CONTRACT 11577A

CONTRACT DOCUMENTS

FOR

CHEESMAN DAM

UPSTREAM CONTROL PROJECT - PHASE 1

IN

JEFFERSON COUNTY

THE STATE OF COLORADO

BOARD OF WATER COMMISSIONERS

DENVER, COLORADO

Penfield W. Tate III, President
H.J. Barry, Manager
Robert J. Mahoney, Director of Engineering

AUGUST 2009
INSTRUCTIONS TO PROPOSERS
REQUEST FOR PROPOSAL
PROPOSAL FORM
SMALL/MINORITY/WOMEN BUSINESS ENTERPRISES PROGRAM
AGREEMENT FORM
PERFORMANCE BOND
PAYMENT BOND
FINAL PAYMENT RELEASE FORM
GENERAL CONDITIONS
SUPPLEMENTARY CONDITIONS

Article 1. Charter of the City and County of Denver
Article 2. Work
Article 3. Engineer
Article 4. Contract Time
Article 5. Contract Price
Article 6. Payment Procedures
Article 7. Contractor's Representations
Article 8. Contract Documents
Article 9. Miscellaneous
Article 10. Signatures

Article 1--Definitions
Article 2--Preliminary Matters
Article 3--Contract Documents: Intent, Amending, Reuse
Article 4--Availability of Lands; Subsurface and Physical Conditions; Reference Points
Article 5--Bonds and Insurance
Article 6--Contractor's Responsibilities
Article 7--Other Work
Article 8--Owner's Responsibilities
Article 9--Engineer's Responsibilities
Article 10--Changes in the Work
Article 11--Change of Contract Price
Article 12--Change of Contract Times
Article 13--Tests and Inspections; Correction, Removal or Acceptance of Defective Work
Article 14--Payments to Contractor and Completion
Article 15--Suspension of Work and Termination
Article 16--Claims and Disputes
Article 17--Miscellaneous

SUPPLEMENTARY CONDITIONS SC-1
SPECIFICATIONS: DETAILED SECTIONS (CONT.)

DIVISION 8 – OPENINGS

SECTION 08 11 00 STEEL DOORS AND FRAMES 1-4
SECTION 08 51 00 ALUMINUM WINDOWS 1-4
SECTION 08 71 00 DOOR HARDWARE 1-8
SECTION 08 81 00 GLASS GLAZING 1-4

DIVISION 9 – FINISHES

SECTION 09 90 00 PAINTING AND COATING 1-7

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 00 50 INSTALLATION OF OWNER-FURNISHED PRODUCTS 1-12
SUPPLEMENT 1-1

DIVISION 22 – PLUMBING

SECTION 22 15 19 COMPRESSED AIR SYSTEMS 1-6
SUPPLEMENT 1-1

DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

SECTION 23 05 00 COMMON WORK RESULTS FOR MECHANICAL 1-6
SECTION 23 05 93 HVAC SYSTEMS, ADJUSTING, AND BALANCING 1-3
SECTION 23 09 00 HVAC CONTROLS 1-3
SECTION 23 11 00 HYDRAULIC TUBING, VALVES AND ACCESSORIES 1-9
SECTION 23 31 13 DUCTWORK AND ACCESSORIES 1-6
SECTION 23 43 00 HVAC FANS 1-4
SUPPLEMENT 1-2
SECTION 23 82 00 CONVECTION HEATING UNITS 1-2

DIVISION 26 – ELECTRICAL

SECTION 26 00 10 BASIC ELECTRICAL REQUIREMENTS 1-9
SECTION 26 05 10 BASIC ELECTRICAL MATERIALS AND METHODS 1-20
SECTION 26 05 19 LOW-VOLTAGE CONDUCTORS 1-10
SECTION 26 05 26 GROUNDING AND BONDING 1-5
SECTION 26 05 33 RACEWAYS 1-15
SECTION 26 05 70 ELECTRICAL SYSTEMS ANALYSIS 1-7
SECTION 26 08 00 COMMISSIONING OF ELECTRICAL SYSTEMS 1-10
SECTION 26 32 13 ENGINE-GENERATOR 1-20
SECTION 26 43 00 TRANSIENT VOLTAGE SURGE SUPPRESSORS (TVSS) 1-5
SECTION 26 50 10 LIGHTING 1-5

DIVISION 27 – COMMUNICATIONS

SECTION 27 00 00 COMMUNICATIONS SYSTEMS 1-7

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 28 10 00 SECURITY SYSTEM 1-4

DIVISION 31 - EARTHWORK

SECTION 31 71 05 DRILLING OF INCLINED HOLES 1-2
SECTION 31 71 16 BLASTING 1-8
DIVISION 33 - UTILITIES

SECTION 33 11 00  PIPING-GENERAL  1-10
SECTION 33 11 00.07  POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS  1-1
SECTION 33 11 00.09  COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS  1-1

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 53 00  UNDERWATER CONSTRUCTION  1-3

DIVISION 40 – PROCESS INTEGRATION

SECTION 40 90 00  PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS)  1-17
SUPPLEMENT A  1-9
SUPPLEMENT B  1-5
SUPPLEMENT C  1-2

APPENDIX A  -  LOW LEVEL GATE MANUFACTURER’S DRAWINGS
APPENDIX B  -  MID LEVEL GUARD GATE MANUFACTURER’S DRAWINGS
APPENDIX C  -  AUXILIARY LEVEL GUARD GATE MANUFACTURER’S DRAWINGS
APPENDIX D  -  TRASHRACK STRUCTURAL DRAWINGS
APPENDIX E  -  SUPPLEMENTAL SURVEY INFORMATION
APPENDIX F  -  CHEESMAN RESERVOIR ELEVATIONS
INSTRUCTIONS TO PROPOSERS

The Board is soliciting Proposals for the following work:

This request for proposal is for Cheesman Dam Upstream Control Phase 1 work, detailed below, which includes both Phase 1A and Phase 1B work; the proposer must propose on the entirety of work including Phase 1A and Phase 1B.

1. Completed Proposals must be returned by 5:00 p.m., local time, on Tuesday, September 1, 2009, to Jeff Martin, Project Engineer.

2. Qualifications: After Proposals have been opened, a statement of competency may be required from any CONTRACTOR to be considered in making the award, which statement will include:
   A. List of 5 projects completed in the last 2 years of similar complexity to this project.
   B. A list of equipment, in detail, available to use on this project.
   C. Recent financial statement relative to resources, including cash and bank credits available.
   D. Name of Surety Company that has indicated its willingness to bond the CONTRACTOR.

3. Project Execution Plan: A project execution plan must be submitted as part of the proposal, and will be used in conjunction with the proposed cost in evaluation of the proposals. The project execution plan is intended to allow the CONTRACTOR to convey a detailed level of understanding of the project to Denver Water.

4. Proposals shall be written in ink or typewritten on the form attached to and made a part of the Contract and any addendum issued by the OWNER must be acknowledged on the Proposal Form. All corrections or erasures shall be initialed by the person signing the Proposal.

5. The Proposal must be signed by someone duly authorized to do so. Officials of corporations shall designate their official title. Persons submitting a Proposal as partners or sole proprietors shall so state.

6. A jobsite tour and pre-proposal conference covering project questions is scheduled for 8:00 a.m., local time, Wednesday, August 19, 2009, in Engineering Conference Room 310, 1600 West 12th Avenue, Denver, CO 80204. Attendance is a requirement, including prequalified and non-prequalified subcontractors for submission of a Proposal. The CONTRACTOR, General Contractors, Drilling Subcontractors, and Electrical Subcontractors are required to attend the site visit after the pre-proposal conference.

