushbutton Link. Executes a Command Language script
      g) Multi-pen Chart Link
         i. Any number of pens
         ii. Displays run time and historical data on same chart
         iii. Configurable time span
         iv. Configurable trend direction (left to right and right to left)
         v. Configurable Zoom
         vi. Scrolling Grid
         vii. Ability to invert Hi and Low limits
         viii. Minimum of 5 line styles for pens
         ix. Minimum of 3 pre built line makers and a customizable line marker.
      h) OLE objects. Displays a third party OLE object

e. Dynamic Properties for Objects
   1) Dynamic properties that may be assigned to an object or group of objects must include the following:
      a) Color changes:
         i. Foreground Color
         ii. Edge Color
         iii. Background Color
      b) Fill Percentage:
         i. Horizontal (Left/Right)
         ii. Vertical (Up/Down)
      c) Position/ animation:
         i. Horizontal (X)
         ii. Vertical (Y)
         iii. Rotate
         iv. Scale
      d) Script Language:
         i. Commands on down (mouse button or key)
         ii. Commands on up (mouse button or key
         iii. Commands on mouse click
         iv. Commands on mouse double click
         v. Commands on mouse move
         vi. Commands on edit

e) Fill Style:
   i. Solid
   ii. Hollow
   iii. Horizontal
   iv. Vertical
   v. Downward Diagonal
   vi. Upper Diagonal
   vii. Cross Hatch
   viii. Diagonal Cross Hatch

f) Edge Style:
   i. Solid
   ii. Hollow
   iii. Dash
   iv. Dot
   v. Dash Dot
   vi. Dash Dot Dot
   vii. Null
   viii. Inside Frame

2) Objects may be assigned more than one (1) dynamic property. In addition, objects within groups may have individual dynamic properties in addition to those dynamic properties assigned to the overall group.

3) For properties other than "Commands", configuration shall be by "point and click" operations; scripting or programming shall not be required.

4) When building object dynamics properties must support configuration from a dialog box, pop-up menu and customizable dialog boxes or forms.

5) Positioning property changes must support a method to retrieve screen coordinates and automatically fill in the required coordinates for positioning.

6) Customizable dialog boxes or forms must be customizable through VBA. The system must supply the following pre built forms:
   a) Fill
   b) Rotate
   c) Position
   d) Scale
   e) Visibility
   f) Edge Color
   g) Foreground Color
   h) Background Color
   i) Data Entry
   j) Open Picture
   k) Close Picture
   l) Replace Picture
   m) Open Digital Tag
   n) Close Digital Tag
   o) Toggle Digital Tag
   p) Toggle Digital Tag
   q) Acknowledge Alarm

7) Graphic Refresh Rate. The refresh rate shall be definable on a per object basis with the fastest rate being fifty (50) milliseconds; although it is recognized that achieving this performance is dependent upon the overall system configuration.

8) Sources of Data for Object Animation
   a) The animation of the graphics and objects with dynamic properties shall be able to be linked to any of these types of data:
      i. Data acquired by the system and stored in its memory resident database
      ii. Data acquired by another networked system and stored in its memory resident database
      iii. OPC Data Source
      iv. Variables declared in the command language scripts
      v. Local and networked relational databases using SQL/ODBC
      vi. The system shall provide a wild card supported filter for assigning a data source.

9) The system shall provide an expression builder that is accessible from the graphic workspace.
   a) The builder shall allow an expression to be assigned to the data source.
   b) Supported functions of the builder are:
      i. Addition +
      ii. Subtraction -
      iii. Multiplication *
      iv. Division /
      v. Left & Right Parenthesis ()
      vi. Equal To =
      vii. Not Equal To <>
      viii. Greater Than >
      ix. Less Than <
      x. Greater Than or Equal To ≥
      xi. Less Than or Equal To ≤

9. Reusing graphic objects
   a. A method shall be provided for allowing graphics objects or groups of objects to be re-used easily.
      1) It shall allow the developer to insert native language prompts that request appropriate tag or other animation information whenever the object or grouped object is reused in another graphic display.
      2) These objects, either single or grouped, shall be intelligent, Windows wizard-like objects, so that it is possible, for example, to have a single prompt request and substitute:
         a) A single tag name into multiple dynamic properties within the object
         b) Multiple attributes (current value, high alarm limit, tag name, etc.) from a single tag into multiple dynamic properties within the object
         c) Text into the object
         d) Parameters within command language sequences

3) A library of these objects shall be included with the standard product. a) At a minimum, this library shall include:
   a) Pipes
   b) Valves
   c) Pumps
   d) Motors
   e) Tanks
4) Bitmaps
   a) The system shall allow for bitmaps created by other packages to be imported into the graphics, Bitmaps must support a transparent mode and Metafiles must import as objects not just bitmaps.
   b) At a minimum the system must support:
      i. .bmp
      ii. .msp
      iii. .jpg
      iv. wmf
      v. pcx
      vi. ico
      vii. cur
      viii. psd
      ix. epr
      x. wpg.

10. Graphic screen aliasing. The system must support a means of a generic node name for sharing graphic screen between different nodes with different names.
11. Documenting graphic displays. Printing of graphic displays in color and black and white shall be supported via the standard Microsoft Windows Print Manager in both the graphics development and runtime environments.
12. Operator entry methods. There shall be provided a flexible, Microsoft Windows standard methodology of operator interaction with the system.
13. Input devices
    a. The system shall support a variety of input devices, including
       1) Mouse or Trackball
       2) Touch-screen
       3) Keyboard (standard or function-style)
    b. The support for and use of any of these entry devices shall be as provided within Microsoft Windows or by the manufacturer of the input device.
    c. Simultaneous support for multiple of these devices shall be provided.
14. Item selection and data entry
    a. Items on a display shall be available to have their values changed by the operator, as appropriate.
    b. Selecting an item for data entry shall be done with the use of a pointing device or keyboard.
    c. The selected item shall be highlighted by a box surrounding it.
    d. The system must support the following data entry methods
       1) Numeric Data Entry
       2) Slider
       3) Pushbutton
       4) Ramp Value Entry
       5) Alphanumeric
    e. Each data entry type must be configurable to require confirmation if so desired. The use of third party Active X controls may be used.

15. Operator action tracking. The system shall print a descriptive message with a time stamp and user ID on the alarm printer or to an alarm file (if so configured whenever any of the following events occur:
    a. Alarm acknowledgment
    b. Data entry into a tag
    c. Reloading a database file
    d. Saving a database file
    e. Restarting the system
16. Command/scripting language
    a. The scripting language used by the system must be Microsoft's Visual Basic for Applications (VBA) not Visual Basic or Visual Basic "like".
    b. Scripts shall be simple or complex and allow for automated operation tasks, and create automated solutions.
    c. The scripting language must use Microsoft's IntelliSense feature, exposing all methods and properties of graphic objects.
    d. Editing shall be with the Visual Basic Editor (VBE), which is part of VBA.
    e. Scripting language requirements:
        1) Animation of objects in pictures.
        2) Automatic generation of pictures or objects.
        3) Read from, write to, and create database blocks.
        4) Automatically run other applications.
        5) Incorporate custom security features:
        6) Create custom prompts and messages for operators.
        7) Access ODBC data sources.
        8) Incorporate and communicate with third party and custom Active X controls.
        9) Trap bad or misbehaving Active X controls to prevent crashes.
        10) Write custom wizards for frequently performed tasks
        11) Allow use of global scripts and global variables.
        12) Scripts become part of the graphic screen.
        13) The VBE must allow import and export capability.
        14) There must be a link from the graphic editor to the VBE.
        15) VBA or the VBE shall be launched from within the system, without any commands.
        16) All Properties, methods, and event of Graphic Object created within the graphic editor or third party Active X controls used in the graphic screen must be exposed to VBA.
17. Object hierarchy overview
    a. Global level objects. These objects are available to all other objects and contain application-wide information.
    b. Document level objects. Objects that shall contain other objects. Example a graphic screen object containing a shape object, and a toolbar object containing a button object.
    c. Shapes and user objects. Visible objects, such as shapes, bitmaps, charts, and Active X objects, which shall be drawn or inserted in pictures.
    d. Hidden Objects. Objects that have no graphic representations in graphic screens; however are available and work with any other object, and perform specific functions. Example would be a timer object.
18. Renaming, duplicating and moving objects
    a. If an object is renamed in a graphic screen the name must be changed automatically in the VBA script or form.

b. When an object is duplicated in a graphic picture the script, form and module must also be duplicated and a new name reference mus1 automatically happen to for the new object, form, module, and script.

c. When an object is moved between pictures the form, module and script must move with it. If the object is placed into a graphic screen that already is using the same name, the renaming mentioned above mus1 take place for the object, form, script, and module.

19. Global scripts and variables. The system shall have the ability to have scripts and variables available across all graphic screens. These global scripts and variables must be loaded when the system is started.

D. ALARM HANDLING

1. The system shall be capable of detecting alarm conditions based on the states and values of the various sensed variables.
2. The alarm conditions shall be detected even if the variables causing alarms are not currently on the display.
3. Alarms shall be used to report potentially harmful process conditions requiring a response.
   a. Typically when a process value exceeds the pre-defined limits.
   b. An example would be a tank's level that is too high is an alarm condition to which an operator must respond.
4. Alarm limits shall be entered by the at configuration time or from the operator's display during run-time.
5. Alarm limits shall be expressed in engineering units.
6. Alarm types.
   a. Analog input or alarm variables shall have the following alarm types:
      1) High High
      2) High
      3) Low
      4) Low Low
      5) Time rate-of-change
      6) Bad input from I/O
      7) Alarm Disable
      8) Off
      9) Deadband
   b. Digital input variables shall have the following alarm types:
      1) None
      2) Change of state
      3) Open
      4) Close
   c. 3-term (PID) control functions shall have the following alarm types (in addition to the alarm types associated with the analog input or alarm block providing the measurement): Deviation from setpoint
7. Alarm priorities and filters.
   a. The system shall support at least 3 alarm priorities for each alarm type:
      1) High
      2) Medium
      3) Low
   b. A filtering mechanism shall be provided so that the operator shall adjust the system alarm priority.
   c. The handling shall be as follows:

1) If priority level is Low then messages shall be sent to alarm destinations for tags with high, medium, and low alarm priorities.
2) If priority level is Medium then messages shall be sent to alarm destinations for tags with high, and medium alarm priorities.
3) If priority level is High then messages shall be sent to alarm destinations for tags with high alarm priorities.

d. Special alarm messages (such as I/O failure) shall be non-maskable and shall always print.

8. Alarm destinations
   a. The system shall provide a means for placing an alarm message in one or more of the following locations
      1) Alarm summary display
      2) Alarm printer
      3) Alarm message file on disk
      4) Alarm history window (first-in, first-out scrolling window on the display)
   b. The system shall allow COM1, COM2, LPT1 or LPT2 to be the alarm printer. The use of multiple alarm printers shall be supported to allow routing of alarms from different alarm areas to different printers.
   c. Alarm messages shall be independently configurable as to what information is provided and its sequence within the message. The following shall be available choices
      1) Time of the alarm
      2) Name of the tag causing the alarm
      3) Alarm condition code
      4) Engineering units value when the alarm occurred
      5) Descriptor text assigned to the tag
      6) Engineering units of the tag
      7) Directly to a relational database
   d. The operator shall be able to specify the length of the alarm queue for each destination.
9. Time stamping
   a. A time stamp shall be included with every alarm or message.
   b. This time stamp shall indicate the time and date that the alarm or message was generated.
   c. Time stamping shall be supported from
   d. The local workstation.
   e. OPC server time
   f. Process hardware's clock.
10. Auto alarm manager
   a. The system shall support a method for alarms to be acknowledged from a central location, or via modem.
   b. The connections from the remote node to the central node must only be live during an alarm condition.
   c. This connection shall use Microsoft's Remote Access Service (RAS).
   d. The system shall support a primary and a secondary selection for alarms reporting.
11. Alarm notification and acknowledgment
   a. When a new alarm condition is detected, an alarm message shall be generated.
   b. If the alarm condition code text for the block is on the current display, then the text shall flash until the alarm is acknowledged.

c. Alarm acknowledgment shall be performed from the operator's workstation using the keyboard or with the mouse and shall require no more than one keystroke or mouse click.

d. The system shall be capable of "freezing" the highest alarm status value on the display until acknowledgment is made. Once acknowledgment is made, the system shall display the current alarm status text.

e. When an alarm is acknowledged from any node on the network, the acknowledgment shall be made directly at the node from which the alarm was generated, and a message indicating that it has been acknowledged shall then be distributed to all alarm destinations.

12. The software shall provide built-in capabilities to support the following:

a. Remote acknowledgment: This shall allow, for example, a button to be depressed by the operator which closes a digital tag and acknowledges one or more alarm conditions.

b. Alarm suspension. This shall allow the operator to specify digital tags, that when closed, cause alarms not to be generated for one or more alarm conditions. This is useful, for example, during the start-up phase of a project to avoid nuisance alarms.

c. Re-alarm time. This shall allow the system to re-generate an alarm after a configurable amount of time, should the alarm condition still exist.

d. Delay time. This shall allow a period of time for which an alarm condition must remain before an alarm is generated. This is useful, for example, if certain actions may cause a temporary, but acceptable, fluctuation beyond alarm limits and the generation of alarms is not desired.

e. For analog values, re-alarm time and delay time alarm capabilities shall be supported, not just on a tag by tag basis, but for the following individual alarm types within a tag:

1) High High
2) High
3) Low
4) Low Low
5) Rate of change
6) Deviation from target value
7) All other

13. Alarm summary display

a. The system shall offer an alarm summary display as a pre-defined, customizable, OCX, dynamic link within the graphics package.

b. This alarm summary display shall show a list of the pending alarms in the system.

c. As new alarms are detected, entries are made to the display list.

d. As the alarm conditions clear, the entries are removed from the list.

e. In addition to being able to configure the placement of the information (tag name, current value, descriptor, time of alarm, and alarm status), it shall be possible to specify the color codes to be used to indicate the various alarm conditions.

f. Alarms shall be acknowledged from the alarm summary display either individually (by clicking on an alarm acknowledgment field) or for all alarms in the queue.

g. The alarm summary display shall provide sorting and filtering capabilities.

1) It shall be possible to filter on node name, alarm area(s), alarm status and alarm priority.

2) It shall be possible to sort on time, tag, alarm area, alarm priority and alarm status.
3) It shall be possible to display field or fields about the alarm block in a column format and do complex filtering.

14. Alarm areas
    a. In order to logically divide a process into smaller units, the system shall allow for unlimited, named individual alarm areas to be defined.
    b. These alarm areas shall be definable on an individual tag level.
    c. All alarm areas shall be accessible by each tag and the system shall support multiple alarm areas per tag
    d. Alarm areas are used to determine which destinations receive each alarm. The method of alarm distribution over a network must be session-based in order to guarantee alarm distribution and reception. Broadcasting of alarms on the network shall not be permitted.
    e. Each alarm block shall be able to support an area that shall associate a graphic screen for the alarm.

E. ARCHIVING AND REPORTING

1. The system shall provide a facility for automatically collecting, storing and recalling data. Recalled data shall be made available to a trend display program, a report generation program and to user-written programs.
2. Data file handling
    a. Data shall be stored in Windows-compatible files in compressed format.
    b. Compression shall be performed through a selectable deadband.
    c. Entries containing time, name, value and status shall be made in the file whenever the real-time value exceeds the previously-stored value by the deadband limit.
    d. A deadband value of zero shall cause an entry in the file each time the real-time value is examined.
    e. Files shall be organized according to time and shall contain values for multiple, named variables. The file shall be placed on the hard disk or a floppy disk, and shall be placed on a file server if LAN server software in installed.
    f. A mechanism for on-line maintenance and automatic purging of files shall also be provided.
    g. The system shall support third part applications for ODBC queries.
3. Archive configuration
    a. The data to be collected by the archiving program shall be identified through an interactive, menu-based configurator.
    b. The operator shall enter the tag name, collection rate, and data compression deadband value.
        1) Collection Rates shall be:
            a) 1 Second
            b) 2 Seconds
            c) 10 Seconds
            d) 20 Seconds
            e) 30 Seconds
            f) 1 Minute
            g) 2 Minutes
            h) 10 Minutes
            i) 20 Minutes
            j) 30 Minutes

c. The collection task shall be run at any one (1) or more workstations on the network.

d. The task shall have the ability to access data from the memory-resident tag list in its own workstation and/or any other workstation on the network.

4. Displaying archived data

a. The operator shall be able to recall archived data from the disk to be displayed in graphic format along with real-time data.

b. The display of archived data shall be configurable. It shall be possible to configure objects in graphic displays that, when selected, retrieve pre-defined historical trend data from disk and display it to the operator. The system must allow for editing a pen's attributes during runtime.

c. The historical trend display shall be made up of the following components:

1) Pen Group.

a) The pen group configuration is used to define the particular tagnames which shall be displayed.

b) Along with tagnames, pen color, marker style and engineering units range may be defined.

2) Time Group. The time group configuration is used to define the time period over which the archived data is to be displayed.

3) Legend Group.

a) The legend group configuration is used to define the legend parameters for a historical display.

b) Both a primary and alternate legend may be displayed.

d. The display shall support unlimited variables to be displayed on the same time/value axis simultaneously.