7. Denver Water has implemented an Access Control - Identification Badge (ID) program for all Denver Water employees, contractors, vendors and visitors at all Denver Water facilities. All Contractors, vendors, and visitors are required to sign-in and receive a Denver Water Non-Photo “Visitor” ID badge at the appropriate Security Station. Access expires daily and all contractors, vendors, and visitors must return the badge to Denver Water Security before departing the facility. See DIVISION 1 of the Specifications for site specific security information.

8. Proposers shall comply with the provisions of the Board’s Small/Minority/Women Business Enterprises (SMWBEs) Program set forth in the Contract Documents. Goals for the Work to be completed under the Phase 1A Drawing Package have been established as 5% participation of the total amount. It is the intent of the Program that qualified Contractors, Subcontractors, or Suppliers be utilized to the fullest extent possible, to perform work or provide the supplies and services required by the Drawings and Specifications. Proposers are encouraged to identify as many aspects of the work as possible to enhance the utilization of Minority and Women Business Enterprises (MWBEs). Proposers are required to have the entire Statement of Intent completed in full, at the time the Proposal is due.

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A ) IP-1
Please note that Proposers will no longer have until 5:00 p.m. to submit clarifications to this form.

9. OWNER shall award a Contract to the Proposer who, in OWNER's judgment, is the lowest responsive, responsible Proposer after an evaluation of proposals based upon the total proposal. OWNER will not award a Contract for only a portion of the Work. OWNER reserves the right to reject all Proposals, to waive informalities and to reject nonconforming, non-responsive, or conditional Proposals. The evaluation process will give equal consideration to the Proposal cost and the Project Execution Plan.

In evaluating Proposals, OWNER shall consider the qualifications of the Proposers, whether or not the Proposals comply with the prescribed requirements, and whether or not all lump sum amounts as requested in the Proposal Form have been completed. OWNER may consider the qualifications and experience of subcontractors and other persons and organizations (especially those who are to furnish the principal items of material or equipment), and may reject the Proposal of any Proposer who does not pass any such evaluation to OWNER's satisfaction.

If the Contract is awarded, OWNER shall give the apparent successful Proposer a Notice of Award within 60 days of the Proposal due date.

10. Questions or comments concerning this Proposal should be directed to Denver Water, Engineering Division, 1600 West 12th Avenue, Denver, Colorado 80204. Attention: Jeff Martin, Project Engineer, at (303) 628-6508, EMAIL jeff.martin@denverwater.org, or FAX (303) 628-6851.
REQUEST FOR PROPOSAL

Cheesman Dam Upstream Control Project Phase 1

Denver Water is requesting price proposals from pre-qualified underwater construction contractors for the installation of slide gates, appurtenant structures, construction of a control building, and electrical improvements at the Cheesman Dam in Jefferson County, Colorado.

The following request for proposal text is intended to provide an understanding of the project, and does not completely specify the entirety of work required to complete the project. The project Drawings and Specifications fully govern the requirements of the project.

Introduction and Background

The Cheesman Dam is an on-stream facility located on the South Platte River in Jefferson County, Colorado, in the Pike National Forest. The dam is owned and operated by Denver Water. The dam structure is a gravity arch masonry dam constructed with solid granite blocks laid in cement mortar as facing over a core consisting of granite rubble in a bed of concrete. The dam is 221 feet in height and impounds 79,064 acre-feet of water, and is classified as a large high hazard dam.

The dam itself is 221 feet in height with a crest length of 1,050 feet, a crest width of 18 feet formed to a 480 foot radius arch along the main part of the crest. The crest of the dam is built to an elevation of 6849.58 USGS, excluding the parapet walls. The parapet wall on the dam crest consists of two courses of granite blocks measuring approximately 2 feet wide by 2 feet tall and 6 feet long. A small turnout approximately 60 feet long and 35 feet wide is located on the left abutment between the dam and the spillway.

The outlet works tunnels are located through the left abutment at approximate elevations 6,780, 6,690, and 6,645, respectively named within the drawing set as the Auxiliary Outlet, Mid-Level Outlet, and Low-Level Outlet. A fourth outlet tunnel at elevation 6734 was originally constructed, but was abandoned with the inlet portion being filled with concrete. The Auxiliary Outlet, built in 1925, is an independent tunnel outlet with no connection to the other tunnels and is controlled by a 5 foot x 7 foot slide gate and by the Larner-Johnson Needle Valve. The Low and Mid Level outlet tunnels combine to one tunnel approximately two-thirds of the way through the abutment. Both tunnels can be controlled by a total of six 42-inch gate valves (two on the mid-level and four on the low-level), and by various cone and free-discharge valves in the downstream Valve House.

The only major work succeeding the original construction is the Valve House constructed at the toe of the dam in 1971. The original waterway tunnel was extended with a 78-inch diameter steel pipe. The pipe is manifolded to provide passageways for two 42-inch, one 24-inch, one 12-inch, and one 8-inch Howell Bunger type outlet valves. Each of the outlet valves are guarded by one or more ball valves.

Project Description

The Cheesman Upstream Control project is a phased project spanning several years of design and construction. This request for proposal is for Phase 1 work, detailed below, which includes both Phase 1A and Phase 1B work; the proposer must bid on the entirety of work including Phase 1A and Phase 1B.

Phase 1A: Control Building and Electrical/Control Upgrades

A new Control Building will be constructed to house the Hydraulic Power Unit (HPU), bubbler system, and standby generator. The Control Building will be located on the left abutment just upstream from the crest access road. The existing Shaft House superstructure that services the Johnson Valve will be removed and the new Control Building will envelop the access shaft to the Johnson Valve. The Control Building is for limited occupancy and functions as shelter for the HPU, bubbler system, standby generator, and Johnson Valve access. The new building features include cast-in-place concrete walls, double access doors, windows, lights, heating and ventilation, truss roofing system, and granite masonry clad façade.
Additional electric components and systems include limited environmental control systems (ventilation and heating), a security and instrumentation system interconnected to other locations on site, a lightning protection and grounding system, and various electrical distribution equipment.

OWNER furnished and CONTRACTOR furnished equipment will be installed within the Control Building. The new HPU servicing the slide gates is OWNER furnished and CONTRACTOR installed. All other Control Building equipment including the new generator and air compressors are CONTRACTOR furnished and installed.

The Cheesman facility will require electrical and control upgrades throughout the site. Key components of the electrical and control upgrades include providing temporary power to the Johnson Valve and other loads as well as temporary construction power, energizing the new Control Building, replacing the electrical conduit, wiring, lighting, general power and controls within the manway tunnels, electrical and control upgrades to the caretakers offices, electrical and control upgrades to the Valve House, and new electrical and controls to the downstream measurement flume. The Control Building will be linked to the Valve House via a new bore from the dam crest to the upper manway entrance. The CONTRACTOR will then install power, controls, communications, etc. through the manway and continue this work to the Valve House.

**Phase 1B: Upstream Control Gates**

The CONTRACTOR will install new spools, slide gates and trashracks at all three inlet levels at the Cheesman Dam.

The Auxiliary Level improvements include rock removal, removal and disposal of the existing trashrack (installed in 2002), installation of a new 8’x8’ OWNER-furnished hydraulically operated slide gate and tunnel spool (liner), rock anchoring, grouting the spool in place, and the installation of the OWNER-furnished trashrack.

The Mid Level improvements include rock removal, removal and disposal of the existing trashrack, installation of a new 4’x7’ OWNER-furnished hydraulically operated slide gate and tunnel spool (liner), rock anchoring and grouting the spool in place, and installation of the OWNER-furnished trashrack.

The Low Level improvements include rock removal, removal and disposal of the remnants of the existing trashrack, installation of a new 4’x7’ OWNER-furnished hydraulically operated slide gate and tunnel spool (liner), rock anchoring and grouting the spool in place, and installation of the OWNER-furnished trashrack.

All gates are to be hydraulically controlled with the HPU in the Control Building. The hydraulic and air transmission lines will be routed from the Control Building to the new slide gates through new rock borings within the left abutment. The rock borings originate adjacent to the Control Building and daylight approximately 10-feet above the respective slide gate (low level gate routing is greater than 10-feet). The remainder of the hydraulic line transmission will be surface mounted along the reservoir bottom.

Installation of the gate spools requires a limited amount of blasting to remove rock from the tunnel portals and tunnel brow areas. Special provisions will be required while blasting to protect the downstream gates and aquatic life within the reservoir.

**Site Location**

Cheesman Dam and Reservoir is located about 60 miles southwest of Denver, Colorado on the South Platte River. The nearest town with full services is Woodland Park approximately 30 miles South of Cheesman Dam. Access to Cheesman Dam is from Highway 126 via a one and a half wide lane dirt/gravel Forest Service Road 3 miles in length with steep grades (as much as 10%) and tight turning radii. The spillway for the dam is adjacent to the dam and is the only access across the dam’s crest. Large equipment and 18 wheel trucks can use the spillway and dam access when the spillway is not operating; however, parking or storing materials and equipment on the dam and spillway crest will not be
permitted. Snow removal along the Forest Service access road for the CONTRACTOR’s access will be the responsibility of the CONTRACTOR.

Staging areas for CONTRACTOR facilities including office/trailer space and equipment storage areas are limited. The CONTRACTOR’s offices may be located within the existing Denver Water security fence, the equipment storage area is outside of the Denver Water security fence and must be secured by the CONTRACTOR. The CONTRACTOR will be required to provide trailers for Denver Water construction management and for the ENGINEER.

The reservoir elevation at time of mobilization is difficult to predict. Grading to support a launch area for the CONTRACTOR’s barges, support craft, equipment, and the construction trailers is the responsibility of the CONTRACTOR. Denver Water will support the CONTRACTOR with required site surveys.

**CONTRACTOR Selection Process**

Denver Water will select the CONTRACTOR based on a weighted system giving equal consideration to the proposal cost and the project execution plan.

The CONTRACTOR for this work will be required to enter into a contract with Denver Water under the provisions of the enclosed documents. These documents consists of:

- **Proposal Documents:**
  - Instruction to Bidders
  - Contract
  - Construction Bond
  - General Conditions
  - Supplemental or Special Conditions
  - Detailed Specifications
  - Project Drawing Package Phase 1A
  - Project Drawing Package Phase 1B
  - Addendums issued during bidding

**Project Execution Plan**

A project execution plan must be submitted as part of the proposal, and will be used in conjunction with the proposed cost in evaluation of the proposals. The project execution plan is intended to allow the CONTRACTOR to convey a detailed level of understanding of the project to Denver Water. The plan at a minimum should include the following:

1. Proposed project team and experience specific to the project. Include key members and experience for major subcontractors (i.e. Drilling Contractor, Blaster-In-Charge, Building Contractor, Electrical Contractor, I&C Contractor, Communications Contractor, and Mechanical Contractor)

2. Proposed equipment to be used on the project, and anticipated schedule for specialized equipment.

3. Means and Methods to install key components, including:
   a. Installation of auxiliary level gate spool, gate, trashrack and grouting.
   b. Installation of mid-level gate spool, gate, trashrack, and grouting.
   c. Installation of low-level gate spool, gate, trashrack, and grouting
   d. Installation of inclined rock borings, hydraulic lines, and surface mounted hydraulic lines
   e. Control Building Construction
   f. Electrical work, including powering the control building and installation of the upgraded electrical and controls in the manway, Valve House, measurement flume, and caretakers office. Include a detailed scope of work.

(BOARD OF WATER COMMISSIONERS)
(CHEESMAN DAM UPSTREAM)
(CONTROL PROJECT - PHASE 1)
(11577A) RFP-3
4. A detailed and cost loaded project schedule with discussion of contract milestones and means and methods to accomplish said milestones. The proposal requests the CONTRACTOR consider the construction milestones Denver Water envisions for the project. The CONTRACTOR may however, propose a proprietary schedule based on alternative milestones which accomplish the goals of the project.

5. A cost loaded schedule outlining the payment Schedule of Values corresponding to activities within the project schedule, including detailed items within the Control Building, underwater construction, and electrical work. The cost loaded schedule and payment Schedule of Values should break down Proposal Schedule of Value items into further detail, including duration and quantities. The electrical cost loaded schedule and payment Schedules of Values portion must include items specified within specification Section 26 00 10. Project exclusions should be noted within this section, including all Subcontractor exclusions.

6. List of Major Subcontractors to Include:
   a. Licensed Colorado General Building Contractor
   b. Electrical Subcontractor
   c. Instrumentation and Controls Subcontractor
   d. Drilling Subcontractor
   e. Mechanical Subcontractor
   f. Blasting Subcontractor or Blaster-In-Charge

7. Project Management methods and organization chart proposed to promote a partnering team effort between the CONTRACTOR, ENGINEER, and OWNER. The organization chart should include key management personnel from both the General CONTRACTOR as well as key subcontractors; include communication protocol for communications between the OWNER, ENGINEER, and CONTRACTOR.

Proposal Schedule

The anticipated proposal schedule for the Phase 1 work is outlined below:

- **Friday, August 7th** - Proposal Documents Issued to Proposers
- **Wednesday, August 19th** – Mandatory Site Visit
- **Tuesday, September 1st** – Proposals Due at Denver Water Offices
- **Thursday, September 10th** – Interviews with selected proposers
- **Wednesday, September 23rd** – Selected proposal recommended to Board of Water Commissioners for approval
- **Friday, October 2nd** – Notice to proceed to selected proposer

Project Schedule

Denver Water wishes to complete the project as soon as a reasonable schedule allows. In order to accommodate the possible winter time construction constraints, Denver Water has set a no-later-than completion date of August 31, 2010. However, Denver Water has an interest in completing the project or key components of the project at an earlier date and encourages the proposers to consider non-linear scheduling and alternate project delivery methods. Denver Water has evaluated multiple scheduling options to complete the project in less time and to put some of the project features online prior to winter weather and possible lake ice.

Specifically Denver Water is interested in completion of either the Auxiliary Level Intake, or both the Mid/Low Level Intakes early within the construction project. The Auxiliary Level Intake in the Fall 2009, may present opportunities for air diving operations when the reservoir is at a low level and experiences the least amount of fluctuation. The saturation diving for the Low and Mid Level Intakes could then begin in spring 2010. The Control Building must have power for testing and control of either the Auxiliary Level Gate or the Low/Mid Level Gates prior to putting either tunnel system in service. The power source could

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A )
RFP-4
be permanent or consist of a CONTRACTOR provided, fueled, and maintained standby generator sized to accommodate the HPU system and other major systems including the bubbler, heating and cooling, building power and lighting systems until the permanent power is completed.

The proposer is to evaluate and propose the schedule for the project. The proposed and accepted project schedule and milestone dates will become part of the contract documents.