1) For each entry in the display list, the operator shall be able to assign a given tag name and marker to a particular line color selected from palettes of unlimited colors.

2) The operator may also enter display engineering units ranges to cause scaling of the display.

3) Support shall be provided for multiple, different Y-axis engineering units to be displayed, as appropriate.

e. The display shall have two fields of view:

1) The top portion of the screen shall be the graphic field and shall display the values of the variables (Y-axis) against time (X-axis). It shall also contain labels for the axes and graphs.

2) The bottom portion of the screen shall be configurable to display the following information:

i. Node names.

ii. Tag names.

iii. Descriptors, pertaining to the tags in the trend display.

5. Trending.

a. The trend object shall allow for bi-directional trending and scrolling.

b. It shall be possible to select right to left or left to right.

c. A movable, vertical line shall act as a time cursor on the display.

1) This cursor shall be moved by dragging it with the mouse.

2) The date, time, and values of the trends corresponding to that time shall be displayed in the bottom portion of the screen.

d. The grid of the trend object shall be scrollable.
   1) The trend may be shifted forward or backward in time ("panning") by clicking on left/right buttons.
   2) New data shall be retrieved from the historical file as appropriate.
   3) Two sets of buttons shall be provided that cause shifting by different amounts of time.
   4) The amount of time shifting caused by these buttons shall be configurable.

e. The ability to display historical (pre-collected) data with current (real time) data on the same chart shall be supported.

f. It shall be possible to be able to "zoom" in on any section of the trend display by "cutting" that section with a mouse. The software shall automatically re-scale both the Y-axis and time axis and shall retrieve the appropriate data for the time period selected.

g. The trend object shall have a refresh rate selectable in .1 second increments from a minimum of.10 seconds to a maximum of 1800 seconds.

h. Display output.
   1) The trend graphic display shall be printable to a black and white or color printer via the standard Microsoft Windows Print Manager.
   2) The data contained in the display must also be capable of being sent to an ASCII file or .PRN file.

6. Event scheduling

a. The system shall support an event scheduler with event-based events, and time-based events.

b. Event-based events
   c. Event based items are to be used by any data source available to the system to trigger events.
   d. The system must be able to trigger an event on the following conditions:
      a) On true. When the data source resolves to a non-zero value.
      b) On false. When the data source resolves to a zero value.
      c) While true. At a specified interval as long as the data source evaluates to a non-zero value.
      d) While false. At a specified interval as long as the data source evaluates to zero.
      e) On change. When the data source changes.

c. Time-based events
   1) Time-based events are events that occur at a scheduled time and are not tied to a data source.
   2) The system must allow for scheduling of the following time-based events:
      a) One shot. Events that run once at the specified data and time.
      b) Continuous. Events that run continuously at the specified date and time.
      c) Daily. Events that run on the scheduled day of the week at a particular time.
      d) Monthly. Events that run on the scheduled day or the month at a particular time.

d. Events with VBA scripts
   1) The system shall support a script authoring wizard for events.
   2) The wizard shall generate a VBA script tied to the appropriate event.
   3) Once this script is created, editing must be allowed from the wizard or the supplied Visual Basic Editor (VBE).

F. MANUFACTURER

1. Latest version of G.E. Proficy HMI/SCADA – iFIX, Standard SCADA Pack, Developers License, USB Key.
2. From the date of substantial completion, 1 year of iGlobalCare support in the name of the OWNER.
3. or equal.

17710.10.3 PROGRAMMING

A. Operator interface screens shall be configured to maximize user-friendliness for the operators.

1. The process of calling up a display screen shall consist of pointing a cursor at pre-configured targets on the current screen and clicking.
2. Or of pushing a function key which shall be selected from a labeled list on the current display.
3. Each screen shall include targets or function key labels to related screens and to the main menu screen.
4. There shall also be targets on the current screen that will allow the operator to access the previous and next screens.
5. Screens shall be organized according to process flow in the same manner as the P&IDs.

B. The various required screens shall use text of all capital letters with the exception of certain engineering units.

1. All text shall be horizontal.
2. Screens showing equipment shall include the equipment TAG and LOOP and name as used in the P&IDs.
3. Total equipment run times shall be displayed as hours and tenths of hours on a pop-up table that shall be accessed via clicking on the equipment symbol.
4. Each screen shall show the current time and date which shall appear in the same place on each screen.
5. The Electrical & Controls Contractors shall provide a minimum of 15 screens.

C. DISPLAY SCREENS

1. The Electrical & Controls Contractors shall configure display screens to display all status and analog data contained in the system database.
2. The Contract Drawings, Control Strategies, P&IDs, and Specifications shall form the basis of the system database.
3. Some status and analog points shall be displayed on more than one display screen, especially where it relates to more than one process or is significant to facility operations.
4. Every analog and status value shall appear on at least one display screen.

5. Analog values shall be displayed with appropriate engineering units, and shall use techniques such as variable fill and/or color changes to provide clarity to plant operators.
6. Status points shall incorporate symbol and/or color changes along with labels, OPEN/CLOSE, ON/OFF, etc., to inform plant operators of the current status.
7. Color and labeling conventions shall be approved by the OWNER in writing prior to submitting display screens for review.

D. TREND DISPLAY SCREENS

1. The Electrical & Controls Contractors shall configure trend display screens which show real time and historical process data in an X-Y pilot with time on the horizontal axis.
2. Trend displays shall be configured with from one to four process variables displayed.
3. Each variable shall be drawn in a separate color with its vertical axis, scale, units, tag number, and description shown in the same color.
4. All variables on a trend display shall be shown on a single full screen X-Y plot with a vertical axis and scale for each variable, and a common horizontal time axis.
5. Each trend display shall have a preset time window when called up by a plant operator, but shall be easily changed by operator inputs to display alternate time ranges.
6. It shall also be possible to scroll a cursor across the X-Y plot to a specific time and read the corresponding process variables digitally at that point.
7. All analog values must be trended, whether or not specifically called out in the P&IDs.

E. DISPLAYS

1. Software shall be provided to allow any CRT screen to display data and reports pertinent to the operation of the system.
2. The displays shall be configured by the Electrical & Controls Contractors and delivered with the system in complete operational form at the factory acceptance test.
3. The display program shall provide for the following general attributes and display types:
   a) Provision shall be made to call a screen by entering the page number, and date, if required, using the keyboard.
   b) It shall also be possible to page from one page to another related page using the trackball and a vector poke point. If a page to page vectoring system is employed, a hierarchical paging scheme shall be developed with the screens.
   c) Alternatively, a display menu paging system may be employed.
      1) If a menu based paging system is employed it shall be possible to return to the displayed screen's menu through a single key stroke or utilize a poke point.
      2) Menus shall provide for menu to menu paging on a hierarchical basis.
4. Point Displays:
   a) For each analog and digital input, calculated/control point, and output there shall be provided a point display.

b) These displays shall have a standard format for each point type and shall show all data pertinent to each point:
   1) Point number.
   2) Name.
   3) I/O address.
   4) Filter factor.
   5) Scaling factors.
   6) Calculation.
   7) Alarm limits.
   8) Priorities.
   9) Set points.
   10) Tuning constants.
   11) Scan status.
   12) Operational status.
   13) Etc.

c) An operator shall be able to configure a point on-line using an interactive fill-in-the-blanks scheme.

d) A point so configured shall be saved automatically on command including an update of the database and scan program at the operator interface as well as downloading to the RTU all pertinent configuration and operational data.

e) In a similar manner, an operator shall be able to modify a configured point on-line.

f) An operator shall be able to modify or change any point attribute on line.

g) These displays shall also provide for other operator override functions including:
   1) Input blocking.
   2) Auto/manual control mode selection.
   3) Manual control manipulation.
   4) Etc.

h) Provisions shall be made to page directly to a point display from any display field that is controlled by that point.

5. Alarm Summary Display: Provide an alarm summary display.

6. Trend Displays:
   a) Trend displays shall be provided to allow data to be presented in a trend or strip-chart like format.
   b) Each and every analog value shall be trended, and the trends shall be developed by the Electrical & Controls Contractors.

7. Operator Interface:
   a) Software shall be provided to allow the operator to perform control selection, manual control, and acknowledgement function interactively through the CRT screen displays.
   b) It shall be possible to perform these functions through an interactive workline or window.
   c) It shall be possible to call the workline/window by positioning the trackball pointer on a symbol or data field that is tied to a database point and clicking.
   d) The type of equipment item or data point called will determine the exact operation that can be performed but, in general, provisions shall be made to allow for:
      1) Control mode selection, manual, local auto, central auto.
      2) Manual mode commands, start, stop, open, close, etc.

3) Alarm acknowledgments.
4) Setpoint Adjustments.
5) Interlock resets.
6) Totalizer resets.

F. DATA COLLECTION

1. The Electrical & Controls Contractors shall provide programming that collects current values of specified variables from on line data storage areas, statistically manipulates data, and creates and maintains a historical data base of collected values.
2. Statistical manipulation shall include linear averaging, filtered averaging, and noting of "bad" values.
3. Statistically manipulated data shall then be stored in a historical data base.
4. The frequency of historical collection shall be Operator selectable between once per second to once per month.
5. The type and quantity of historical data shall be selectable by addition and deletion to/from the historical data base.
6. The system shall provide adequate on-line storage to retain 60 days of 6 minute average values for 2,000 variables and hourly maximum, minimum, and average values of 2,000 variables.
7. The system shall provide adequate on-line storage to retain 2 years of daily and monthly maximum, minimum, and average values.

G. DISPLAYS

1. Overview:
   a) The overview display shall be a geographical representation of the plant. The Electrical & Controls Contractors shall use the contract documents as a basis for the development of the overview screen.
      (1) The overview shall include:
         i. A vector target to the graphic display for that site.
         ii. A symbol showing pumps and valve status.
            (i) On.
            (ii) Off.
            (iii) Fail.
            (iv) Opened.
            (v) Closed.
         iii. A station common alarm symbol.
2. Station Graphics:
   a) For each device both in the treatment plant, process area, and/or remote sites, a station graphic display shall be configured, this graphic shall include:
      1) Symbols for:
         i. Pumps.
         ii. Valves
         iii. Major instruments.
         iv. Flowmeters.
         v. Pressure transmitter.
         vi. Etc.
      2) Alarm symbols including intrusion alarm. Relevant test and operational data.

3) Each pump and valve shall include indication of status:
   i. Hand.
   ii. Off.
   iii. Automatic
   iv. Local.
   v. Remote.
   vi. Run.
   vii. Call.
   viii. Fail.
   ix. Open.
   x. Close.
4) Change of state of pumps and valves shall be depicted by change in color.

3. Production and Usage Bar Graph: A display shall depict the production for each site and/or piece of equipment both within the treatment plant and remote, summarized to type, and total usage, with a bar graph and numeric value for each analog value.
4. System Level Summary: A display using bar graphs and numbers shall show the level for the monitored reservoirs, and plant influent and effluent production, etc.
5. Trends: A trend chart shall be configured for each measured analog value in the database.
6. Sample Graphic Displays:
   a) The Electrical & Control Contractor shall provide samples of graphic displays that represent similar remote sites and treatment plant applications.
   b) These sample displays shall be in color and of typical applications that the Electrical & Controls Contractor has used on previous projects and meet the requirements of this contract specification.
   c) These sample displays shall be discussed and reviewed with the OWNER and ENGINEER.
   d) Furnish an additional 5 additional screens to be directed by ENGINEER & OWNER during construction.

H. CONFIGURATION OF REPORTS

1. It is the sole responsibility of the Electrical & Controls Contractors to configure the database that shall be used for the reports.
2. It is the sole responsibility of the Electrical & Controls Contractors to develop, design, engineer, configure and test all of the reports required for this project.
   a) All of this work shall take into account the specific needs of the OWNER.
   b) In order to facilitate this work the Electrical & Controls Contractor shall conduct meetings with owner's groups.
3. The reports shall be configured by the Electrical & Controls Contractors and delivered with the system in complete operational form.
4. Report format shall match the requirements of the OWNER.

17710.11 SOURCE QUALITY CONTROL

In accordance with Section 17000 “Process Control & Instrumentation General Requirements.”

17710.12 INSTALLATION

In accordance with Section 17000 "Process Control & Instrumentation General Requirements."

17710.13 FIELD QUALITY CONTROL

In accordance with Section 17000 "Process Control & Instrumentation General Requirements."

17710.14 TRAINING

In accordance with Section 17000 "Process Control & Instrumentation General Requirements."

17710.15 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000.

17710.16 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

APPENDIX A

SUNRISE
ENGINEERING

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

REPORT
GEOTECHNICAL STUDY
DIVISION OF WILDLIFE RESOURCES
SPRINGVILLE FISH HATCHERY – RACEWAY COVERS
1115 NORTH MAIN STREET
SPRINGVILLE, UTAH
DFCM PROJECT NO. 08259520/ CONTRACT NO. 097297

Submitted To:

State of Utah
Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

Submitted By:

Gordon Spilker Huber Geotechnical Consultants, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

February 19, 2009

Job No. 0128-035-09

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

February 19, 2009
Job No. 0128-035-09

State of Utah
Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

Attention: Mr. Bob Anderson

Ladies and Gentlemen:

Re: Report
Geotechnical Study
Division of Wildlife Resources
Springville Fish Hatchery – Raceway Covers
1115 North Main Street
Springville, Utah
DFCM Project No. 08259520/Contract No. 097297

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed for the proposed raceway cover at the site of the Department of Natural Resources Springville Fish Hatchery which is located at 1115 North Main Street in Springville, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1998, is presented on Figure 1, Vicinity Map. The location of the proposed raceway cover, on an aerial photograph base, is presented on Figure 2, Site Plan. The locations of the borings drilled in conjunction with this study are also presented on Figure 2.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. Bob Anderson of the State of Utah, Division of Facilities Construction Management (DFCM), and Mr. Alan Spilker of Gordon Spilker Huber Geotechnical Consultants, Inc. (GSH).

In general, the objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions across the site.

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2. Provide appropriate foundation, earthwork, pavement, and geoseismic recommendations to be utilized in the design and construction of the proposed facility.

In accomplishing these objectives, our scope has included the following:

1. A field program consisting of the drilling, logging, and sampling of seven borings.

2. A laboratory testing program.

3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this geotechnical report.

1.3 AUTHORIZATION

Authorization was provided by returning a signed copy of DFCM Project No. 08259520/Contract No. 09729.

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the physical properties of the soils encountered in the exploration borings, projected groundwater conditions, and the layout and design data discussed in Section 2., Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, GSH must be informed so that our recommendations can be reviewed and amended, if necessary.

Our professional services have been performed, our findings developed, and our recommendations prepared in accordance with generally accepted engineering principles and practices in this area at this time.

2. PROPOSED CONSTRUCTION

As part of the process of raising fish, fingerling fish are allowed to grow in concrete channels that are approximately three feet deep and three feet wide. These concrete channels are often called raceways. A raceway cover is proposed to be constructed over the existing raceways at the Springville Fish Hatchery. The raceway cover will consist of a one- to one-extended-level structure placed slab-on-grade and projected to be of steel-frame construction with steel veneer (skin). Structural loads will be transmitted down through interior and exterior columns to supporting foundations. It is our understanding there will be no continuous wall foundations associated with the structure. The maximum column loads, as provided by the structural engineer for the project, are on the order of 120 to 150 kips. Floor slabs are not anticipated but in the event new concrete is

placed, loads will be light (less than 200 pounds per square foot). If heavier footing or floor slab loads are anticipated, GSH must be contacted as soon as possible to review our recommendations.

Traffic in parking areas is projected to consist of a light volume of automobiles and light trucks and occasional medium-weight trucks. In primary roadway areas, it is projected that the traffic will consist of a moderate volume of automobiles and light trucks and a very light volume of medium- and heavy-weight trucks. If heavier traffic loads are anticipated, GSH must be contacted as soon as possible to review our recommendations.

Maximum site grading cuts and fills are anticipated to be on the order of one to two feet.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions across the site, 7 exploration borings were drilled to depths ranging from 14.0 to 16.5 feet below existing grades using a rubber tire-mounted rotary drill rig. The boreholes were advanced using hollow-stem augers. The approximate locations of the borings are presented on Figure 2.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the drilling operations, a continuous log of the subsurface conditions encountered was maintained. In addition, samples of the typical soils and fills penetrated were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications were later supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered during this study is presented on Figures 3A through 3G, Log of Borings. Soils were classified in accordance with the nomenclature described on Figure 4, Unified Soil Classification System.

A 3.25-inch outside diameter, 2.42-inch inside diameter drive sampler (Dames & Moore) was utilized in the majority of the subsurface sampling at the site. Additionally, a 2.0-inch outside diameter, 1.38-inch inside diameter drive sampler (SPT) was utilized at select locations. The blow counts recorded on the boring logs were those required to drive the sampler 12 inches with a 140-pound hammer dropping 30 inches.

Following completion of drilling operations, one and one-quarter-inch diameter slotted PVC pipe was installed in Boring B-1 and Borings B-3 through B-7 in order to provide a means of monitoring the groundwater fluctuations.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was completed. The program included moisture, density, consolidation, partial gradation, sulfate, and pH tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density Tests

To provide index parameters and to correlate other test data, moisture and density tests were performed on selected samples. The results of these tests are presented on the boring logs, Figures 3A through 3G.

3.2.3 Consolidation Tests

To provide data necessary for our settlement analyses, a consolidation test was performed upon each of three representative samples of the fine-grained clay soils encountered in the exploration borings. The results indicate that the soils are lightly to moderately over-consolidated. When loaded below the over-consolidation pressure, the soils will exhibit moderate to high compressibility characteristics. Detailed results of the tests are maintained within our files and can be transmitted to you, upon your request.

3.2.4 Partial Gradation Tests

To aid in classifying the granular soils, partial gradation tests were performed. Results of the tests are tabulated below:

Boring No.	Depth (feet)	Percent Passing No. 200 Sieve	Soil Classification
B-5	4.5	11.6	GC/GP SC/SP
B-5	10.5	8.7	GM/GP
B-5	15.5	23.9	SC/GC

3.2.5 pH and Soluble Sulfates Tests

To determine if the site soils will react detrimentally with concrete, pH and soluble sulfates tests were performed on a representative sample of the natural near-surface soils. The results of those tests are tabulated on the following page.

Boring No.	Depth (feet)	Soil Classification	pH	Water Soluble Sulfate (mg/kg-dry)
B-4	3.0	CL	7.58	1,400

4. SITE CONDITIONS

4.1 SURFACE

The raceway cover is proposed to be located at the existing Department of Natural Resources Springville Fish Hatchery at 1150 North Main Street in Springville, Utah. The site contains existing concrete fish runs, asphalt concrete pavements, and existing single-story structures with associated landscaped areas. The site is bounded to the west by Main Street with multi-story residential structures beyond; north and south of the site are open RV storage areas; and to the east is undeveloped wetlands.

The site is relatively flat with an overall relief of approximately three to four feet across the site sloping downward to the west. The majority of the site near the fish runs is covered with asphalt concrete pavement and/or gravel.

4.2 SUBSURFACE SOIL

From the surface in each boring, with the exception of Boring B-5, and extending to depths of one-half to seven feet, is non-engineered fills consisting of pavements, roadbase, silty clay with varying amounts of gravel and silty sand. The non-engineered fills will exhibit variable and, in most cases, poor engineering characteristics. Additionally, topsoil/loose disturbed soils were encountered in Borings B-5 through B-7.

Underneath the non-engineered fills and from the surface in Boring B-5 is natural silty clay with some fine sand. The clay is soft to stiff, moist to saturated, and dark brown, gray, and black. The clay extends to the explored depths of 14.0 to 16.5 feet in Borings B-1, B-2, B-4, B-6, and B-7. In Borings B-3 and B-5, the clay extends to depths of nine and three and one-half feet, respectively. The clay will exhibit moderate to moderately low strength and moderate to moderately high compressibility characteristics within the anticipated loading range.

Underneath the silty clay in B-3 and B-5 are sands and gravels with varying amounts of clay and silt. The sands and gravels are loose to dense, saturated, gray, will exhibit moderate high strength and low compressibility characteristics within the anticipated loading range.

The lines designating the interface between soil types on the boring logs generally represent approximate boundaries. In-situ, the transition between soil types may be gradual.

4.3 GROUNDWATER

To facilitate monitoring future groundwater fluctuations, prior to backfilling each boring, with the exception of Boring B-2, slotted PVC pipe was installed. The following chart summarizes the groundwater levels measured:

Boring No.	Groundwater Depth (feet)	
	January 16, 2009	**February 11, 2009***
B-1	7.0	5.0
B-2	6.0	No Pipe Installed
B-3	6.0	0.5**
B-4	5.0	2.7
B-5	4.0	2.6
B-6	6.0	1.7
B-7	8.0	3.0

* Stabilized groundwater depths

** The PVC pipe installed in Boring B-3 extends through the surficial layer of clay into underlying sands and gravels and artesian conditions are present, creating a high water level within the pipe.

Seasonal and longer-term groundwater fluctuations of one to two feet should be anticipated. The highest seasonal levels will generally occur during the late spring and summer months.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The most significant geotechnical aspects of the site are:

1. The highly compressible layer of silty clay generally encountered from depths of approximately five to eight feet in Borings B-3 and B-6.

2. The shallow depth to groundwater and potential artesian conditions at Boring B-3.

3. Non-engineered fills encountered to depths of one-half to seven feet at each boring with the exception of Boring B-5.

Highly compressible, slightly over-consolidated layers of silty clay were encountered from depths of approximately five to eight feet in Borings B-3 and B-6. Results of the consolidation testing indicate the clays have a relatively low preconsolidation pressure and will exhibit high compressibility characteristics under the proposed loads. It is likely that the soft silty clay will be encountered in isolated locations throughout the site.

Groundwater measurements taken on February 11, 2009 indicate groundwater is relatively close to the surface. The majority of the measurements were between 1.7 and 3.0 feet. A measurement of one-half foot was measured in Boring B-3, which may indicate an artesian condition due to the boring penetrating the silty clays into the underlying sands and gravels.

Non-engineered fills were encountered within most of the borings and were likely placed in association with the construction of the existing raceways. The non-engineered fills will exhibit variable and, most likely, poor engineering characteristics and are not suitable for the support of buildings, rigid pavements, or exterior flatwork. Non-engineered fills may remain beneath flexible pavement areas if properly prepared as discussed in this report.

Due to the soft clays and the potential for artesian groundwater conditions, GSH recommends the following options.

The first option is the installation of a permanent area dewatering system in association with the foundations of the raceway cover. Within this option, the dewatering system will be installed to an appropriate depth (approximately 18 inches below the bottom of the raceway channels) on the outside of exterior footings and adjacent to interior footings. Subsequent to the installation of the area drain, the soft silty clay soils within footing locations will be excavated, removed, and replaced with select granular structural fill.

The removal of the soft clay soils will cause groundwater to enter into the excavation. The groundwater will need to be controlled to the full depth of the temporary excavation until structural fill has been placed and compacted. It is recommended that structural fill contain at a minimum 20 percent fines (passing the No. 200 sieve) to render it less permeable. Subsequent to the placement of structural fill and footings, temporary dewatering may cease, allowing groundwater to flow into the permanent area dewatering system.

The dewatering system will have two benefits. The first is to reduce groundwater elevations for constructability and the second is to reduce the potential for infiltration of potentially Whirling Disease contaminated groundwater into the raceways. The dewatering system will require a suitable gravity discharge point or a sump with a suitably sized pump. The disadvantage of the dewatering system is that the dewatering of groundwater where artesian conditions are encountered may create large water flows and potentially affect the water level of up-gradient surface water

(wetlands). Water collected in the area dewatering system can be re-used and pumped either into the pretreatment system or into the wetlands. Details of the area dewatering system are discussed in Section 5.6, Area Subdrain, of this report.

The second option is to install deep foundation through the soft clay soils and into the underlying sands and gravels. As previously mentioned, the soft clay soils are anticipated to be in isolated locations across the site and each footing may or may not need deep foundations. GSH recommends that each footing location be pre-drilled to verify the presence of soft clay soils. If the soft clay soils are not encountered, then conventional spot footings may be utilized overlying 18 inches of replacement structural fill. If the soft clay soils are encountered, deep foundations will be required. Deep foundations may include helical piers or driven pipe piles. Details for deep foundations may be provided upon request.

A third option is to place conventional spot footings at a depth of two and one-half feet on the natural clay soils and design the structure to withstand total settlement of two to three inches and a differential settlement of one to one and one-half inches. If overall settlement is unacceptable after the structure is completed, helical piers may be installed post-construction to level the structure.

In the following sections, detailed discussions pertaining to earthwork, foundations, pavements, the geoseismic setting of the site, and other geotechnical parameters that could affect design, construction, or performance of the proposed facilities are presented.

5.2 EARTHWORK

5.2.1 Site Preparation

Preparation of the site will consist of the removal of non-engineered fills, loose/disturbed surficial soil, surface vegetation, topsoil, and other deleterious materials from beneath an area extending at least three feet beyond the perimeter of the proposed structure, rigid pavements, or exterior flatwork areas. In flexible pavement areas, the existing non-engineered fill and/or loose/disturbed surficial soils may remain provided that they do not contain deleterious material and the upper nine inches are scarified, moisture prepared, and compacted to the requirements for structural fill. Even if properly prepared, some long-term movements of flexible pavements overlying existing non-engineered fill, and/or loose/disturbed surficial soils may occur. If these long-term movements are not acceptable, the non-engineered fill and loose/disturbed surficial soils must be completely removed.

Subsequent to the above operations and prior to the placement of footings, structural site grading fill, floor slabs, or pavements, the exposed subgrade must be proofrolled by running moderate-weight rubber tire-mounted construction equipment uniformly over the surface at least three times. If excessively soft or otherwise unsuitable soils/fills are encountered beneath footings, they must be completely removed. In pavement and floor slab areas, unsuitable soils/fills encountered during proofrolling must be removed to a maximum depth of two feet and replaced with compacted granular structural fill.

Surface vegetation and other deleterious materials should generally be removed from the site. The on-site soils can be utilized as structural site grading fill if they meet the requirements of such. The natural fine-grained soils will require close moisture control and may be very difficult, if not impossible, to properly place and compact during wet and cold periods of the year.

5.2.2 Temporary Excavations

Within excavations at the site, groundwater is anticipated at depths of approximately one-half to five feet. Temporary construction excavations not exceeding four feet in depth, above or below the water table within the non-engineered fills and natural silty clay, may be constructed with near-vertical side slopes. Deeper construction excavations up to eight feet in depth in the natural cohesive (clay) soils, above or below the water table, may be constructed with sideslopes no steeper than one-half horizontal to one vertical. Deeper construction excavations up to eight feet in depth in the natural silty and clayey sands and gravels, above or below the water table, may be constructed with sideslopes no steeper than one horizontal to one vertical. Excavations deeper than eight feet are not anticipated.

Excavations below the groundwater in these sands and gravels will be extremely difficult since these soils will tend to "flow" into the excavations. This condition will require significant effort to stabilize and will likely include significantly flatter sideslopes, dewatering, and/or the use of shoring/bracing. GSH anticipates that temporary dewatering will be required during excavation of footing and soft silty clay soils.

All excavations must be inspected periodically by qualified personnel. If any signs of instability are noted, immediate remedial action must be initiated.

5.2.3 Structural Fill

Structural fill will be required as site grading fill, as backfill over foundations and utilities, and potentially as replacement fill below footings. All structural fill must be free of sod, rubbish, construction debris, frozen soil, and other deleterious materials. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade.

To stabilize soft subgrade conditions or where structural fill is required to be placed below a level one foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or one and one-half- to two-inch minus gravel (stabilizing fill) should be utilized.

The maximum particle size within structural site grading fill shall generally not exceed four inches; although, occasional particles up to six to eight inches may be incorporated provided that they do not result in "honeycombing" or preclude the obtainment of the desired degree of compaction. In confined areas, the maximum particle size shall be restricted to two and one-half inches.

The on-site soils can be utilized as structural site grading fill if they meet the requirements of such. The fine-grained soils will require that very close moisture control be maintained during placement

and compaction. It will be very difficult, if not impossible, to properly place and compact these fills during wet and cold periods of the year. Generally, we recommend that all imported structural fill consist of a well-graded mixture of sands and gravels with no more than 18 percent fines (material passing the No. 200 sieve). In areas where soft clays are removed overlying the deeper sands and gravels, we recommend that structural fill consist of a well-graded mixture of sands and gravels with no less than 20 percent fines (material passing the No. 200 sieve). Granular fills are recommended in all confined areas.

Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.2.4 Fill Placement and Compaction

All structural fill should be placed in lifts not exceeding eight inches in loose lift thickness. Structural fills up to 10 feet thick, as well as all structural fills beneath an area extending out at least 3 feet from the perimeter of the structures, must be compacted to at least 95 percent of the maximum dry density as determined by the AASHTO[1] T-180 (ASTM[2] D-1557) compaction criteria. Structural fills greater than 10 feet are not anticipated at the site. Structural fills less than 5 feet thick, which are not beneath an area extending out at least 3 feet from the perimeter of the structure, should be compacted to at least 90 percent of the above-defined criteria.

Coarse gravel and cobble mixtures (stabilizing fills), where utilized for subgrade stabilization, shall be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment over the surface of each lift at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately compacted so that the "fines" are "worked into" the voids in the underlying coarser gravels and cobbles.

Prior to the placement of structural site grading fill, pavements, floor slabs, or footings, the exposed subgrade must be prepared as discussed in Section 5.2.1, Site Preparation, of this report. In confined areas, subgrade preparation must consist of the removal of all loose or disturbed soils.

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill should be proofrolled

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1 American Association of State Highway and Transportation Officials
2 American Society for Testing and Materials

and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling shall be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they shall be removed to a maximum depth of two feet below design finish grade and replaced with structural fill.

Most utility companies and City-County governments are now requiring that Type A-1 or A-1a (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities. These organizations are also requiring that in public roadways the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

The fine-grained soils/fills are not recommended for use as trench backfill.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The proposed structure can be supported upon conventional spread foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Options for foundation systems have been discussed previously in this report. The soft clay soils encountered at some locations at the site are not suitable for the support of conventional spread footings and must be removed and replaced with granular structural fill. Alternatively, in areas where soft clay soils are encountered, deep foundations or alternative designs may be implemented. GSH can provide information for alternative designs upon request. For design, the following parameters are provided:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions for footings placed on a minimum of 18 inches of granular structural fill	- 2,000 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

5.3.2 Installation

Under no circumstances shall the footings be established upon or overlying non-engineered fills, unsuitable, soft natural clay soils, loose/disturbed soils, sod, rubbish, topsoil, other deleterious materials, frozen soils, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted structural fill. If granular soils become loose or disturbed, they must be recompacted to the requirements for structural fill.

The width of structural replacement fill below footings shall be equal to the width of the footing plus one foot for each foot of fill thickness.

5.3.3 Settlements

Settlements of foundations designed and installed in accordance with the above recommendations (on replacement fill extending to suitable soils - first option), and supporting maximum anticipated structural loads, are anticipated to be approximately one-half to five-eighths of an inch. Settlements are expected to occur rapidly with approximately 50 to 60 percent of the settlements occurring during construction.

Settlements for helical piers may be provided by the selected helical pier installer/manufacturer (for second option).

Total settlements for footings established on the natural clayey soils area are anticipated to be between two and three inches. Differential settlements are anticipated to be between one and one and one-half inches (for third option).

If loads greater than those discussed in Section 2., Proposed Construction, of this report are to be imposed, GSH must be contacted so that our recommendations can be reviewed and amended, if necessary.

5.4 LATERAL RESISTANCE

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.40 should be utilized. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot.

Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

5.5 FLOOR SLABS

It is anticipated that floor slabs will only be placed in limited areas within the footprint of the structure. Floor slabs must be established upon suitable natural soils and/or upon structural fill extending to suitable natural soils. Under no circumstances shall floor slabs be established upon, loose or disturbed soils, non-engineered fills, sod, rubbish, deleterious materials, frozen soils, or within ponded water. In order to provide a capillary break and to facilitate curing of the concrete, it is recommended that floor slabs be directly underlain by at least four inches of "free-draining" fill, such as "pea" gravel or three-quarters- to one-inch minus clean gap-graded gravel.

Settlement of lightly loaded floor slabs (200 pounds per square foot or less) is anticipated to be minor (less than one-quarter inch).

5.6 AREA SUBDRAIN

5.6.1 General

As previously discussed, an area drain is required to provide for constructability of the proposed foundations and to reduce the potential for groundwater intrusion into the raceways.

5.6.2 Area Subdrains

Area subdrains should consist of a six-inch diameter perforated or slotted plastic or PVC pipe enclosed in clean gravel. The invert of a subdrain should be at least 18 inches below the top of the lowest raceway. The gravel portion of the drain should extend two inches laterally and below the perforated pipe and at least one foot above the top of the adjacent raceway. To reduce the possibility of plugging, the gravel must be wrapped with a geotextile, such as Mirafi 140N or equivalent. Above the subdrain, a minimum four-inch-wide zone of "free-draining" sand and gravel should extend to within two feet of final grade. The slope of the subdrain should be at least 0.3 percent. The gravel placed around the drain pipe should be clean, three-quarters to one-inch minus gap-graded gravel and/or "pea" gravel. GSH recommends that the area subdrain be installed around the perimeter of the exterior footings with at least one drain traversing longitudinally through the center of the raceways. The subdrains can be discharged into storm drains, a sump with a suitably sized pump, or other suitable down-gradient location.

5.7 PAVEMENTS

The existing non-engineered fills and natural clay soils encountered at the site will exhibit poor pavement support characteristics when saturated or near saturated. Non-engineered fills and topsoil/loose disturbed soils may remain in flexible pavement areas if they are properly prepared, as previously mentioned. Considering the non-engineered fills and natural clay as the subgrade soils and the projected traffic as discussed in Section 2., Proposed Construction, the following pavement sections are recommended:

Parking Areas

(Light Volume of Automobiles and Light Trucks,
Occasional Medium-Weight Trucks,
and No Heavy-Weight Trucks)
[1 equivalent 18-kip axle loads per day]

Flexible:

2.5 inches	Asphalt concrete
7.0 inches	Aggregate base course
Over	Properly prepared existing non-engineered fill, and/or existing loose/disturbed soils, or suitable natural soils, and/or structural site grading fill extending to these soils

Rigid:

5.0 inches	Portland cement concrete (non-reinforced)
3.0 inches	Aggregate base course
Over	Properly prepared suitable natural soils, and/or structural site grading fill extending to these soils*

* Under no circumstances should rigid pavements be placed overlying non-engineered fills and/or loose/disturbed soils.