**Project Milestones, Opportunities and Constraints**

Successful completion of the project requires a complete understanding of the relationship between the project components and site conditions. Many key activities and milestone completions are dependent on preceding work, and site operational conditions such as facility operations, historical reservoir elevations, weather, and lake ice. The contract documents include historical information on lake ice, weather, reservoir elevation, and inflow rates. A list of what Denver Water believes to be critical Milestones and Constraints are listed below for consideration within the proposal:

- Notice to Proceed - 10/2/09
- Control Building Operational – 1/31/2010
- Project Completion – 8/31/2010
- Inclined Drilling and Hydraulic/Air Line Assembly Installation Completion must precede Control Building Construction
- Control Building operation must precede Installation of HPU and the bulk of the electrical system
- HPU Operation must precede testing of any one of the three slide gates
- Inflow increases to reservoir historically begin in April
- Fluctuations of the reservoir within a 45 day time period beginning November 1, 2009, are typically 3 ft, but could be greater
- Fluctuations of the reservoir within a 45 day time period beginning April 15, 2009, are typically 15 ft, but could be greater
- Reservoir draw down rates could be as high as 0.5 ft/day in the fall
- Reservoir fill rates could be greater than 1 ft/day in the spring/summer
- At all times of construction, either the Auxiliary Level Gate or both the Mid and Low Level Gates must be in operation, and under the control of Denver Water

**Subcontractors**

Denver Water understands a large portion of the work requires major and specialized subcontractors. Denver Water is providing a list of prequalified subcontractors that may be utilized for portions of the work for the project. The subcontractors on the following list do not need to be prequalified by Denver Water. The CONTRACTOR may choose to use other subcontractors, conditional to qualification by Denver Water. Subcontractors included in the CONTRACTOR's proposal are required to attend the pre-proposal site visit.

*General CONTRACTOR:*
- Paramount Construction
- Moltz Constructors
- Jennison Construction Co
- ASI Constructors
- Concrete Works of Colorado

*Mechanical (Heating and Ventilation):*
- Walrath Heating and Air Conditioning
- Murphy Mechanical
- Horizon Sheetmetal
- Kuck Mechanical
Electrical:

- Ludvick Electric
- MWI McDade Woodcock
- Sturgeon Electric

Instrumentation and Control:

- Quality Electrical Systems
- Wunderlick – Malec
- Instrument Control Systems

Drilling:

- Hayward Baker
- Layne Christensen
- Nicholson Construction

Quality Control Contractor

Denver Water intends to contract with a third party to monitor quality control of all aspects of the underwater construction. The CONTRACTOR will be required to provide all provisions for the quality control of the CONTRACTOR’s diving operations. The CONTRACTOR shall provide all necessary support, other than personnel and their personal equipment, for the third party quality control. The CONTRACTOR will be required to furnish and install visual monitoring equipment adequate to maintain continuous visual inspection from the surface of all underwater construction activities. CONTRACTOR will also be required to provide continuous digital records of all diving activities.

In addition to the full time Under Water Construction Quality Contractor, Denver Water intends to contract with a third party to monitor the quality control aspects of the blasting operations. The CONTRACTOR shall provide all necessary support other than personnel and their personal equipment, for the third party blasting quality control.

Project Partnering

Denver Water believes the successful completion of the Cheesman Upstream Control Project Phase 1 is dependent on a fair and balanced partnering relationship between the OWNER and CONTRACTOR. The beginning of this process is through the proposal and proposal evaluation by Denver Water, which is based on both the proposal cost and the project execution plan.
To: Board of Water Commissioners  
of the City and County of Denver

THE UNDERSIGNED, having familiarized himself with the work required by the Proposal, the site where the work is to be performed, local labor conditions and all laws, regulations and other factors affecting or potentially affecting performance of the work, and having satisfied himself of the expense and difficulties attending performance of the work,

HEREBY PROPOSES and agrees, if this Proposal is accepted, to perform all work, including the assumption of all obligations, duties and responsibilities necessary to the successful completion of the Proposal and the furnishing of all materials and equipment required to be incorporated in and form a permanent part of the work; to provide the tools, equipment, supplies, transportation, facilities, labor, superintendence and services required to perform the work; and to supply Bonds, insurance and submittals; all as indicated or specified in the Proposal to be performed and/or furnished by CONTRACTOR for the following:
## SCHEDULE OF VALUES

**CHEESMAN DAM**

**UPSTREAM CONTROL PROJECT - PHASE 1**

**FURNISH AND INSTALL CONTRACT**

<table>
<thead>
<tr>
<th>Item</th>
<th>Work &amp; Material</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHASE 1A - CONTROL BUILDING:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Furnish and install Control Building, equipment, electrical, instrumentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and controls throughout the site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td><strong>PHASE 1B - GATE INSTALLATION:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Initial underwater site survey/inspection</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Installation of OWNER-furnished hydraulic power unit</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Demolish and remove auxiliary level trashrack</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Rock blasting and removal at auxiliary level</td>
<td>2,239 CF</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Per CF</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Installation of OWNER-furnished auxiliary slide gate and spool</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Installation of OWNER-furnished auxiliary level trashrack</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Drilling of inclined bore hole to auxiliary level intake</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Furnish and install hydraulic and air line assembly within auxiliary inclined</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bore hole</td>
<td></td>
<td>bore hole</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Furnish and install hydraulic and air line assembly from auxiliary rock</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bore hole outlet to the auxiliary slide gate</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Demolish and remove mid level trashrack</td>
<td></td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Rock blasting and removal at mid level</td>
<td>860 CF</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Per CF</td>
<td>$</td>
</tr>
</tbody>
</table>

(BOARD OF WATER COMMISSIONERS)  
(CHEESMAN DAM UPSTREAM)  
(CONTROL PROJECT - PHASE 1)  
(11577A)  
P-2
SCHEDULE OF VALUES
CHEESMAN DAM
UPSTREAM CONTROL PROJECT - PHASE 1
(Continued)

FURNISH AND INSTALL CONTRACT

<table>
<thead>
<tr>
<th>Item</th>
<th>Work &amp; Material</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>Installation of OWNER-furnished mid level slide gate and spool</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Installation of OWNER-furnished mid level trashrack</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Demolish and remove low level temporary trashrack</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Rock blasting and removal at low level intake</td>
<td>987 CF</td>
<td>$___________</td>
<td>$____________</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Per CF</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Installation of OWNER-furnished low level slide gate and spool</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Installation of OWNER-furnished low level trashrack</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Drilling of inclined bore hole to mid level intake</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Furnish and install hydraulic and air line assembly within inclined bore hole mid/low level</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Furnish and install hydraulic and air line assembly from existing mid/low level rock bore hole outlet to mid/low level gate</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Furnish and install hydraulic lines from existing mid/low level rock bore hole outlet to low level gate</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Drilling of inclined bore hole to downstream manway house</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Mobilization (not to exceed 15% of Total)</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td>$___________</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: The Contract will be awarded on an “all or none” basis.
1. The Contract, referred to and incorporated herein by reference, includes all items set forth in the Contract Documents. No one part shall constitute the Contract, but the whole taken together shall be the Contract between the parties.

2. The price offered to provide materials and/or services is the amount set opposite each item listed in the Schedule of Values. Unless otherwise specified, the unit price for each item must be given in the column headed "Unit Price" and must be for the particular unit or measurement specified in the column headed "Quantity". In addition, the prices must be extended for each item and the extensions totaled. In the case of a discrepancy, the unit price shall govern.

3. Payment for all materials and services provided hereunder shall be made as set forth in the Supplementary Conditions.

4. The Contract entered into upon acceptance of this Proposal, shall be deemed to be performable in the City and County of Denver, notwithstanding that the parties hereto may find it necessary to take some action in furtherance thereof outside said City and County and venue for any dispute arising hereunder resulting in litigation shall be in the District Court in and for the City and County of Denver. The Contract shall be governed by and construed under the laws of the State of Colorado.