Primary Roadway Areas

(Moderate Volume of Automobiles and Light Trucks,
Very Light Volume of Medium- and Heavy-Weight Trucks)
[5 equivalent 18-kip axle loads per day]

Flexible:

3.0 inches	Asphalt concrete
8.0 inches	Aggregate base course
Over	Properly prepared existing non-engineered fill, and/or existing loose/disturbed soils, or suitable natural soils, and/or structural site grading fill extending to these soils

Rigid:

6.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base course
Over	Properly prepared suitable natural soils, and/or structural site grading fill extending to these soils*

* Under no circumstances should rigid pavements be placed overlying non-engineered fills and/or loose/disturbed soils.

For dumpster pads, we recommend a pavement section consisting of six and one-half inches of Portland cement concrete, four inches of aggregate base course, over properly prepared natural subgrade or site grading structural fills.

These rigid pavement sections are for non-reinforced Portland cement concrete. Concrete should be designed in accordance with the American Concrete Institute (ACI) and joint details should conform with the Portland Cement Association (PCA) guidelines. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6 percent ±1 percent air-entrainment.

5.8 CEMENT TYPES

The laboratory tests indicate that the surficial soils contain a moderate amount of water soluble sulfates. Based on our test results, concrete in contact with the on-site soil will have a moderate potential for sulfate reaction (ACI 318, Table 4.3.1). To achieve the required protection against sulfate-related corrosion, we recommend a maximum water-to-cement ratio of 0.5 (by weight, normal weight aggregate concrete) and using Type II, or equivalent sulfate protection cement in concrete to obtain a minimum compressive strength of 4,000 pounds per square inch (psi). Details can be found in the above ACI reference and in the Portland Cement Association publication, "Design and Control of Concrete Admixtures."

5.9 GEOSEISMIC SETTING

5.9.1 General

Utah municipalities adopted the International Building Code (IBC) 2006 on January 1, 2007. The IBC 2006 code determines the seismic hazard for a site based upon 2002 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2006 edition.

5.9.2 Faulting

Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The nearest active fault is the Provo segment of the Wasatch fault approximately one-third mile east of the site. The Wasatch fault zone is considered capable of generating earthquakes as large as magnitude 7.4.

5.9.3 Soil Class

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Table 1613.5.2, Site Class Definitions, of the IBC 2006 can be utilized.

5.9.4 Ground Motions

The IBC 2006 code is based on 2002 USGS (United States Geologic Survey) mapping, which provides values of short and long period accelerations for the Site Class B-C boundary for the Maximum Considered Earthquake (MCE). This Site Class B-C boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for a MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the second column. Based on the site latitude

and longitude (40.18048 degrees north and -111.60928 degrees west, respectively), the values for this site are tabulated below:

Spectral Acceleration Value, T Seconds	Site Class B-C Boundary [mapped values] (% g)	Site Class D [adjusted for site class effects] (% g)
Peak Ground Acceleration	50.2	50.2
0.2 Seconds, (Short Period Acceleration)	$S_S = 125.4$	$S_{MS} = 125.4$
1.0 Seconds (Long Period Acceleration)	$S_1 = 52.7$	$S_{M1} = 79.0$

The IBC 2006 code design accelerations (S_{DS} and S_{D1}) are based on multiplying the above accelerations (adjusted for site class effects) for the MCE event by two-thirds (⅔).

5.9.5 Liquefaction

The site is located in an area that has been mapped by Utah County as having a "moderate potential" for liquefaction. Liquefaction is defined as the condition when saturated, loose, fine sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Clayey soils, even if saturated, will not liquefy during a major seismic event.

Due to the clayey nature of the majority of soils and the dense nature of the granular soils encountered on the site, liquefaction will not likely occur during the design seismic event. Calculations were performed using the procedures described in NCEER-97-0022 entitled, "Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils," and only apply to the saturated cohesionless deposits.

We appreciate the opportunity of providing this service for you. If you have any questions or require additional information, please do not hesitate to contact us.

Respectfully submitted,

GSH Geotechnical Consultants, Inc.

Alan D. Spilker, State of Utah No. 334228
Professional Engineer

Reviewed by:

Joshua M. Whitney, State of Utah No. 6252902
Professional Engineer

ADS/JMW:jlh

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A through 3G, Log of Borings
Figure 4, Unified Soil Classification System

Addressee (3 + email)
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Department of National Resources
Division of Wildlife Resources
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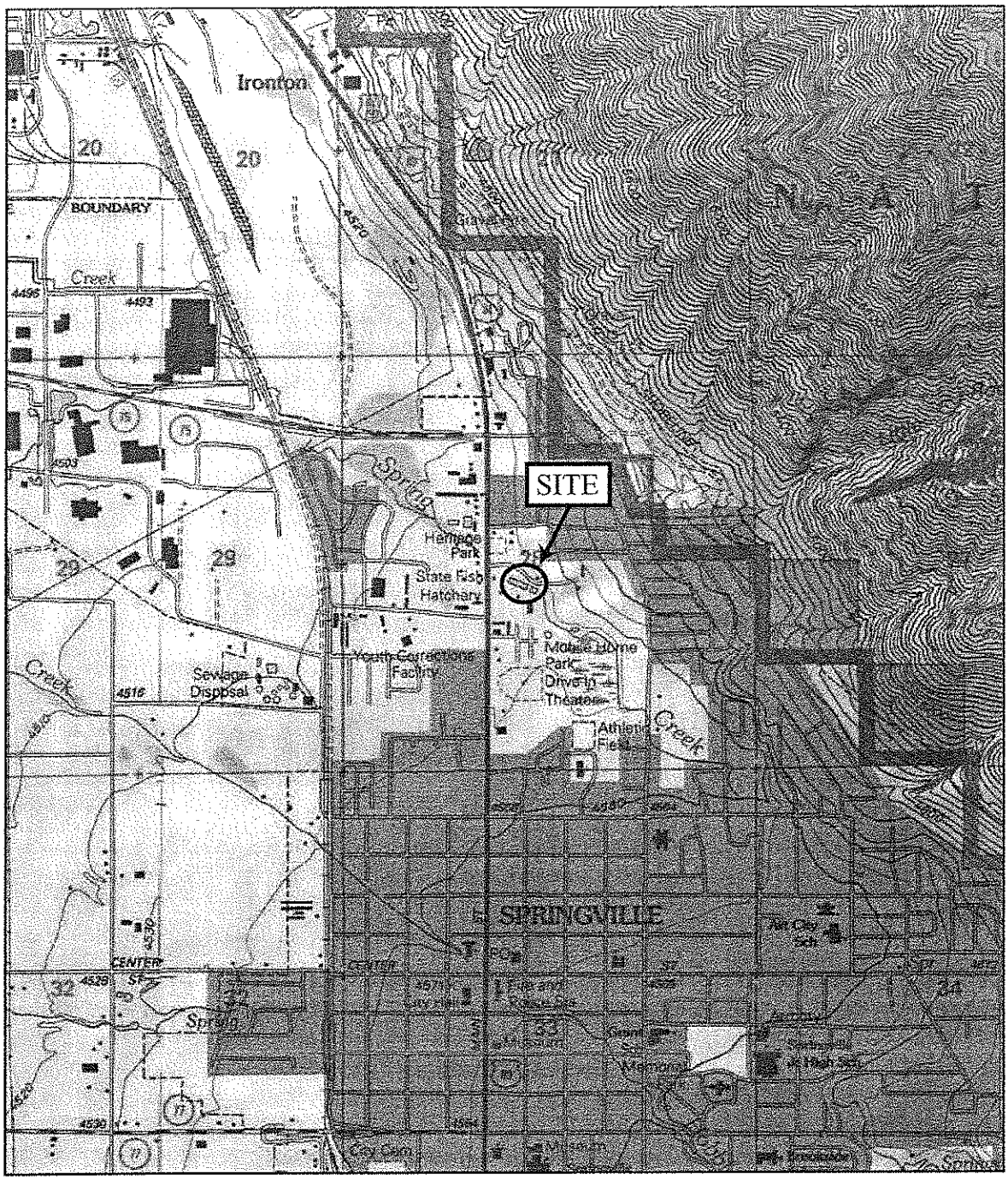
Salt Lake City, Utah 84114

STATE OF UTAH - DFCM
JOB NO. 0128-035-09



SCALE IN FEET
1000 0 1000 2000

FIGURE 1
VICINITY MAP

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAPS
TITLED "SPRINGVILLE, UTAH" AND "PROVO, UTAH"
BOTH DATED 1998

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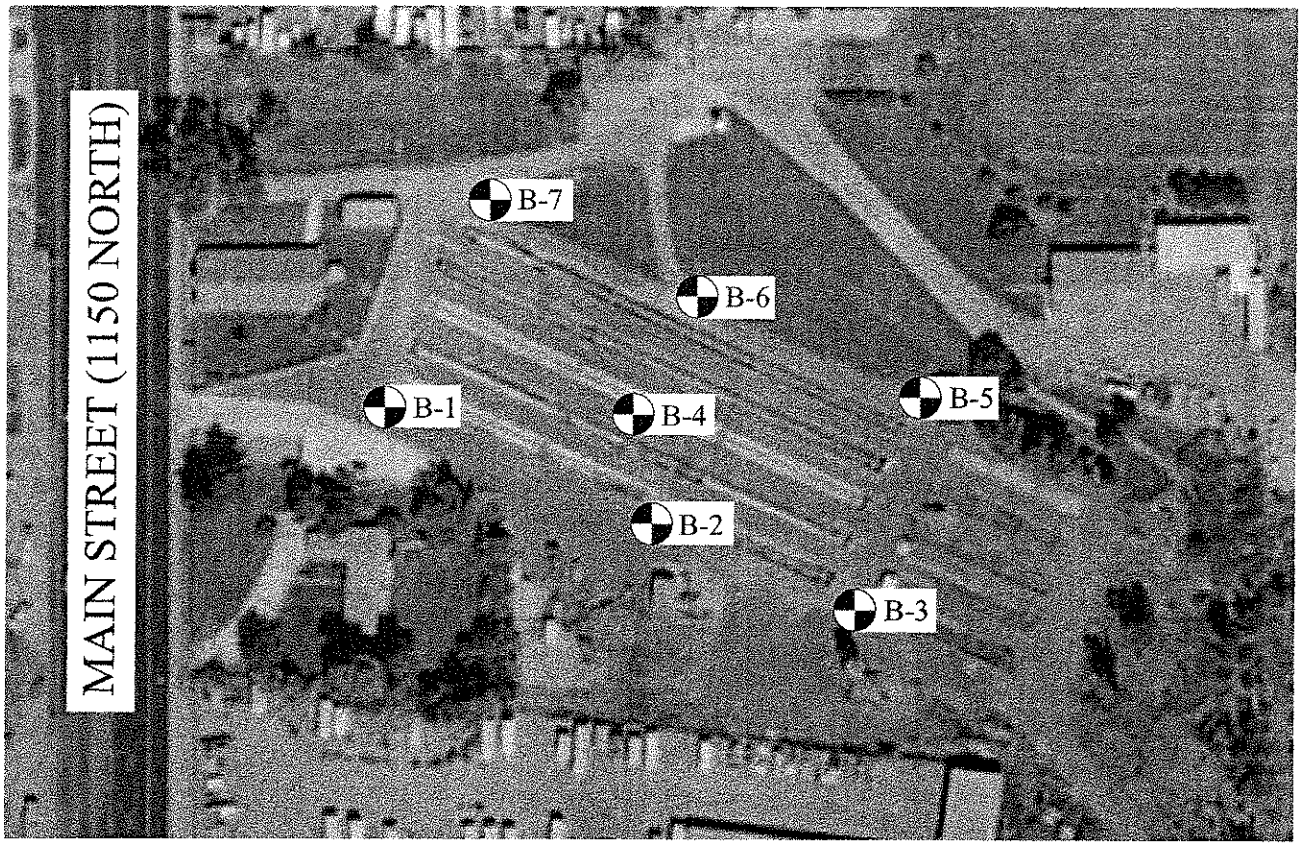
STATE OF UTAH - DFCM
JOB NO. 0128-035-09



NOT TO SCALE

FIGURE 2
SITE PLAN

REFERENCE:
ADAPTED FROM AERIAL PHOTOGRAPH
BY GOOGLE EARTH, DATED 2008

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Geotechnical Consultants, Inc.

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09 GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 7.0' (01-16-09) 5.0' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		2.5"ASPHALT CONCRETE									
		3.5" ROADBASE, FILL 3/4" minus									moist medium stiff
		SILTY CLAY with some fine sand; brown (CL)		7							
		grades with cemented nodules; brown with oxidation mottling	5	7		26.9		97			saturated
		grades with occasional layers up to 1' thick of clayey fine to coarse sand; brown and gray with oxidation	10	20							stiff
			15	15		26.7		97			
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3A

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-2

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		2.5"ASPHALT CONCRETE									moist
		21.5" ROADBASE, FILL 3/4" minus									medium dense
		SILTY CLAY with some fine and coarse gravel; brown and dark brown (CL)									moist medium stiff
				7							
			5								very moist
				7							saturated
				12		28.6		96			stiff
			10								
		grades with trace organics; gray		8		34.0		86			medium stiff
		Stopped drilling at 13.0'.	15								
		Stopped sampling at 14.5'.									
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3B

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09) 0.5' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		2.5"ASPHALT CONCRETE									
		9.5" ROADBASE, FILL 3/4" minus									
		SILTY CLAY with some fine sand; dark brown (CL)									saturated moist soft
		grades with some fine and coarse gravel		9		24.7		100			very moist medium stiff
			5								
		grades with some fine sand and trace organics; gray and black		3		57.3		66			soft
		CLAYEY GRAVEL fine to coarse gravel; dark gray (GC)	10	38							saturated dense
		grades with some fine to coarse sand and fine and coarse gravel with trace silt; grading silty	15	23							medium dense
		Stopped drilling at 14.0'.									
		Stopped sampling at 15.5'.									
		Installed 1-1/4" diameter slotted PVC pipe to 15.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3C

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-4

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09 GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 5.0' (01-16-09) 2.7' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		2.5"ASPHALT CONCRETE									
		9.5" ROADBASE, FILL 3/4" minus									moist very soft
		SILTY CLAY, FILL with some fine and coarse gravel; brown (CL-FILL)		33		14.1		121			saturated
			5								
		SILTY CLAY with some fine sand; cemented nodules; brownish-tan with oxidation (CL)		15		13.5		106			saturated stiff
		grades without cemented nodules; gray with trace organics	10	12		26.8		96			
		grades with trace fine sand; gray	15	3							soft
		Stopped drilling at 15.0'.									
		Stopped sampling at 16.5'.									
		Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3D

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09 GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 4.0' (01-16-09) 2.6' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SILTY CLAY with some fine and coarse gravel; major roots (topsoil) to 2"; brown (CL)									loose to 2" moist
				10							very moist stiff
											saturated
		GRAVEL AND SAND with some clay; fine and coarse gravel; fine to coarse sand; gray (GC/GP/SC/SP)	5	30		14.7	11.6				medium dense
		GRAVEL with some fine to coarse sand and some silt; fine to coarse gravel; gray (GM/GP)									saturated medium dense
			10	20		14.0	8.7				
		CLAYEY SAND AND GRAVEL fine to coarse sand; fine and coarse gravel; gray (SC/GC)									saturated loose
			15	7		19.5	23.9				
		Stopped drilling at 15.0'.									
		Stopped sampling at 16.5'.									
		Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3E

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-6

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09 GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09) 1.7' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SILTY CLAY, FILL with some fine and coarse gravel; major roots (topsoil) to 2"; gray (CL/GC-FILL)									loose to 2" very moist medium stiff saturated
		SILTY CLAY with some fine sand; gray and black (CL)		9		26.3		89			saturated
			5	4		32.1		91			
				6		30.8		87			medium stiff
			10								
		grades with trace fine sand and trace organics; gray		3							soft
		Stopped drilling at 12.5'.	15								
		Stopped sampling at 14.0'.									
		Installed 1-1/4" diameter slotted PVC pipe to 14.0'.									
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3F

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 8.0' (01-16-09) 3.0' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SILTY CLAY, FILL with some fine and coarse gravel; major roots (topsoil) to 2"; dark brown (CL-FILL)									loose to 2" moist very stiff
	▼			28							saturated
		SILTY SAND, FILL with trace clay; fine to coarse sand; brown (SM-FILL)	5								saturated medium dense
				58							
		SILTY CLAY with some fine sand; grayish-brown (CL)									saturated stiff
			10	6							
			15	13							
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3G

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES				GRAPH SYMBOL	LETTER SYMBOL ‡	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size. ▶ (The No. 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		SW	Well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		SC	Clayey sands, poorly graded sand-clay mixtures.

IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE							
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size. (The No. 200 sieve size is about the smallest particle visible to the naked eye)		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)			
	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity.
		Medium to high	None to very slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to very high	None	High		CH	Inorganic clays of high plasticity, fat clays.
		Medium to high	None to very slow	Slight to medium		OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other highly organic soils.

‡ Boundary classifications—Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW–GC, well graded gravel–sand mixture with clay binder.
▶ All sieve sizes on this chart are U.S. standard.

USCS

GENERAL NOTES

1. In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There rore, actual designations (based on laboratory testing) may differ.

2. Lines seperating strata on the logs represent approximate boundaries only Actual transitions may be gradual.

3. Logs represent general soil conditions observed at teh point of exploration onthe date indicated.

4. No warranty is provided as to the continuity of soil conditions between individual sample locations.

FINE - GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by Thumb. Squeezes through fingers.
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1 " by Thumb . Molded by light finger pressure.
Medium Stiff	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2 " by Thumb with moerate effort. Molded by strong finger pressure.
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2 " by Thumb but penetrated only with great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by Thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty by Thumbnail

LOG KEY SYMBOLS

- Bulk / Bag Sample
- Thin Wall
- Standard Penetration Split Spoon Sampler
- No Recovery
- Rock Core
- 3-3/4" ID D&M Sampler
- 3" ID D&M Sampler
- Water Level
- California Sampler

COARSE -GRAINDE SOIL

APPERENT DENSITY	SPT (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	<4	0 - 15	Easily penetrated with 1/2 " reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrated with 1/2 " reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Dense	30 - 50	65 - 85	Difficult to penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Very Dense	>50	85 - 100	Penetrated only a few inches with 1/2 " reinforcing rod driven with 5-lb hammer

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2 "
LAYER	1/2 - 12 "

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness
Frequent	More than on per foot of thickness

CEMENTATION

DESCRIPTION	DESCRIPTION
Weakely	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumbles or breaks with finger pressure

MODIFIERS

DESCRIPTION	%
Trace	<5
Some	5 - 12
With	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil below Water Table

FIGURE 4

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

APPENDIX B

SUNRISE
ENGINEERING

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

REPORT
GEOTECHNICAL STUDY
DIVISION OF WILDLIFE RESOURCES
SPRINGVILLE FISH HATCHERY
PRE-TREATMENT STRUCTURE
1115 NORTH MAIN STREET
SPRINGVILLE, UTAH
DFCM PROJECT NO. 08259520/
CONTRACT NO. 75030

Submitted To:

State of Utah
Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

Submitted By:

Gordon Spilker Huber Geotechnical Consultants, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

November 13, 2009

Job No. 0128-35A-09

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

November 13, 2009
Job No. 0128-35A-09

State of Utah
Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

Attention: Mr. Bob Anderson

Gentlemen:

Re: Report
Geotechnical Study
Division of Wildlife Resources
Springville Fish Hatchery – Pre-treatment Structure
1115 North Main Street
Springville, Utah
DFCM Project No. 08259520/Contract No. 75030

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed for the proposed pre-treatment structure at the site of the Department of Natural Resources Springville Fish Hatchery, which is located at 1115 North Main Street in Springville, Utah. Gordon Spilker Huber Geotechnical Consultants, Inc. (GSH) completed a geotechnical study dated February 9, 2009[1] for the proposed raceway covers, which are located immediately southwest of the proposed pre-treatment structure. The general location of the site with respect to major topographic features and existing facilities, as of 1998, is presented on Figure 1, Vicinity Map. The location of the proposed pre-treatment structure, on an aerial photograph base, is presented on Figure 2, Site Plan. The locations of the borings drilled in conjunction with this study and the February 9, 2009 study are also presented on Figure 2.

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1 "Report, Geotechnical Study, Division of Wildlife Resources, Springville Fish Hatchery – Raceway Covers, 1115 North Main Street, Springville, Utah, DFCM Project No. 08259520/Contract No. 097297." GSH Job No. 0128-035-09.

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1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. Skyler Davies of Sunrise Engineering; Mr. Bob Anderson of the State of Utah, Division of Facilities Construction Management (DFCM); and Mr. Alan Spilker of GSH.

In general, the objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions across the site.

2. Provide appropriate foundation, earthwork, pavement, drainage, and geoseismic recommendations to be utilized in the design and construction of the proposed facility.

In accomplishing these objectives, our scope has included the following:

1. A field program consisting of the drilling, logging, and sampling of two borings.

2. A laboratory testing program.

3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this geotechnical report.

1.3 AUTHORIZATION

Authorization was provided by returning a signed copy of DFCM Project No. 08259520/Contract No. 75030.

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the physical properties of the soils encountered in the exploration borings and previous study, projected groundwater conditions, and the layout and design data discussed in Section 2., Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, GSH must be informed so that our recommendations can be reviewed and amended, if necessary.

Our professional services have been performed, our findings developed, and our recommendations prepared in accordance with generally accepted engineering principles and practices in this area at this time.

2. PROPOSED CONSTRUCTION

As part of the process of raising fish, fingerling fish are allowed to grow in water-filled concrete channels that are approximately three feet deep and three feet wide. Surface and groundwater at the site is reported to contain biological constitutes that cause fish to contract "whirling disease." Surface water that is used to raise the fish must be treated to eliminate critical biological agents from the production water stream. A small one- to one-extended-level structure placed slab-on-grade is proposed for the pre-treatment system and projected to be of steel-frame construction with steel veneer (skin). Structural loads will be transmitted down through interior and exterior columns to supporting foundations. It is our understanding there will be no continuous wall foundations associated with the structure. The maximum column loads, as provided by the structural engineer for the project, are on the order of 100 to 120 kips. Floor slabs are anticipated to be lightly loaded (less than 200 pounds per square foot). If heavier footing or floor slab loads are anticipated, GSH must be contacted as soon as possible to review our recommendations.

Traffic in parking areas is projected to consist of a light volume of automobiles and light trucks and occasional medium-weight trucks. In primary roadway areas, it is projected that the traffic will consist of a moderate volume of automobiles and light trucks and a very light volume of medium- and heavy-weight trucks. If heavier traffic loads are anticipated, GSH must be contacted as soon as possible to review our recommendations.

Maximum site grading cuts and fills are anticipated to be on the order of one to two feet.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions across the site, 2 exploration borings were drilled to a depth of 16.5 feet. During our February 9, 2009 study, 7 exploration borings were drilled to depths ranging from 14.0 to 16.5 feet below existing grades using a rubber tire-mounted rotary drill rig. The boreholes were advanced using hollow-stem augers. The approximate locations of the borings from this study and the February 9, 2009 study are presented on Figure 2.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the drilling operations, a continuous log of the subsurface conditions encountered was maintained. In addition, samples of the typical soils and fills penetrated were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications were later supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered during this study is presented on Figures 3A and 3B, Log of Borings. This study and those encountered during our February 9, 2009 study are presented on Figures 4A through 4G, Log of Borings

(February 9, 2009 Study). Soils were classified in accordance with the nomenclature described on Figure 5, Unified Soil Classification System.

A 2.0-inch outside diameter, 1.38-inch inside diameter drive sampler (SPT) was utilized in the majority of the subsurface sampling at the site. Additionally, a 3.25-inch outside diameter, 2.42-inch inside diameter drive sampler (Dames & Moore) was utilized at select locations and depths. The blow-counts recorded on the boring logs were those required to drive the sampler 12 inches with a 140-pound hammer dropping 30 inches.

Following completion of drilling operations, one and one-quarter-inch diameter slotted PVC pipe was installed in Boring B-1A and B-2A in order to provide a means of monitoring the groundwater fluctuations.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was completed. The program included moisture, partial gradation, pH and soluble sulfates tests. Due to the granular nature of the site soils, samples for more sophisticated tests were unavailable. Design data is based on gradation results and upon our experience with granular soils. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture Tests

To aid in classifying the soils and to help correlate other test data, moisture tests were performed on selected undisturbed samples. The results of these tests are presented on the boring logs, Figures 3A and 3B.

3.2.3 Partial Gradation Tests

To aid in classifying the granular soils, partial gradation tests were performed. Results of the tests are tabulated on the following page.

Boring No.	Depth (feet)	Percent Passing No. 200 Sieve	Soil Classification
B-1A	5.5	14.0	GC
B-1A	10.5	7.5	GC/GP
B-1A	15.5	13.5	GC
B-2A	4.5	7.1	GC/GP
B-2A	8.5	7.8	GC/GP
B-2A	15.5	11.7	GC/GP

3.2.4 pH and Soluble Sulfates Tests

To determine if the site soils will react detrimentally with concrete, pH and soluble sulfates tests were performed on a representative sample of the natural near-surface soils. The results of those tests are tabulated below:

Boring No.	Depth (feet)	Soil Classification	pH	Water Soluble Sulfate (mg/kg-dry)
B-1A	5.5	GC	7.78	230

4. SITE CONDITIONS

4.1 SURFACE

The proposed pre-treatment structure is to be located at the Department of Natural Resources Springville Fish Hatchery at 1115 North Main Street in Springville, Utah. The site contains existing concrete fish runs, asphalt concrete pavements, and existing single-story structures with associated landscaped areas. The pre-treatment structure is to be located near the northeast corner of the existing fish raceways. The site is bounded to the west by Main Street with multi-story residential structures beyond; north and south of the site are open RV storage areas; and to the east is undeveloped wetlands.

The site is relatively flat with an overall relief of approximately three to four feet across the site sloping downward to the west. The majority of the site near the fish runs is covered with asphalt concrete pavement and/or gravel.

4.2 SUBSURFACE SOIL

The soils encountered during this study were similar to those encountered during the February 9, 2009 report.

From the surface in Borings B-1A and B-2A, and extending to depths of four and one-half to five and one-half feet, are non-engineered fills consisting of pavements, roadbase, silty clay with varying amounts of gravel, and clayey and silty fine to coarse sand and gravel. The non-engineered fills will exhibit variable and, in most cases, poor engineering characteristics.

Underneath the non-engineered fills in Borings B-1A and B-2A, and extending to the explored depths of 16.5 feet, are gravels with varying amounts of sand, clay, and silt. The gravels are medium dense to dense, saturated, gray, and will exhibit moderately high strength and low compressibility characteristics within the anticipated loading range. A one-foot layer of silty clay was encountered in Boring B-1A. The clay is medium stiff, saturated, and brown.

The lines designating the interface between soil types on the boring logs generally represent approximate boundaries. In-situ, the transition between soil types may be gradual.

4.3 GROUNDWATER

To facilitate monitoring future groundwater fluctuations, prior to backfilling each boring with the exception of Boring B-2 (February 9, 2009), slotted PVC pipe was installed. The following chart summarizes the groundwater levels for this study and the February 9, 2009 study:

	Groundwater Depth (feet)			
Boring No.	**01-16-09**	**2-11-09***	**10-13-09**	**10-27-09***
B-1A	-	-	4.0	2.3
B-2A	-	-	3.5	3.2
B-1	7.0	5.0	Not Located	Not Located
B-2	6.0	No Pipe Installed	No Pipe Installed	No Pipe Installed
B-3	6.0	0.5	0.0	0.0
B-4	5.0	2.7	3.1	3.3
B-5	4.0	2.6	-	2.2
B-6	6.0	1.7	Artesian	Artesian
B-7	8.0	3.0	-	2.5

* Stabilized groundwater depths

Seasonal and longer-term groundwater fluctuations of one to two feet should be anticipated. The highest seasonal levels will generally occur during the late spring and summer months.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The most significant geotechnical aspects of the site are:

1. Non-engineered fills encountered to depths of four and one-half to five and one-half feet at Borings B-1A and B-2A.

2. The shallow depth to groundwater and potential artesian conditions, as identified in our February 9, 2009 study.

The non-engineered fills were likely placed in association with the construction of the existing raceways. The non-engineered fills will exhibit variable and, most likely, poor engineering characteristics and are not suitable for the support of buildings, rigid pavements, or exterior flatwork, and must be completely removed under such. Non-engineered fills may remain beneath flexible pavement areas if properly prepared, as discussed in this report.

Groundwater measurements taken in conjunction with this study indicate groundwater is relatively close to the surface. The majority of the measurements were between 1.7 and 3.0 feet. A groundwater measurement of one-half foot at Boring B-3 indicates that an artesian condition may exist.

Due to the relatively high groundwater and possible artesian groundwater conditions, GSH recommends that a permanent area dewatering system in association with the foundations of the pre-treatment structure, raceways, and raceway cover be utilized. The dewatering system shall be installed to an appropriate depth (approximately 18 inches below the bottom of the raceway channels and footings) on the outside of exterior footings and adjacent to interior footings. GSH recommends that at a minimum, one dewatering pipe extend the full length of the site (raceways and pre-treatment structure) and be installed midway through the raceways and along the south side of the proposed pre-treatment structure.

The dewatering system will have two benefits: the first is to reduce groundwater elevations for constructability; and the second is to reduce the potential for infiltration of potentially "Whirling Disease"-contaminated groundwater into the raceways. The dewatering system will require a suitable gravity discharge point or a sump with a suitably sized pump. The disadvantage of the dewatering system is that the dewatering of groundwater where artesian conditions are encountered may create large water flows and potentially affect the water level of up-gradient surface water (wetlands). Water collected in the area dewatering system can be re-used and pumped either into the pre-treatment system or into the wetlands. Details of the area dewatering system are discussed in Section 5.6, Area Subdrain, of this report.

Soft silty clay soils were encountered during our February 9, 2009 study. Soft silty clay soils, where encountered under footings and floor slabs, shall be excavated, removed, and replaced with select granular structural fill. The removal of the soft clay soils will cause groundwater to enter into the excavation. The groundwater will need to be controlled to the full depth of the temporary excavation until structural fill has been placed and compacted. It is recommended that structural fill contain at a minimum 20 percent fines (passing the No. 200 sieve) to render it less permeable. Subsequent to the placement of structural fill and footings, temporary dewatering may cease, allowing groundwater to flow into the permanent area dewatering system.

In the following sections, detailed discussions pertaining to earthwork, foundations, pavements, the geoseismic setting of the site, and other geotechnical parameters that could affect design, construction, or performance of the proposed facilities are presented.

5.2 EARTHWORK

5.2.1 Site Preparation

Preparation of the site will consist of the removal of non-engineered fills, silty clay (as encountered in Boring B-1A), loose/disturbed surficial soil, surface vegetation, topsoil, and other deleterious materials from beneath an area extending at least three feet beyond the perimeter of the proposed structure, rigid pavements, or exterior flatwork areas. In flexible pavement areas, the existing non-engineered fill and/or loose/disturbed surficial soils may remain provided that they do not contain deleterious material and the upper nine inches are scarified, moisture prepared, and compacted to the requirements for structural fill. Even if properly prepared, some long-term movements of flexible pavements overlying existing non-engineered fill, and/or loose/disturbed surficial soils may occur. If these long-term movements are not acceptable, the non-engineered fill and loose/disturbed surficial soils must be completely removed.

Subsequent to the above operations and prior to the placement of footings, structural site grading fill, floor slabs, or pavements, the exposed subgrade must be proofrolled by running moderate-weight rubber tire-mounted construction equipment uniformly over the surface at least three times. If excessively soft or otherwise unsuitable soils/fills are encountered beneath footings, they must be completely removed. In pavement and floor slab areas, unsuitable soils/fills encountered during proofrolling must be removed to a maximum depth of two feet and replaced with compacted granular structural fill.

Surface vegetation and other deleterious materials should generally be removed from the site. The on-site soils can be utilized as structural site grading fill if they meet the requirements of such. The natural fine-grained soils will require close moisture control and may be very difficult, if not impossible, to properly place and compact during wet and cold periods of the year.

5.2.2 Temporary Excavations

Within excavations at the site, groundwater is anticipated at depths of approximately one-half to five feet. Temporary construction excavations not exceeding four feet in depth, above or below the water table within the non-engineered fills and natural silty clay, may be constructed with near-vertical side slopes. Deeper construction excavations up to eight feet in depth in the natural cohesive (clay) soils, above or below the water table, may be constructed with sideslopes no steeper than one-half horizontal to one vertical. Deeper construction excavations up to eight feet in depth in the natural silty and clayey sands and gravels, above or below the water table, may be constructed with sideslopes no steeper than one horizontal to one vertical. Excavations deeper than eight feet are not anticipated.

Excavations below the groundwater in these sands and gravels will be extremely difficult since these soils will tend to "flow" into the excavations. This condition will require significant effort to stabilize and will likely include significantly flatter sideslopes, dewatering, and/or the use of shoring/bracing. GSH anticipates that temporary dewatering will be required during excavation of footing and soft silty clay soils.

All excavations must be inspected periodically by qualified personnel. If any signs of instability are noted, immediate remedial action must be initiated.

5.2.3 Structural Fill

Structural fill will be required as site grading fill, as backfill over foundations and utilities, and potentially as replacement fill below footings. All structural fill must be free of sod, rubbish, construction debris, frozen soil, and other deleterious materials. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade.

To stabilize soft subgrade conditions or where structural fill is required to be placed below a level one foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or one and one-half- to two-inch minus gravel (stabilizing fill) should be utilized.