5. In the event that a Contract is entered into upon acceptance of this Proposal, it is understood and agreed that such Contract is made under and conformable to the provisions of the Charter of the City and County of Denver which control the operations of the Denver Municipal Water System consisting of Article X of said Charter. Insofar as applicable, said Charter provisions are incorporated herein and made a part hereof by this reference, and shall supersede any apparently conflicting provisions otherwise contained in the Contract.

6. The undersigned CONTRACTOR hereby certifies that this Proposal is genuine and is not made in the interest of, or in the behalf of, any undisclosed person, firm, or corporation, and is not submitted in conformity with any agreement or rules of any group, association, organization, or other entity.

7. By executing this Proposal, CONTRACTOR certifies that it has complied, and during the term of any Contract entered into upon acceptance of the Proposal will continue to comply, with the Immigration Reform and Control Act of 1986.

8. The undersigned CONTRACTOR agrees to furnish the required Bonds and provide Certificates of Insurance and will enter into a Contract within 10 days after receiving Notice of Award from OWNER, and further agrees to complete all Work in accordance with the following:

<table>
<thead>
<tr>
<th>Completion Item</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substantial Completion</td>
<td>July 31, 2010</td>
</tr>
<tr>
<td>Final Completion</td>
<td>August 31, 2010</td>
</tr>
</tbody>
</table>

9. OWNER reserves the right to reject any or all Proposals, either in part or whole; to waive any informalities or defects in the Proposal, and to accept such Proposal as it deems to be in the best interests of the OWNER. Except as herein stated, the Bid of the lowest responsible Proposer may be accepted.

10. OWNER also reserves the right to reject any Proposal from and the right not to award a Contract to any Proposer who is deemed irresponsible or unreliable, who is in arrears to OWNER upon debt or contract, or who is a defaulter upon any obligation to OWNER.

11. OWNER also reserves the right to reject any Proposal from and the right not to award a Contract to any Proposer where the surety issuing the Proposer’s performance bond or payment bond is deemed irresponsible or unreliable, who is in arrears to OWNER upon debt or contract, or who is a defaulter upon any obligation to OWNER.

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A )
P-4
12. OWNER also reserves the right, where OWNER has prequalified subcontractors for a project, to reject any Proposal from and the right not to award a Contract to any Proposer utilizing a subcontractor that is deemed irresponsible or unreliable, who is in arrears to OWNER upon debt or contract, or who is a defaulter upon any obligation to OWNER.

13. Proposers shall comply with the provisions of the Board’s Small/Minority/Women Business Enterprises (SMWBES) Program set forth in the Contract Documents. **Goals for the Work to be completed under the Phase 1A Drawing Package have been established as 5% participation of the total amount.** It is the intent of the Program that qualified Contractors, Subcontractors, or Suppliers be utilized to the fullest extent possible, to perform work or provide the supplies and services required by the Drawings and Specifications. Proposers are encouraged to identify as many aspects of the work as possible to enhance the utilization of Minority and Women Business Enterprises (MWBEs). **Proposers are required to have the entire Statement of Intent completed in full, at the time the Proposal is due. Please note that Proposers will no longer have until 5:00 p.m. to submit clarifications to this form.**

14. The undersigned CONTRACTOR acknowledges receipt of the following addenda, which have been considered in preparation of this Proposal:

<table>
<thead>
<tr>
<th>No.</th>
<th>Dated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dated this ________________ day of ________________________, 2009.

Name of Firm: ____________________________________________

By __________________________ (Signature of Authorized Agent) (Print or type name of authorized agent)

(SEAL)

Whose permanent Post Office address is:

Street No. or P.O. Box ________________________________ Telephone No. ________________________________

City, State, Zip Code ________________________________ FAX ________________________________

Proposer’s status as to: ________________________________

Sole Proprietor, Partnership, Corporation (To include State of Incorporation)
STATEMENT OF INTENT TO USE MINORITY AND WOMEN BUSINESS ENTERPRISES (MWBE’s)

All Proposers shall complete the form below for the involvement of MWBEs on this project and shall submit the form with their bid. **IF THIS FORM IS NOT COMPLETED IN FULL AND IN DETAIL, SIGNED AND SUBMITTED WITH THE BID, SUCH BID MAY BE CONSIDERED INFORMAL BY THE BOARD OF WATER COMMISSIONERS AND REJECTED.** Please note that Proposers will no longer have until 5:00 p.m. to submit clarifications to this form.

The following MWBEs will be utilized for Phase 1A Work Only:

<table>
<thead>
<tr>
<th>Name</th>
<th>Schedule of Values Item No.</th>
<th>Type of Work</th>
<th>Subcontractor</th>
<th>Amount of Contract $</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By executing this document, the Proposer hereby certifies that it fully intends to employ the MWBEs listed on this STATEMENT OF INTENT TO USE MINORITY AND WOMEN BUSINESS ENTERPRISES. Should one or more listed MWBEs be deleted after the bid has been submitted or if it becomes necessary to replace an MWBE, the CONTRACTOR MUST FIRST OBTAIN THE APPROVAL OF THE OWNER (See page SMWBE-4: Replacement of MWBE).

**Total Program Participation Achieved: MWBE ____%**

(Signature of Authorized Representative of Bidder)  
(Print or type name and title of authorized representative of Bidder)

(Name of Bidder)  
(Address of Bidder)  
(DATE: _________________________)
SMALL/MINORITY/WOMEN BUSINESS ENTERPRISES PROGRAM
OF THE
DENVER BOARD OF WATER COMMISSIONERS

Introduction

The Small/Minority/Women Business Enterprises Program provides opportunities for Small/Minority/Women Business Enterprises (SMWBEs), by ensuring such businesses obtain a fair portion of the Board’s construction, purchasing and professional service contracts. The Board has established an SMWBE Committee to administer and implement the Board’s Nondiscrimination in Contracting Program.

SMWBE refers to Denver Water’s Program and Committee. All Denver Water Construction Contract Goals must seek participation from Minority and/or Women Business Enterprises (MWBEs) only.

Board construction contracts are subject to MWBE participation goals established by the appropriate Division Director. Goals are based on the size of the contract, availability of certified MWBE’s, previous levels of MWBE participation in similar Board contracts, and other appropriate factors. Parties seeking contracts must either meet these goals or demonstrate a good faith effort to do so. The SMWBE Committee will conduct a hearing to determine if the potential contractor or supplier has made a good faith effort to obtain MWBE participation.

MWBE’s include any business enterprise that has been certified, in compliance with applicable law, as a Minority and Women Business Enterprise with certification by the City and County of Denver, U.S. Small Business Administration, or other governmental/certifying entity.

The SMWBE Committee has adopted procedures necessary to implement the SMWBE participation program. The SMWBE Committee will respond to formal complaints regarding the program, handle appeals of adverse decisions, and make determinations of good-faith efforts.

The goal for the Work to be completed under the Phase 1A Drawing Package is to attain 5% MWBE participation of the total bid amount.

All MWBEs utilized to satisfy this goal MUST be listed on the Statement of Intent at the time a bid is submitted. Proposers are required to have the entire Statement of Intent completed in full, at the time of the bid opening. Please note that Proposers will no longer have until 5:00 p.m. to submit clarifications to this form.