The maximum particle size within structural site grading fill shall generally not exceed four inches; although, occasional particles up to six to eight inches may be incorporated provided that they do not result in "honeycombing" or preclude the obtainment of the desired degree of compaction. In confined areas, the maximum particle size shall be restricted to two and one-half inches.

The on-site soils can be utilized as structural site grading fill if they meet the requirements of such. The fine-grained soils will require that very close moisture control be maintained during placement and compaction. It will be very difficult, if not impossible, to properly place and compact these fills during wet and cold periods of the year. Generally, we recommend that all imported structural fill consist of a well-graded mixture of sands and gravels with no more than 18 percent fines (material passing the No. 200 sieve). In areas where soft clays are removed overlying the deeper sands and gravels, we recommend that structural fill consist of a well-graded mixture of sands and

gravels with no less than 20 percent fines (material passing the No. 200 sieve). Granular fills are recommended in all confined areas.

Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.2.4 Fill Placement and Compaction

All structural fill should be placed in lifts not exceeding eight inches in loose lift thickness. Structural fills up to 10 feet thick, as well as all structural fills beneath an area extending out at least 3 feet from the perimeter of the structures, must be compacted to at least 95 percent of the maximum dry density as determined by the AASHTO[2] T-180 (ASTM[3] D-1557) compaction criteria. Structural fills greater than 10 feet are not anticipated at the site. Structural fills less than 5 feet thick, which are not beneath an area extending out at least 3 feet from the perimeter of the structure, should be compacted to at least 90 percent of the above-defined criteria.

Coarse gravel and cobble mixtures (stabilizing fills), where utilized for subgrade stabilization, shall be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment over the surface of each lift at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately compacted so that the "fines" are "worked into" the voids in the underlying coarser gravels and cobbles.

Prior to the placement of structural site grading fill, pavements, floor slabs, or footings, the exposed subgrade must be prepared as discussed in Section 5.2.1, Site Preparation, of this report. In confined areas, subgrade preparation must consist of the removal of all loose or disturbed soils.

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill should be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling shall be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they shall be removed to a maximum depth of two feet below design finish grade and replaced with structural fill.

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2 American Association of State Highway and Transportation Officials
3 American Society for Testing and Materials

Most utility companies and City-County governments are now requiring that Type A-1 or A-1a (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities. These organizations are also requiring that in public roadways the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

The fine-grained soils/fills are not recommended for use as trench backfill.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The proposed structure can be supported upon conventional spread and continuous wall foundations established upon suitable natural soils (clayey gravel and/or gravel with some clay) and/or structural fill extending to suitable natural soils. For design, the following parameters are provided:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Recommended Minimum Width for Continuous Wall Footings	- 18 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions for footings	- 3,000 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

5.3.2 Installation

Under no circumstances shall the footings be established upon or overlying non-engineered fills, unsuitable, soft natural clay soils, loose/disturbed soils, sod, rubbish, topsoil, other deleterious materials, frozen soils, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted structural fill. If granular soils become loose or disturbed, they must be recompacted to the requirements for structural fill.

The width of structural replacement fill below footings shall be equal to the width of the footing plus one foot for each foot of fill thickness.

5.3.3 Settlements

Settlements of foundations designed and installed in accordance with the above recommendations and supporting maximum anticipated structural loads, are anticipated to be approximately one-half to five-eighths of an inch. Settlements are expected to occur rapidly with approximately 50 to 60 percent of the settlements occurring during construction.

If loads greater than those discussed in Section 2., Proposed Construction of this report, are to be imposed, GSH must be contacted so that our recommendations can be reviewed and amended, if necessary.

5.4 LATERAL RESISTANCE

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.45 should be utilized. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

5.5 FLOOR SLABS

It is anticipated that floor slabs will only be placed in limited areas within the footprint of the structure. Floor slabs must be established upon suitable natural soils and/or upon structural fill extending to suitable natural soils. Under no circumstances shall floor slabs be established upon loose or disturbed soils, non-engineered fills, sod, rubbish, deleterious materials, frozen soils, or within ponded water. In order to provide a capillary break and to facilitate curing of the concrete, it is recommended that floor slabs be directly underlain by at least four inches of "free-draining" fill, such as "pea" gravel or three-quarters- to one-inch minus clean gap-graded gravel. GSH anticipates

that floor slabs will be placed at or above the existing ground surface and due to the area subdrain system, will not require a minimum elevation due to groundwater.

Settlement of lightly loaded floor slabs (200 pounds per square foot or less) is anticipated to be minor (less than one-quarter inch).

5.6 AREA SUBDRAIN

5.6.1 General

As previously discussed, an area subdrain is required to provide for constructability of the proposed foundations and to reduce the potential for groundwater intrusion into the raceways and floor slabs.

5.6.2 Area Subdrains

Area subdrains should consist of an eight-inch diameter perforated or slotted plastic or PVC pipe enclosed in clean gravel. The invert of a subdrain should be at least 18 inches below the top of the lowest raceway and/or floor slab. The gravel portion of the subdrain should extend two inches laterally and below the perforated pipe and at least one foot above the top of the adjacent raceway. To reduce the possibility of plugging, the gravel must be wrapped with a geotextile fabric, such as Mirafi 140N or equivalent. Above the subdrain, a minimum four-inch-wide zone of "free-draining" sand and gravel should extend to within two feet of final grade. The slope of the subdrain should be at least 0.3 percent. The gravel placed around the subdrain pipe should be clean, three-quarters- to one-inch minus gap-graded gravel and/or "pea" gravel. GSH recommends that the area subdrain be installed around the perimeter of the exterior footings with at least one subdrain traversing longitudinally through the center of the raceways. The subdrains can be discharged into storm drains, a sump with a suitably sized pump, or other suitable down-gradient location. A depiction of the area subdrain is included in Figure 6, Area Subdrain.

5.7 PAVEMENTS

The existing non-engineered fills and natural clay soils encountered at the site will exhibit poor pavement support characteristics when saturated or near saturated. Non-engineered fills and topsoil/loose disturbed soils may remain in flexible pavement areas if they are properly prepared, as previously mentioned. Considering the non-engineered fills and natural clay as the subgrade soils and the projected traffic as discussed in Section 2., Proposed Construction, the pavement sections on the following pages are recommended.

Parking Areas

(Light Volume of Automobiles and Light Trucks,
Occasional Medium-Weight Trucks,
and No Heavy-Weight Trucks)
[1 equivalent 18-kip axle load per day]

Flexible:

2.5 inches	Asphalt concrete
7.0 inches	Aggregate base course
Over	Properly prepared existing non-engineered fill, and/or existing loose/disturbed soils, or suitable natural soils, and/or structural site grading fill extending to these soils

Rigid:

5.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base course
Over	Properly prepared suitable natural soils, and/or structural site grading fill extending to these soils*

* Under no circumstances should rigid pavements be placed overlying non-engineered fills and/or loose/disturbed soils.

Primary Roadway Areas

(Moderate Volume of Automobiles and Light Trucks,
Very Light Volume of Medium- and Heavy-Weight Trucks)
[5 equivalent 18-kip axle loads per day]

Flexible:

3.0 inches	Asphalt concrete
8.0 inches	Aggregate base course
Over	Properly prepared existing non-engineered fill, and/or existing loose/disturbed soils, or suitable natural soils, and/or structural site grading fill extending to these soils

Rigid:

6.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base course
Over	Properly prepared suitable natural soils, and/or structural site grading fill extending to these soils*

* Under no circumstances should rigid pavements be placed overlying non-engineered fills and/or loose/disturbed soils.

For dumpster pads, we recommend a pavement section consisting of six and one-half inches of Portland cement concrete, four inches of aggregate base course, over properly prepared natural subgrade or site grading structural fills.

These rigid pavement sections are for non-reinforced Portland cement concrete. Concrete should be designed in accordance with the American Concrete Institute (ACI) and joint details should conform with the Portland Cement Association (PCA) guidelines. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6 percent ±1 percent air-entrainment.

5.8 CEMENT TYPES

Laboratory tests indicate that the site soils contain negligible amounts of water soluble sulfates. Therefore, all concrete which will be in contact with the site soils may be prepared using Type I or IA cement.

5.9 GEOSEISMIC SETTING

5.9.1 General

Utah municipalities adopted the International Building Code (IBC) 2006 on January 1, 2007. The IBC 2006 code determines the seismic hazard for a site based upon 2002 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2006 edition.

5.9.2 Faulting

Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The nearest active fault is the Provo segment of the Wasatch fault approximately one-third mile east of the site. The Wasatch fault zone is considered capable of generating earthquakes as large as magnitude 7.4.

5.9.3 Soil Class

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Table 1613.5.2, Site Class Definitions, of the IBC 2006 can be utilized.

5.9.4 Ground Motions

The IBC 2006 code is based on 2002 USGS mapping, which provides values of short and long period accelerations for the Site Class B-C boundary for the Maximum Considered Earthquake (MCE). This Site Class B-C boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for a MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the second column. Based on the site latitude and longitude (40.18048 degrees north and -111.60928 degrees west, respectively), the values for this site are tabulated on the following page.

Spectral Acceleration Value, T Seconds	Site Class B-C Boundary [mapped values] (% g)	Site Class D [adjusted for site class effects] (% g)
Peak Ground Acceleration	50.2	50.2
0.2 Seconds, (Short Period Acceleration)	$S_S = 125.4$	$S_{MS} = 125.4$
1.0 Seconds (Long Period Acceleration)	$S_1 = 52.7$	$S_{M1} = 79.0$

The IBC 2006 code design accelerations (S_{DS} and S_{D1}) are based on multiplying the above accelerations (adjusted for site class effects) for the MCE event by two-thirds (⅔).

5.9.5 Liquefaction

The site is located in an area that has been mapped by Utah County as having a "moderate potential" for liquefaction. Liquefaction is defined as the condition when saturated, loose, fine sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Clayey soils, even if saturated, will not liquefy during a major seismic event.

Due to the clayey nature of the majority of soils and the dense nature of the granular soils encountered on the site, liquefaction will not likely occur during the design seismic event. Calculations were performed using the procedures described in NCEER-97-0022 entitled, "Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils," and only apply to the saturated cohesionless deposits.

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We appreciate the opportunity of providing this service for you. If you have any questions or require additional information, please do not hesitate to contact us.

Respectfully submitted,

GSH Geotechnical Consultants, Inc.

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Project Geotechnical Engineer

ADS/JMW:jlh

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A and 3B, Log of Borings (This Study)
Figures 4A through 4G, Log of Borings (February 9, 2009 Study)
Figure 5, Unified Soil Classification System
Appendix A Area Subdrain

Addressee (2 + email)
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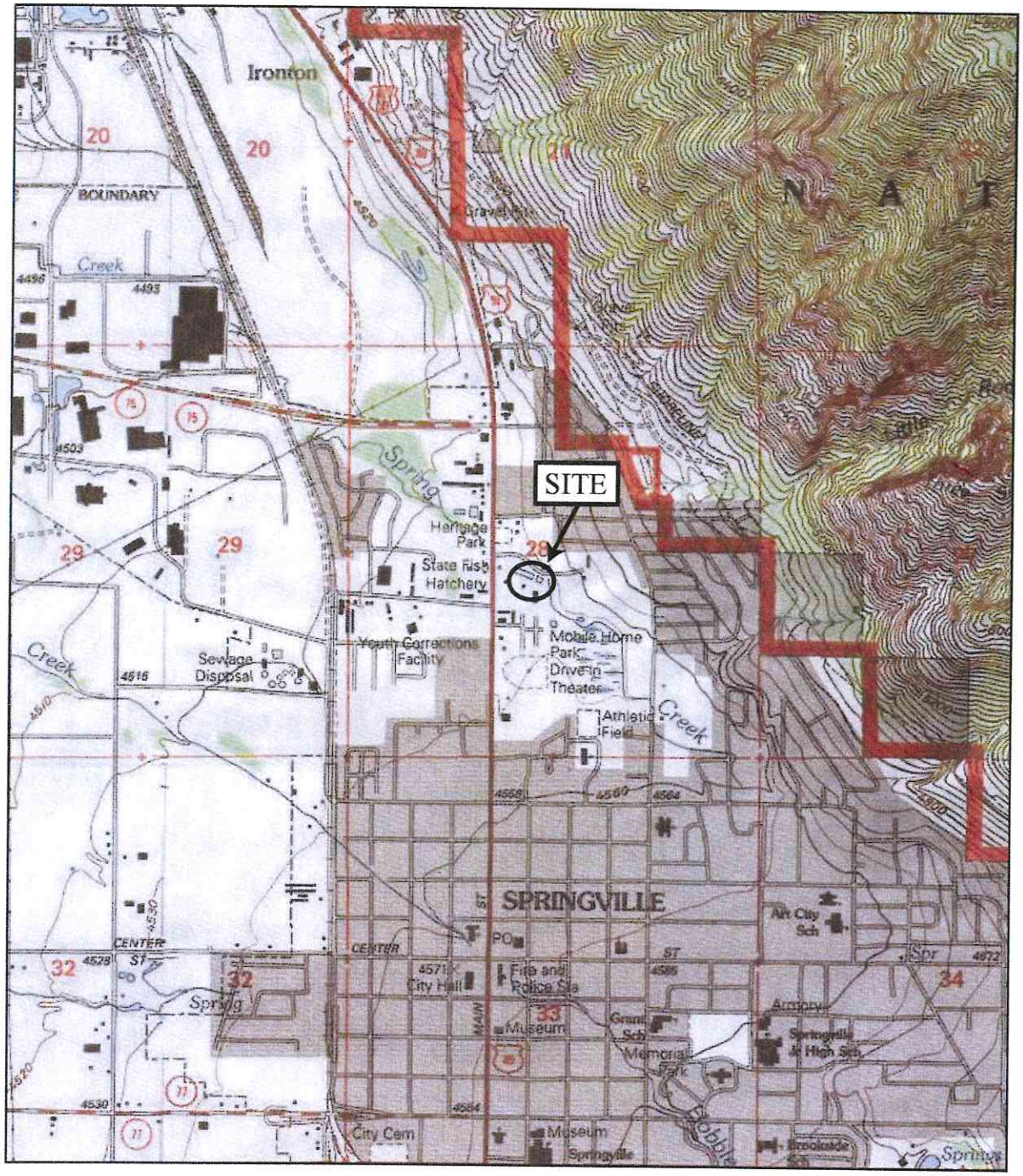
REGISTERED PROFESSIONAL ENGINEER
No. 334228-2202
ALAN DONALD SPILKER
11-13-09
STATE OF UTAH

STATE OF UTAH - DFCM
JOB NO. 0128-035A-09



SCALE IN FEET
1000 0 1000 2000

FIGURE 1
VICINITY MAP

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAPS
TITLED "SPRINGVILLE, UTAH" AND "PROVO, UTAH"
BOTH DATED 1998

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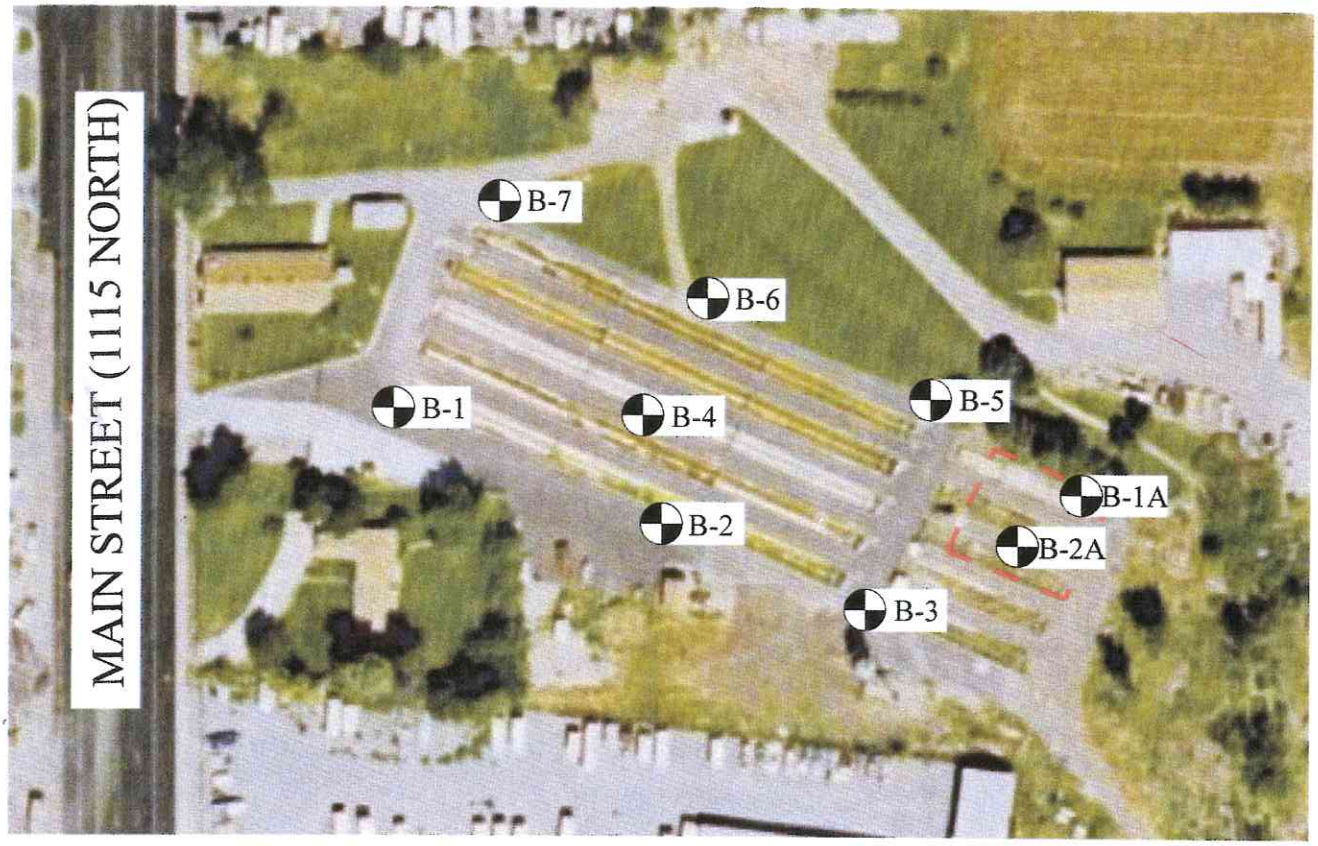
JOB NO. 0128-35A-09



NOT TO SCALE

FIGURE 2
SITE PLAN

REFERENCE:
ADAPTED FROM AERIAL PHOTOGRAPH
DOWNLOADED FROM 2008 GOOGLE EARTH

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Salt Lake City, Utah 84123

BOREHOLE B-1A

Project Name: Proposed Springville Fish Hatchery
Project No.: 0128-35A-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 10-13-09
GSH Field Rep.: RJG
Elevation: - -
Water Level: 4.0' (10-13-09) 2.3' (10-27-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		CLAYEY FINE TO COARSE SAND, FILL with occasional to some fine and coarse gravel; light brown (SC-FILL)									loose to 2" moist
				27							saturated medium dense
		SILTY CLAY with some fine sand; gray (CL)	5	23		14.0	14.0				saturated medium stiff
		CLAYEY FINE AND COARSE GRAVEL with some fine to coarse sand; gray (GC)									saturated medium dense
		grades with some clay	10	27		13.6	7.5				
			15	29		10.0	13.5				
		Stopped drilling at 15.0'.									
		Stopped sampling at 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 3A

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-2A

Project Name: Proposed Springville Fish Hatchery
Project No.: 0128-35A-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 10-13-09 GSH Field Rep.: RJG
Elevation: - -
Water Level: 3.5' (10-13-09) 3.2' (10-27-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		CLAYEY AND SILTY FINE TO COARSE SAND, FILL with some fine gravel; dark brown (SC/SM-FILL)									loose to 2" moist
		SILTY CLAY, FILL with some fine sand and occasional fine gravel; dark brown (CL-FILL)		18							medium dense very moist medium stiff
		FINE AND COARSE GRAVEL, FILL with some clay and fine to coarse sand; brown (GC/GP-FILL)									saturated medium dense
			5	18		8.5	7.1				
		FINE AND COARSE GRAVEL with some clay and fine to coarse sand; gray (GC/GP)									saturated dense
				30		7.5	7.8				
			10								
			15	9		13.1	11.7				medium dense
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 3B

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-1

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 7.0' (01-16-09) 5.0' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		2.5"ASPHALT CONCRETE									
		3.5" ROADBASE, FILL 3/4" minus									moist medium stiff
		SILTY CLAY with some fine sand; brown (CL)		7							
		grades with cemented nodules; brown with oxidation mottling	5	7		26.9		97			saturated
		grades with occasional layers up to 1' thick of clayey fine to coarse sand; brown and gray with oxidation	10	20							stiff
			15	15		26.7		97			
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 4 A

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-2

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		2.5" ASPHALT CONCRETE									moist
		21.5" ROADBASE, FILL 3/4" minus									medium dense
		SILTY CLAY with some fine and coarse gravel; brown and dark brown (CL)									moist medium stiff
				7							
			5								very moist
				7							saturated
				12		28.6		96			stiff
			10								
		grades with trace organics; gray		8		34.0		86			medium stiff
		Stopped drilling at 13.0'.	15								
		Stopped sampling at 14.5'.									
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 4B

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-3

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09) 0.5' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		2.5" ASPHALT CONCRETE									
		9.5" ROADBASE, FILL 3/4" minus									
		SILTY CLAY with some fine sand; dark brown (CL)									saturated moist soft
		grades with some fine and coarse gravel		9		24.7		100			very moist medium stiff
			5								
		grades with some fine sand and trace organics; gray and black		3		57.3		66			soft
		CLAYEY GRAVEL fine to coarse gravel; dark gray (GC)	10	38							saturated dense
		grades with some fine to coarse sand and fine and coarse gravel with trace silt; grading silty	15	23							medium dense
		Stopped drilling at 14.0'.									
		Stopped sampling at 15.5'.									
		Installed 1-1/4" diameter slotted PVC pipe to 15.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 4C

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-4

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 5.0' (01-16-09) 2.7' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		2.5"ASPHALT CONCRETE									
		9.5" ROADBASE, FILL 3/4" minus									moist very soft
		SILTY CLAY, FILL with some fine and coarse gravel; brown (CL-FILL)		33		14.1		121			saturated
			5								
		SILTY CLAY with some fine sand; cemented nodules; brownish-tan with oxidation (CL)		15		13.5		106			saturated stiff
		grades without cemented nodules; gray with trace organics	10	12		26.8		96			
		grades with trace fine sand; gray	15	3							soft
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 4D

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-5

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 4.0' (01-16-09) 2.6' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SILTY CLAY with some fine and coarse gravel; major roots (topsoil) to 2"; brown (CL)									loose to 2" moist
				10							very moist stiff
											saturated
		GRAVEL AND SAND with some clay; fine and coarse gravel; fine to coarse sand; gray (GC/GP/SC/SP)	5	30		14.7	11.6				medium dense
		GRAVEL with some fine to coarse sand and some silt; fine to coarse gravel; gray (GM/GP)									saturated medium dense
			10	20		14.0	8.7				
		CLAYEY SAND AND GRAVEL fine to coarse sand; fine and coarse gravel; gray (SC/GC)									saturated loose
			15	7		19.5	23.9				
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 4E

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-6

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09) 1.7' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SILTY CLAY, FILL with some fine and coarse gravel; major roots (topsoil) to 2"; gray (CL/GC-FILL)									loose to 2" very moist medium stiff saturated
		SILTY CLAY with some fine sand; gray and black (CL)		9		26.3		89			saturated
			5	4		32.1		91			
				6		30.8		87			medium stiff
			10								
		grades with trace fine sand and trace organics; gray		3							soft
		Stopped drilling at 12.5'. Stopped sampling at 14.0'. Installed 1-1/4" diameter slotted PVC pipe to 14.0'.	15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 4E

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-7

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09 GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 8.0' (01-16-09) 3.0' (02-11-09)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY, FILL with some fine and coarse gravel; major roots (topsoil) to 2"; dark brown (CL-FILL)	0								loose to 2" moist very stiff
				28							saturated
		SILTY SAND, FILL with trace clay; fine to coarse sand; brown (SM-FILL)									saturated medium dense
			5	58							
		SILTY CLAY with some fine sand; grayish-brown (CL)									saturated stiff
			10	6							
			15	13							
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS,

FIGURE 4G

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES				GRAPH SYMBOL	LETTER SYMBOL ‡	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size. ‡ (The No. 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		SW	Well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		SC	Clayey sands, poorly graded sand-clay mixtures.

IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE							
		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)			
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size. (The No. 200 sieve size is about the smallest particle visible to the naked eye)	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity.
		Medium to high	None to very slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to very high	None	High		CH	Inorganic clays of high plasticity, fat clays.
		Medium to high	None to very slow	Slight to medium		OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other highly organic soils.

‡ Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.
‡ All sieve sizes on this chart are U.S. standard.

GENERAL NOTES

1. In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There rore, actual designations (based on laboratory testing) may differ.

2. Lines seperating strata on the logs represent approximate boundaries only Actual transitions may be gradual.

3. Logs represent general soil conditions observed at teh point of exploration onthe date indicated.

4. No warranty is provided as to the continuity of soil conditions between individual sample locations.

FINE - GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by Thumb. Squeezes through fingers.
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1 " by Thumb . Molded by light finger pressure.
Medium Stiff	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2 " by Thumb with moerate effort. Molded by strong finger pressure.
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2 " by Thumb but penetrated only with great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by Thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty by Thumbnail

LOG KEY SYMBOLS

- Bulk / Bag Sample
- Thin Wall
- Standard Penetration Split Spoon Sampler
- No Recovery
- Rock Core
- 3-3/4" ID D&M Sampler
- 3" ID D&M Sampler
- Water Level
- California Sampler

COARSE -GRAINDE SOIL

APPERENT DENSITY	SPT (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	<4	0 - 15	Easily penetrated with 1/2 " reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrated with 1/2 " reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Dense	30 - 50	65 - 85	Difficult to penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Very Dense	>50	85 - 100	Peneirated only a few inches with 1/2 " reinforcing rod driven with 5-lb hammer

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2 "
LAYER	1/2 - 12 "

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness
Frequent	More than on per foot of thickness

CEMENTATION

DESCRIPTION	DESCRIPTION
Weakely	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumbles or breaks with finger pressure

MODIFIERS

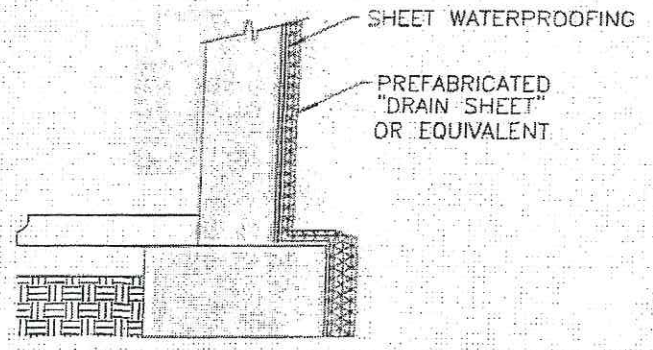
DESCRIPTION	%
Trace	<5
Some	5 - 12
With	>12

MOISTURE CONTENT

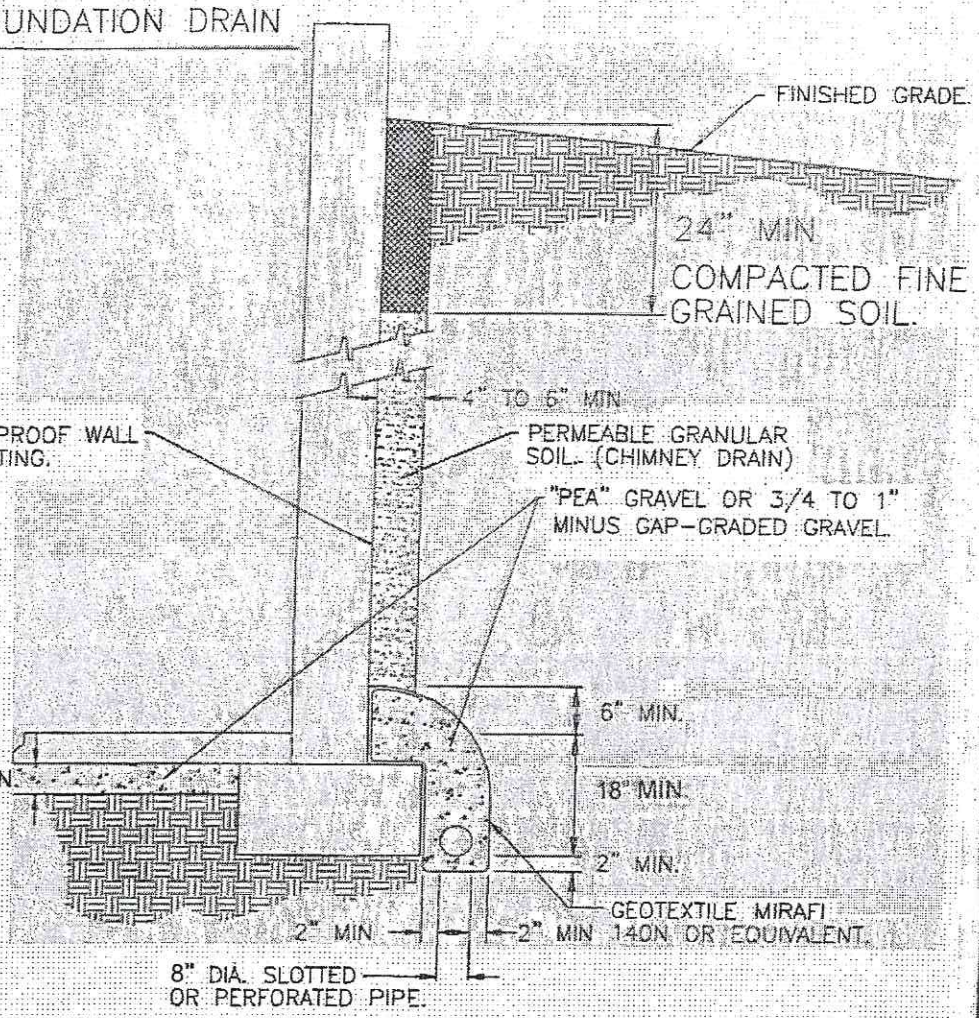
DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil below Water Table

FIGURE 5

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.



ALTERNATE FOUNDATION DRAIN



TYPICAL FOUNDATION DRAIN

(NOT TO SCALE)

TYPICAL FOUNDATION/CHIMNEY SUBDRAIN DETAIL FIGURE 6

GSH

DATE
CHECKED BY
DATE
BY
FILE NO.

APPENDIX C

SUNRISE
ENGINEERING

COM*check* Software Version 3.7.0

Envelope Compliance Certificate

2006 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Springville Fish Hatchery

Construction Site:

Owner/Agent:
DFCM

Designer/Contractor:
Sunrise Engineering
25 East 500 North
Fillmore , UT 84631
435-743-6151

Section 2: General Information

Building Location (for weather data):	**Springville, Utah**
Climate Zone:	**5b**
Vertical Glazing / Wall Area Pct.:	**0%**

Activity Type(s)	Floor Area
Workshop	3240

Section 3: Requirements Checklist

Envelope PASSES: Design 11% better than code.

Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
Roof 1: Metal Building, Screw Down	3290	20.0	5.0	0.079	0.065
Exterior Wall 1: Metal Building Wall	803	25.0	0.0	0.058	0.057
Window 1: Vinyl Frame:Double Pane with Low-E, Clear, SHGC 0.70, PF 0.59	10	---	---	0.550	0.350
Door 1: Insulated Metal, Swinging	21	---	---	0.600	0.700
Exterior Wall 2: Metal Building Wall	804	25.0	0.0	0.058	0.057
Exterior Wall 3: Metal Building Wall	803	25.0	0.0	0.058	0.057
Exterior Wall 4: Metal Building Wall	804	25.0	0.0	0.058	0.057
Door 2: Insulated Metal, Swinging	21	---	---	0.600	0.700
Door 3: Insulated Metal, Non-Swinging Comments: from Thermospan 150 litterature	150	---	---	0.071	1.450
Floor 1: Slab-On-Grade:Unheated, Horizontal with vertical 2 ft. Comments: 1 inch vertical and 2" horizontal foam to 24" below grade and around perimeter	223	---	0.0	---	---

(a) Budget U-factors are used for software baseline calculations ONLY, and are not code requirements.

Air Leakage, Component Certification, and Vapor Retarder Requirements:

- ☐ 1. All joints and penetrations are caulked, gasketed or covered with a moisture vapor-permeable wrapping material installed in accordance with the manufacturer's installation instructions.
- ☐ 2. Windows, doors, and skylights certified as meeting leakage requirements.
- ☐ 3. Component R-values & U-factors labeled as certified.
- ☐ 4. Insulation installed according to manufacturer's instructions, in substantial contact with the surface being insulated, and in a manner that achieves the rated R-value without compressing the insulation.
- ☐ 5. No roof insulation is installed on a suspended ceiling with removable ceiling panels.

- ☐ 6. 'Other' components have supporting documentation for proposed U-Factors.
- ☐ 7. Stair, elevator shaft vents, and other outdoor air intake and exhaust openings in the building envelope are equipped with motorized dampers.
- ☐ 8. Cargo doors and loading dock doors are weather sealed.
- ☐ 9. Recessed lighting fixtures are: (i) Type IC rated and sealed or gasketed; or (ii) installed inside an appropriate air-tight assembly with a 0.5 inch clearance from combustible materials and with 3 inches clearance from insulation material.
- ☐ 10. Building entrance doors have a vestibule equipped with closing devices.
  Exceptions:

  Building entrances with revolving doors.

  Doors that open directly from a space less than 3000 sq. ft. in area.
- ☐ 11. Vapor retarder installed.

Section 4: Compliance Statement

Compliance Statement: The proposed envelope design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed envelope system has been designed to meet the 2006 IECC requirements in COM*check* Version 3.7.0 and to comply with the mandatory requirements in the Requirements Checklist.