MWBE Utilization Mechanisms

Proposers may utilize MWBEs in several different business relationships, including but not limited to, joint ventures, negotiated subcontracts, or competitively bid subcontracts. Proposers are encouraged to identify as many aspects of the work as possible to enhance the utilization of MWBEs. Proposers are expected to use qualified MWBEs. To be qualified, MWBEs must have the necessary financial capabilities, skill, experience, and access to the necessary staff, facilities and equipment to perform the work or to provide the supplies or services that are required. In addition, MWBEs must be certified as Minority and Women Businesses by City and County of Denver, the Rocky Mountain Minority Supplier Development Council (RMMSDC) or the Federal Government Programs.

Flexibility Relative to Bonding Required

Proposers are encouraged to assist MWBEs in their effort to obtain bonding, or to include MWBEs in any overall bond provided by the CONTRACTOR. Proposers may use MWBEs which cannot provide bonding. Rejection of an MWBE due to its inability to provide bonding shall be considered detrimental in the evaluation of the Proposer’s “good faith effort” to meet the goals for MWBE utilization.
Engineering SMWBE Contact

The OWNER has designated an Engineering SMWBE Contact who will administer the OWNER's Engineering Division SMWBE Program. At all phases of the bidding process and subsequent execution of the work pursuant to the Contract, CONTRACTORS, subcontractors, and suppliers shall cooperate fully with the Engineering SMWBE Contact. It shall be the duty of all Proposers, and the CONTRACTOR awarded the Contract, in cooperation with the Engineering SMWBE Contact, to ensure that SMWBEs have an equal opportunity to compete as CONTRACTORS, subcontractors or suppliers. Proposers are encouraged to establish a direct relationship with the Engineering SMWBE Contact, who will respond to all questions relative to the SMWBE Program. All Proposers should understand, however, that all certified MWBEs may not be listed, and some listed MWBEs may no longer be certified. In providing a list of MWBEs, the OWNER assumes no responsibility for the data or the financial or other capabilities or experience of any entity set forth in the list. Further, in providing assistance to Proposers, no warranty is made by the Engineering SMWBE Contact or the OWNER that any particular MWBE is qualified to perform the work or to provide the supplies or services that are required or that any such entity will perform as required.

Good Faith Effort

If the goal specified herein has not been met, it shall be the responsibility of the apparent low Proposer to demonstrate its good faith effort in attempting to meet the goal. The apparent low Proposer, if it has not met the specified goal, must provide a completed Good Faith Effort Questionnaire (with supporting documentation) within 7 days of the bid opening date in support of its good faith effort to meet the goal. A copy of the Good Faith Effort Questionnaire is set forth on pages SMWBE-6 to SMWBE-7. The Program Review Committee may request that the Good Faith Effort Questionnaire be completed and submitted (with supporting documentation) by other Proposers to assist in determining if the apparent low Proposer made a good faith effort.

The determination of the adequacy of a Proposer's good faith effort will be made by the Committee and will be based upon the following items:

1. The apparent low Proposer's utilization of MWBEs compared with other Proposers;
2. The apparent low Proposer's efforts to contact and interest MWBEs, including:
   A. Advertising in:
      1) Trade association publications (Daily Journal); and
      2) Publications (El Semanario, The Weekly Issue, Denver Rocky Mountain News, and VIVA);
   B. Mailings;
   C. Contacts with MWBE Contractor Organizations.
   D. Phone contacts with MWBEs;
   E. Assistance sought from the Engineering SMWBE Contact;
3. List items of work identified by the Proposer for subcontract, supply or joint ventures to meet the Program goals;
4. Efforts to negotiate with MWBEs to obtain them as subcontractors, suppliers or members of joint ventures;
5. Efforts to provide MWBEs a full and fair opportunity to bid, including the opportunity to review drawings and to have the time to prepare bids and negotiate; and
6. The reasons why the Proposer was unsuccessful in its efforts to obtain MWBEs as subcontractors, suppliers or joint venture partners.

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A ) SMWBE-2
The Committee, in making its determination of the apparent low Proposer's good faith effort, may require that the apparent low Proposer attend a hearing(s) to support its good faith effort.

If the Committee determines that a Proposer failed to make a good faith effort, the bid will be deemed nonresponsive and a recommendation to reject the bid shall be made to the OWNER.

**MWBE Documents**

In order to comply with this Program, Proposers must complete, sign and submit with their bid a form entitled **Statement of Intent to Use Minority and Women Business Enterprises (MWBEs)** (page P-6). In addition, if the MWBE goal has not been met, the apparent low Proposer will be required to complete the **Good Faith Effort Questionnaire** (pages SMWBE-6 to SMWBE-7) within 7 days of the bid opening as provided for herein under "Good Faith Effort." The apparent low Proposer will be required to convert its Statement of Intent to individual **Letters of Intent** (page SMWBE-5) within 5 days subsequent to the bid opening. The Letters of Intent shall be substantially the same as the Statement of Intent. Any material changes between the two must be approved by the Board.

Additionally, on the final day of March, June, September and December following issuance of the "Notice to Proceed", the CONTRACTOR will be required to complete and submit a fourth form: **QUARTERLY MWBE PARTICIPATION REPORT** in the format set forth on page SMWBE-8 so that the OWNER can trace the actual utilization of, and payments to, MWBEs. The CONTRACTOR shall also submit a completed **FINAL MWBE PARTICIPATION REPORT** with the Final Partial Payment Estimate. Material failure to utilize MWBEs to the extent listed on the Statement of Intent may be cause to disqualify the CONTRACTOR for future projects by OWNER.

**Replacement of MWBE**

It is anticipated that subcontractors and suppliers specified in a Proposer's Statement of Intent will be utilized by the CONTRACTOR. In order for the CONTRACTOR to replace an MWBE listed in its Statement of Intent or designated in a Letter of Intent, the CONTRACTOR must first obtain the approval of the OWNER. In order to gain approval, the reason for the replacement must be explained to the satisfaction of the OWNER.

To the extent possible, the dollar amount of work committed to an MWBE firm that is replaced should be placed with another MWBE firm. If a portion of the work remains to be done by a replaced MWBE, the CONTRACTOR shall determine the dollar value of the work to be completed and, to the extent possible, contract that remaining dollar amount with a replacement MWBE firm.

**SMWBE Program Complaints**

The SMWBE Liaison shall receive and respond to formal complaints regarding the Board's SMWBE Program as follows. Complaints about any aspect of the SMWBE Program by any Contractor shall be brought to the attention of the SMWBE Liaison. If the complaint is not resolved at that level, the SMWBE Liaison will bring the complaint to the SMWBE Committee for such proceedings as the Committee deems advisable. If the complaint is not resolved at that level, the CONTRACTOR may request that the complaint be referred to the Manager for whatever further action the Manager deems advisable, which shall be the final action of the Board.
LETTER OF INTENT

PROPOSER INFORMATION
Name of Proposer's Firm: ____________________________________________
Address of Firm: ___________________________________________________
Proposer's Telephone: ______________________________________________

MWBE INFORMATION
Type of Firm: Subcontractor ☐ Supplier ☐
Name of MWBE Firm: ________________________________________________
Firm Address: ______________________________________________________
Firm Telephone: ____________________________________________________
Certified By: Federal Agency ☐ City Agency ☐ Other Agency ☐
Certification Expiration Date: _________________________________________

WORK TO BEGIN: Quarter __________ Year __________

DESCRIPTION OF WORK TO BE PERFORMED:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Brief Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>______</td>
<td></td>
<td>______</td>
</tr>
<tr>
<td>______</td>
<td></td>
<td>______</td>
</tr>
<tr>
<td>______</td>
<td></td>
<td>______</td>
</tr>
</tbody>
</table>

TOTAL VALUE OF ESTIMATED WORK $___________

SIGNATURES:
Proposer intends to utilize the above-named MWBE firm for the work described above. If the above-named Proposer is not determined to be the successful Proposer, this Letter of Intent shall be null and void.