Name - Title	Signature	Date
Andrew Robinson P.E.	Andrew Robinson	1/22/2010

Andrew Robinson

COM*check* Software Version 3.7.0

Interior Lighting Compliance Certificate

2006 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Springville Fish Hatchery

Construction Site:

Owner/Agent:
DFCM

Designer/Contractor:
Sunrise Engineering
25 East 500 North
Fillmore , UT 84631
435-743-6151

Section 2: General Information

Building Use Description by: **Activity Type**

Activity Type(s)	Floor Area
Workshop	3240

Section 3: Requirements Checklist

Interior Lighting:

☐ 1. Total proposed watts must be less than or equal to total allowed watts.

Allowed Watts	Proposed Watts	Complies
4536	3888	YES

Controls, Switching, and Wiring:

☐ 2. Independent controls for each space (switch/occupancy sensor).
Exceptions:

Areas designated as security or emergency areas that must be continuously illuminated.

Lighting in stairways or corridors that are elements of the means of egress.

☐ 3. Master switch at entry to hotel/motel guest room.

☐ 4. Individual dwelling units separately metered.

☐ 5. Each space provided with a manual control to provide uniform light reduction by at least 50%.
Exceptions:

Only one luminaire in space;

An occupant-sensing device controls the area;

The area is a corridor, storeroom, restroom, public lobby or sleeping unit.

Areas that use less than 0.6 Watts/sq.ft.

☐ 6. Automatic lighting shutoff control in buildings larger than 5,000 sq.ft.
Exceptions:

Sleeping units, patient care areas; and spaces where automatic shutoff would endanger safety or security.

☐ 7. Photocell/astronomical time switch on exterior lights.
Exceptions:

Lighting intended for 24 hour use.

☐ 8. Tandem wired one-lamp and three-lamp ballasted luminaires (No single-lamp ballasts).
Exceptions:

Electronic high-frequency ballasts; Luminaires on emergency circuits or with no available pair.

Section 4: Compliance Statement

Compliance Statement: The proposed lighting design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2006 IECC requirements in COM*check* Version 3.7.0 and to comply with the mandatory requirements in the Requirements Checklist.

David E. Lund - P.E		1/12/10
Name - Title	Signature	Date

COM*check* Software Version 3.7.0

Interior Lighting Application Worksheet

2006 IECC

Section 1: Allowed Lighting Power Calculation

A Area Category	B Floor Area (ft2)	C Allowed Watts / ft2	D Allowed Watts (B x C)
Workshop	3240	1.4	4536
		Total Allowed Watts =	4536

Section 2: Proposed Lighting Power Calculation

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
Workshop (3240 sq.ft.)				
Linear Fluorescent 1: 46" T5 HO 54W / Electronic	6	12	324	3888
			Total Proposed Watts =	3888

Section 3: Compliance Calculation

If the Total Allowed Watts minus the Total Proposed Watts is greater than or equal to zero, the building complies.

Total Allowed Watts =	4536
Total Proposed Watts =	3888
Project Compliance =	648

Interior Lighting PASSES: Design 14% better than code.

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Exterior Lighting Compliance Certificate

2006 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Springville Fish Hatchery

Construction Site:

Owner/Agent:
DFCM

Designer/Contractor:
Sunrise Engineering
25 East 500 North
Fillmore , UT 84631
435-743-6151

Section 2: Exterior Lighting Area/Surface Power Calculation

A Exterior Area/Surface	B Quantity	C Allowed Watts / Unit	D Tradable Wattage	E Allowed Watts (C x D)	F Proposed Watts
Main entry/exit	3 ft of door width	30	Yes	90	100
Main entry/exit	3 ft of door width	30	Yes	90	100
Other entry/exit	12 ft of door width	20	Yes	240	100
Illuminated length of wall or surface	55 ft	5	No	275	200
Illuminated length of wall or surface	54 ft	5	No	270	100
			Total Tradable Watts* =	420	300
			Total Allowed Watts =	965	
			Total Allowed Supplemental Watts** =	48	

* Wattage tradeoffs are only allowed between tradable areas/surfaces.
** A supplemental allowance equal to 5% of total allowed wattage may be applied toward compliance of both non-tradable and tradable areas/surfaces.

Section 3: Exterior Lighting Fixture Schedule

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
Main entry/exit (3 ft of door width): Tradable Wattage				
HID 1: Metal Halide 100W / Standard	1	1	100	100
Main entry/exit (3 ft of door width): Tradable Wattage				
HID 2: Metal Halide 100W / Standard	1	1	100	100
Other entry/exit (12 ft of door width): Tradable Wattage				
HID 3: Metal Halide 100W / Standard	1	1	100	100
Illuminated length of wall or surface (55 ft): Non-tradable Wattage				
HID 4: Metal Halide 100W / Standard	1	2	100	200
Illuminated length of wall or surface (54 ft): Non-tradable Wattage				
HID 5: Metal Halide 100W / Standard	1	1	100	100
			Total Tradable Proposed Watts =	300

Section 4: Requirements Checklist

Lighting Wattage:

☐ 1. Within each non-tradable area/surface, total proposed watts must be less than or equal to total allowed watts. Across all tradable areas/surfaces, total proposed watts must be less than or equal to total allowed watts.

Compliance: Passes.

Controls, Switching, and Wiring:

- ☐ 2. All exemption claims are associated with fixtures that have a control device independent of the control of the nonexempt lighting.
- ☐ 3. All lighting fixtures are controlled by a photosensor or astronomical time switch that is capable of automatically turning off the fixture when sufficient daylight is available or the lighting is not required.
  Exceptions:

  Covered vehicle entrance/exit areas requiring lighting for safety, security and eye adaptation.

Exterior Lighting Efficacy:

- ☐ 4. All exterior building grounds luminaires that operate at greater than 100W have minimum efficacy of 60 lumen/watt.
  Exceptions:

  Controlled by motion sensor or exempt from consideration under the provisions of Section 505.6.2.

Exterior Lighting PASSES: Design 36% better than code.

Section 5: Compliance Statement

Compliance Statement: The proposed exterior lighting design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2006 IECC requirements in COM*check* Version 3.7.0 and to comply with the mandatory requirements in the Requirements Checklist.

David E. Lund - P.E.		1/12/10
Name - Title	Signature	Date

COM*check* Software Version 3.7.0

Mechanical Compliance Certificate

2006 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Springville Fish Hatchery

Construction Site:

Owner/Agent:
DFCM

Designer/Contractor:
Sunrise Engineering
25 East 500 North
Fillmore , UT 84631
435-743-6151

Section 2: General Information

Building Location (for weather data): **Springville, Utah**
Climate Zone: **5b**

Section 3: Mechanical Systems List

Quantity	System Type & Description
1	HVAC System 1: Heating: Radiant Heater, Gas, Capacity 89 kBtu/h / Single Zone
1	HVAC System 2: Heating: Radiant Heater, Gas, Capacity 27 kBtu/h / Single Zone
1	HVAC System 3: Cooling: Split System, Capacity 15 kBtu/h, Efficiency: 16.00 SEER, Air-Cooled Condenser / Single Zone

Section 4: Requirements Checklist

Requirements Specific To: HVAC System 1 :
None

Requirements Specific To: HVAC System 2 :
None

Requirements Specific To: HVAC System 3 :

- ☐ 1. Equipment minimum efficiency: Split System: 10.0 SEER

Generic Requirements: Must be met by all systems to which the requirement is applicable:

- ☐ 1. Load calculations per ASHRAE Fundamentals
- ☐ 2. Plant equipment and system capacity no greater than needed to meet loads
  - Exception: Standby equipment automatically off when primary system is operating
  - Exception: Multiple units controlled to sequence operation as a function of load
- ☐ 3. Minimum one temperature control device per system
- ☐ 4. Minimum one humidity control device per installed humidification/dehumidification system
- ☐ 5. Automatic Controls: Setback to 55 degrees F (heat) and 85 degrees F (cool); 7-day clock, 2-hour occupant override, 10-hour backup
  - Exception: Continuously operating zones
  - Exception: 2 kW demand or less, submit calculations
- ☐ 6. Outside-air source for ventilation; system capable of reducing OSA to required minimum
- ☐ 7. R-5 supply and return air duct insulation in unconditioned spaces R-8 supply and return air duct insulation outside the building R-8 insulation between ducts and the building exterior when ducts are part of a building assembly
  - Exception: Ducts located within equipment

- Exception: Ducts with interior and exterior temperature difference not exceeding 15 degrees F.
- Exception: Continuously welded and locking-type longitudinal joints and seams on ducts operating at static pressures less than 2 inches w.g. pressure classification

☐ 8. Mechanical fasteners and sealants used to connect ducts and air distribution equipment

☐ 9. Ducts sealed - longitudinal seams on rigid ducts; transverse seams on all ducts; UL 181A or 181B tapes and mastics

☐ 10. Hot water pipe insulation: 1 in. for pipes <=1.5 in. and 2 in. for pipes >1.5 in. Chilled water/refrigerant/brine pipe insulation: 1 in. for pipes <=1.5 in. and 1.5 in. for pipes >1.5 in. Steam pipe insulation: 1.5 in. for pipes <=1.5 in. and 3 in. for pipes >1.5 in.

- Exception: Piping within HVAC equipment.
- Exception: Fluid temperatures between 55 and 105 degrees F.
- Exception: Fluid not heated or cooled with renewable energy.
- Exception: Runouts <4 ft in length.

☐ 11. Operation and maintenance manual provided to building owner

☐ 12. Balancing devices provided in accordance with IMC (2006) 603.17

☐ 13. Motorized, automatic shutoff dampers required on exhaust and outdoor air supply openings

- Exception: Gravity dampers acceptable in buildings <3 stories
- Exception: Gravity dampers acceptable in systems with outside or exhaust air flow rates less than 300 cfm where dampers are interlocked with fan

☐ 14. Stair and elevator shaft vents are equipped with motorized dampers

☐ 15. Exhaust air heat recovery included for systems 5,000 cfm or greater with more than 70% outside air fraction or specifically exempted

Section 5: Compliance Statement

Compliance Statement: The proposed mechanical design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 2006 IECC requirements in COM*check* Version 3.7.0 and to comply with the mandatory requirements in the Requirements Checklist.

David E. Lund - P.E. | [signature] | 1/12/10

Name - Title | Signature | Date

COM*check* Software Version 3.7.0

Mechanical Requirements Description

2006 IECC

The following list provides more detailed descriptions of the requirements in Section 4 of the Mechanical Compliance Certificate.

Requirements Specific To: HVAC System 1 :

None

Requirements Specific To: HVAC System 2 :

None

Requirements Specific To: HVAC System 3 :

1. The specified heating and/or cooling equipment is covered by ASHRAE 90.1 Code and must meet the following minimum efficiency: Split System: 10.0 SEER

Generic Requirements: Must be met by all systems to which the requirement is applicable:

1. Design heating and cooling loads for the building must be determined using procedures in the ASHRAE Handbook of Fundamentals or an approved equivalent calculation procedure.
2. All equipment and systems must be sized to be no greater than needed to meet calculated loads. A single piece of equipment providing both heating and cooling must satisfy this provision for one function with the capacity for the other function as small as possible, within available equipment options.
   - Exception: The equipment and/or system capacity may be greater than calculated loads for standby purposes. Standby equipment must be automatically controlled to be off when the primary equipment and/or system is operating.
   - Exception: Multiple units of the same equipment type whose combined capacities exceed the calculated load are allowed if they are provided with controls to sequence operation of the units as the load increases or decreases.
3. Each heating or cooling system serving a single zone must have its own temperature control device.
4. Each humidification system must have its own humidity control device.
5. The system or zone control must be a programmable thermostat or other automatic control meeting the following criteria: a) capable of setting back temperature to 55 degrees F during heating and setting up to 85 degrees F during cooling, b) capable of automatically setting back or shutting down systems during unoccupied hours using 7 different day schedules, c) have an accessible 2-hour occupant override, d) have a battery back-up capable of maintaining programmed settings for at least 10 hours without power.
   - Exception: A setback or shutoff control is not required on thermostats that control systems serving areas that operate continuously.
   - Exception: A setback or shutoff control is not required on systems with total energy demand of 2 kW (6,826 Btu/h) or less.
6. The system must supply outside ventilation air as required by Chapter 4 of the International Mechanical Code. If the ventilation system is designed to supply outdoor-air quantities exceeding minimum required levels, the system must be capable of reducing outdoor-air flow to the minimum required levels.
7. Air ducts must be insulated to the following levels: a) Supply and return air ducts for conditioned air located in unconditioned spaces (spaces neither heated nor cooled) must be insulated with a minimum of R-5. Unconditioned spaces include attics, crawl spaces, unheated basements, and unheated garages. b) Supply and return air ducts and plenums must be insulated to a minimum of R-8 when located outside the building. c) When ducts are located within exterior components (e.g., floors or roofs), minimum R-8 insulation is required only between the duct and the building exterior.
   - Exception: Duct insulation is not required on ducts located within equipment.
   - Exception: Duct insulation is not required when the design temperature difference between the interior and exterior of the duct or plenum does not exceed 15 degrees F.
   - Exception: Continuously welded and locking-type longitudinal joints and seams on ducts operating at static pressures less than 2 inches w.g. pressure classification.
8. Mechanical fasteners and seals, mastics, or gaskets must be used when connecting ducts to fans and other air distribution equipment, including multiple-zone terminal units.
9. All joints, longitudinal and transverse seams, and connections in ductwork must be securely sealed using weldments; mechanical fasteners with seals, gaskets, or mastics; mesh and mastic sealing systems; or tapes. Tapes and mastics must be listed and labeled in accordance with UL 181A and shall be marked '181A-P' for pressure sensitive tape, '181A-M' for mastic or '181A-H' for heat-sensitive tape. Tapes and mastics used to seal flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked '181B-FX' for pressure-sensitive tape or '181B-M' for mastic. Unlisted duct tape is not permitted as a sealant on any metal ducts.

10. All pipes serving space-conditioning systems must be insulated as follows: Hot water piping for heating systems: 1 in. for pipes <=1 1/2-in. nominal diameter, 2 in. for pipes >1 1/2-in. nominal diameter. Chilled water, refrigerant, and brine piping systems: 1 in. insulation for pipes <=1 1/2-in. nominal diameter, 1 1/2 in. insulation for pipes >1 1/2-in. nominal diameter. Steam piping: 1 1/2 in. insulation for pipes <=1 1/2-in. nominal diameter, 3 in. insulation for pipes >1 1/2-in. nominal diameter.
    - Exception: Pipe insulation is not required for factory-installed piping within HVAC equipment.
    - Exception: Pipe insulation is not required for piping that conveys fluids having a design operating temperature range between 55 degrees F and 105 degrees F.
    - Exception: Pipe insulation is not required for piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.
    - Exception: Pipe insulation is not required for runout piping not exceeding 4 ft in length and 1 in. in diameter between the control valve and HVAC coil.
11. Operation and maintenance documentation must be provided to the owner that includes at least the following information: a) equipment capacity (input and output) and required maintenance actions b) equipment operation and maintenance manuals c) HVAC system control maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions; desired or field-determined set points must be permanently recorded on control drawings, at control devices, or, for digital control systems, in programming comments d) complete narrative of how each system is intended to operate.
12. Balancing devices provided in accordance with IMC (2006) 603.17.
13. Outdoor air supply and exhaust systems must have motorized dampers that automatically shut when the systems or spaces served are not in use. Dampers must be capable of automatically shutting off during preoccupancy building warm-up, cool-down, and setback, except when ventilation reduces energy costs (e.g., night purge) or when ventilation must be supplied to meet code requirements. Both outdoor air supply and exhaust air dampers must have a maximum leakage rate of 3 cfm/ft2 at 1.0 in w.g. when tested in accordance with AMCA Standard 500.
    - Exception: Gravity (non-motorized) dampers are acceptable in buildings less than three stories in height.
    - Exception: Systems with a design outside air intake or exhaust capacity of 300 cfm (140 L/s) or less that are equipped with motor operated dampers that open and close when the unit is energized and de-energized, respectively.
14. Stair and elevator shaft vents must be equipped with motorized dampers capable of being automatically closed during normal building operation and interlocked to open as required by fire and smoke detection systems. All gravity outdoor air supply and exhaust hoods, vents, and ventilators must be equipped with motorized dampers that will automatically shut when the spaces served are not in use.
    - Exception: Gravity (non-motorized) dampers are acceptable in buildings less than three stories in height above grade.
    - Exception: Ventilation systems serving unconditioned spaces.
15. Individual fan systems with a design supply air capacity of 5000 cfm or greater and minimum outside air supply of 70% or greater of the supply air capacity must have an energy recovery system with at least a 50% effectiveness. If an air economizer is also required, heat recovery must be bypassed or controlled to permit air economizer operation.
    - Exception: Systems serving spaces that are not cooled and heated to <60 degrees F.
    - Exception: Commercial kitchen hoods (grease) classified as Type 1 by NFPA 96.
    - Exception: Systems exhausting toxic, flammable, paint, or corrosive fumes or dust.
    - Exception: Where the largest exhaust source is less than 75% of the design outdoor airflow.
    - Exception: Systems requiring dehumidification that employ energy recovery in series with the cooling coil.