(Signature of Authorized Representative of MWBE) (Signature of Authorized Representative of Proposer)

(Print or type name and title of authorized representative of MWBE) (Print or type name and title of authorized representative of Proposer)

(Date) (Date)

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A ) SMWBE-5
GOOD FAITH EFFORT QUESTIONNAIRE

If you have failed to meet the MWBE goal and you are the apparent low Proposer, you are required to complete and submit this form, along with supporting documentation within 7 days of the bid opening. Please use an additional sheet when space is inadequate.

1. Project MWBE Goals

   CONTRACTOR MWBE Participation

   % %

2. Did your firm advertise for MWBE participation? YES NO

   A. If YES, were the advertisements specific or general?

   (Include a copy(s) of your advertisements)

   B. What sources did your firm use to solicit bids from MWBE subcontractors and suppliers?

   (Include a copy(s) of your advertisements.)

   1) Daily Journal
   2) Publications
   3) Contract or Organizations
   4) Other (List)

3. What items of work were identified for MWBE contracting opportunities? List the items of work identified and the percent of contract:

4. How many MWBE firms did you contact by mail?

   (Provide a copy of all materials mailed and a list showing to which MWBE firms the various mailings were sent.)

5. How many MWBE firms did you contact by phone?

6. The Proposer has contacted the following numbers of MWBE firms as a part of its effort to enter into agreements of the type specified:

   A. Number of MWBE contractors contacted by Proposer for negotiated subcontracts:
   B. Number of MWBE contractors contacted for joint venture agreements:
   C. Number of MWBE contractors contacted for competitive bids:

7. If you did not negotiate with any MWBE firm(s) please explain why. If you did negotiate with one or more MWBE firm(s), please explain the extent of the negotiating effort.

8. Please indicate how many negotiated subcontracts you entered into:

If you negotiated with MWBEs, but no negotiated subcontracts resulted, please give the reasons that your negotiated efforts failed relative to each such failure.
9. For subcontracts or supply contracts where an MWBE bid, but was not used, provide the following information:
   A. Scope of work MWBE bid vs. scope of work non-MWBE bid:
   B. Amount of MWBE bid vs. amount of non-MWBE bid.
      (Note: Include the date the bids were received.)

10. How many MWBE firms reviewed the Drawings and Specifications at your office? ____________
    A. Did your firm provide bonding assistance to any MWBE firm? ______________________
    B. Did your firm waive bonding for any MWBE firm? YES ______________________
       NO ____________ Explain: ______________________________________________________
    C. Were any MWBE bids rejected due to the MWBE’s inability to obtain bonding? YES _____
       NO ____________ If Yes, Explain: ______________________________________________________

11. Have you previously bid on work with public entities in which the bid documents set forth goals for MWBEs? If the answer to this question is Yes, please provide the following information:
    A. Were you ever the low Proposer;
    B. Have you ever failed to meet a specified goal;
    C. Has a Contract submitted by your entity ever been rejected for its failure to respond to an MWBE program;
    D. Relative to each incident in which you have failed to reach the goal, please set forth the reasons for any such failure.
    E. Have you ever competed successfully for a public project and met the goals specified therein;

Relative to each of the questions set forth above, please respond in detail on a separate piece of paper. This information will be used by the Committee as an indication of the Proposer's commitment to the programs.
QUARTERLY MWBE PARTICIPATION REPORT
FINAL MWBE PARTICIPATION REPORT*

CONTRACT NUMBER: ______________________________
PROJECT NAME: ______________________________
REPORTING PERIOD: ___________________________ THROUGH: ___________________________

<table>
<thead>
<tr>
<th>NAME OF MWBE FIRM</th>
<th>Letter of Intent $ Amount</th>
<th>Actual $ Amount of Subcontract</th>
<th>Amount $ Paid this Period</th>
<th>Total $ Amount Paid to Date</th>
<th>Final $ Amount Paid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTALS:

The above and foregoing report, as completed, is true and accurate to the best of my knowledge.

MWBE Participation Reports are to be filed quarterly on the final day of March, June, September and December for the duration of the project. A Final MWBE Participation Report shall be submitted with the Final Partial Payment Estimate. If the final dollar amount paid is less than the amount stated in the Letter of Intent, a letter of explanation shall be attached to the Final MWBE Participation Report.

__________________________________________
FIRM NAME OF CONTRACTOR

By _____________________________

NOTE: This final report must be completed and submitted with the Final Partial Payment Estimate

Print Name _____________________________
Title _____________________________
Date _____________________________

*This form should be used for both the Quarterly and Final Reports. Please strike out the inappropriate title when completing the form.

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A ) SMWBE-8
AGREEMENT FORM

THIS AGREEMENT is dated as of the __________ day of _________________, in the year 2009 by and between the City and County of Denver, acting by and through its Board of Water Commissioners (hereinafter called OWNER) and ________________________________ (hereinafter called CONTRACTOR).

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE 1. CHARTER OF THE CITY AND COUNTY OF DENVER

This Contract is made under and conformable to the provisions of the Charter of the City and County of Denver which control the operation of the Denver Municipal Water System, consisting of Article X of said Charter. Insofar as applicable, said Charter provisions are incorporated herein and made a part hereof by this reference and shall supersede any apparent conflict otherwise contained in this Contract.

ARTICLE 2. WORK

CONTRACTOR shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

CHEESMAN DAM UPSTREAM
CONTROL PROJECT - PHASE 1

ARTICLE 3. ENGINEER

The project has been designed by the Engineering Division of the OWNER. The OWNER’s Director of Engineering or his authorized representative, who is hereinafter called ENGINEER and who is to act as OWNER’s representative, assumes all duties and responsibilities and has the rights and authority assigned to ENGINEER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

ARTICLE 4. CONTRACT TIME

4.1 Substantial completion of the Work will be made on or before July 31, 2010.

4.2 Final completion of the Work will be made on or before August 31, 2010 and be ready for final payment in accordance with Paragraph 14.13 of the General Conditions.

4.3 Liquidated Damages. OWNER and CONTRACTOR recognize that time is of the essence in this Agreement and that OWNER will suffer financial loss if the Work is not completed by the Substantial Completion Date, plus any extensions thereof allowed in accordance with ARTICLE 12 of the General Conditions. They also recognize the delays, expense, and difficulties involved in proving in a legal proceeding the actual loss suffered by OWNER if the Work is not completed on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) CONTRACTOR shall pay OWNER $2,000.00 for each day that expires after the Substantial Completion date.

ARTICLE 5. CONTRACT PRICE

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A ) AF-1
5.1 OWNER shall pay CONTRACTOR for completion of the Work in accordance with the Contract Documents, ARTICLE 14 of the General Conditions, in current funds in accordance with the Schedule of Values.

ARTICLE 6. PAYMENT PROCEDURES

CONTRACTOR shall submit Applications for Payment in accordance with ARTICLE 14 of the General Conditions, or as modified in the Supplementary Conditions. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

6.1 Progress Payments. OWNER shall make progress payments on account of the Contract Price on the basis of CONTRACTOR's Applications for Payment as recommended by ENGINEER, on or before the 20th day of each month during construction as provided below. All progress payments will be on the basis of the progress of the Work measured by the Schedule of Values established in Paragraph 2.9 of the General Conditions (and in the case of Unit Price Work, based on the number of units completed).

6.1.1 OWNER shall retain from progress payments, until payment is due under the terms and conditions governing final payments, amounts required by law (C.R.S. 38-26-107, as amended) and as follows:

Ten percent (10%) of authorized payments until the Work is 50 percent complete.

After the Work is 50 percent complete, no further retainage shall be withheld from each subsequent progress payment unless, in the opinion of the ENGINEER, satisfactory progress is not being made. In such case, 10 percent may be withheld from further progress payments.

When the Work is essentially complete (ready for operational or beneficial occupancy), the retained amount may be further reduced below 5 percent to an amount necessary to assure completion of the Work.

Retainage shall not be reduced if the Work is behind schedule; and, subsequent to reducing retainage, the full 10 percent retainage shall be reinstated any time the Work falls behind schedule.

6.2 Final Payment. Upon final completion and acceptance of the Work in accordance with Paragraph 14.13 of the General Conditions, OWNER shall pay the remainder of the Contract Price as recommended by ENGINEER.

ARTICLE 7. CONTRACTOR'S REPRESENTATIONS

In order to induce OWNER to enter into this Agreement, CONTRACTOR makes the following representations:

7.1 CONTRACTOR has familiarized itself with the nature and extent of the Contract Documents, Work, site, locality and all local conditions and laws and regulations that in any manner may affect cost, progress, performance or furnishing of the Work.

7.2 CONTRACTOR has studied carefully all reports of explorations and tests of subsurface conditions and drawings of physical conditions (if any) which are identified in ARTICLE 4 of the General Conditions, *and accepts the determination set forth in the Supplementary Conditions of the extent of the technical data contained in such reports and drawings upon which CONTRACTOR is entitled to rely.

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A )        AF-2
* IF APPLICABLE

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A ) AF-3
7.3 CONTRACTOR has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests, reports and studies (in addition to or to supplement those referred to in Paragraph 7.2 above) which pertain to the subsurface or physical conditions at or contiguous to the site or otherwise may affect the cost, progress, performance or furnishing of the Work as CONTRACTOR considers necessary for the performance or furnishing of the Work at the Contract Price, within the Contract Time, and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of Paragraph 4.2 of the General Conditions; and no additional examinations, investigations, explorations, tests, reports, studies, or similar information or data are or will be required by CONTRACTOR for such purposes.

7.4 CONTRACTOR has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing underground facilities at or contiguous to the site and assumes responsibility for the accurate location of said underground facilities. No additional examinations, investigations, explorations, tests, reports, studies, or similar information or data in respect of said underground facilities, including specifically the provisions of Paragraph 4.3 of the General Conditions are or will be required by CONTRACTOR in order to perform and furnish the Work at the Contract Price, within the Contract Time, and in accordance with the other terms and conditions of the Contract Documents.

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

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

ARTICLE 8. CONTRACT DOCUMENTS

The Contract Documents which comprise the entire agreement between OWNER and CONTRACTOR concerning the Work consist of the following:

8.1 Specifications bearing the title:

CONTRACT 11577A
BOARD OF WATER COMMISSIONERS
DENVER, COLORADO
CHEESMAN DAM UPSTREAM
CONTROL PROJECT - PHASE 1

and consisting of the divisions and pages, as listed in Table of Contents thereof.

8.2 Drawing Package Phase 1A, Drawing Package Phase 1B, and Drawing Appendices, inclusive.

8.3 Addenda Numbers _____ to _____, inclusive.

8.4 Notice of Award and Notice to Proceed.

8.5 The following which may be delivered or issued after the Effective Date of the Agreement and are not attached hereto: all written amendments and other documents amending, modifying, or supplementing the Contract Documents pursuant to Paragraphs 3.5 and 3.6 of the General Conditions.

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A ) AF-4
There are no Contract Documents other than those listed above in this Article 8. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraphs 3.5 and 3.6 of the General Conditions.

ARTICLE 9. MISCELLANEOUS

9.1 Some of the terms used in this Agreement are defined in ARTICLE 1 of the General Conditions.

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

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

9.4 By executing this document, CONTRACTOR certifies that it has complied, and during the term of this Agreement will continue to comply, with the Immigration Reform and Control Act of 1986.

ARTICLE 10. SIGNATURES

IN WITNESS WHEREOF, OWNER and CONTRACTOR have signed this Agreement in three counterparts, all of which must be returned to the ENGINEER. After execution is complete, one counterpart each will be delivered to OWNER, CONTRACTOR, and Surety. All portions of the Contract Documents have been signed or identified by OWNER and CONTRACTOR or by ENGINEER on their behalf.
This Agreement will be effective on ________________, 2009.

CITY AND COUNTY OF DENVER, ACTING BY AND THROUGH ITS BOARD OF WATER COMMISSIONERS

CONTRACTOR

By ____________________________

President

______________________________

By ____________________________

Attest ____________________________

Secretary

______________________________

Title ____________________________

(SEAL) (SEAL)

APPROVED ____________________________

Director of Engineering

ATTEST ____________________________

Secretary

APPROVED AS TO FORM:

_________________________________

Legal Division

REGISTERED AND COUNTERSIGNED
Dennis J. Gallagher, Auditor
CITY AND COUNTY OF DENVER

By ____________________________

Title: ____________________________

Address for giving notices: Address for giving notices:
(OWNER) (CONTRACTOR)

1600 W. 12th Avenue

______________________________

Denver, CO 80204

License No. ____________________________

[EXECUTION CONTINUES ON FOLLOWING PAGE]

(BOARD OF WATER COMMISSIONERS )
(CHEESMAN DAM UPSTREAM )
(CONTROL PROJECT - PHASE 1 )
(11577A ) AF-6
**Request for Taxpayer Identification Number and Certification**

**Part I  Taxpayer Identification Number (TIN)**

Enter your TIN in the appropriate box. The TIN provided must match the name given on Line 1 to avoid backup withholding. For individuals, this is your Social Security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the Part I instructions on page 3. For other entities, it is your employer identification number (EIN). If you do not have a number, see How to Get a TIN on page 3.

**Note:** If the account is in more than one name, see the chart on page 4 for guidelines on whose name to enter.

**Part II  Certification**

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me), and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding, and
3. I am a U.S. person (including a U.S. resident alien).

**Certification Instructions:** You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the Certification, but you must provide your correct TIN. (See the Instructions on page 4.)

<table>
<thead>
<tr>
<th>Sign Here</th>
<th>Signature of U.S. person</th>
<th>Date</th>
</tr>
</thead>
</table>

---

(BOARD OF WATER COMMISSIONERS )

(CHEESMAN DAM UPSTREAM )

(CONTROL PROJECT - PHASE 1 )

(11577A )

AF-7
FINAL PAYMENT RELEASE

Project: Cheesman Dam Upstream Control Project - Phase 1
OWNER: City and County of Denver, acting by and through its Board of Water Commissioners
CONTRACTOR: ________________________________
Date of Issuance: ________________________________
Final Payment Amount: ________________________________
Surety: ________________________________
OWNER's Contract No.: 11577A
ENGINEER: The Board's Director of Engineering or his authorized representative

Part I - Claims and Unpaid Bills

OWNER has received notice of the following claims and unpaid bills:

<table>
<thead>
<tr>
<th>Claimant</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(BOARD OF WATER COMMISSIONERS )
(11577A FPR-1)
Part II - CONTRACTOR's Affidavit

The CONTRACTOR hereby states that all payrolls, material and equipment bills, and other indebtedness or claims arising in any manner from the performance of the Contract, including those listed above, have been paid in full, except:

<table>
<thead>
<tr>
<th>Claimant</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONTRACTOR agrees to accept the Final Payment Amount shown in this Final Payment Release as full and final payment under the Contract and hereby releases OWNER from all claims arising out of the Contract, except those specifically listed above as in Parts I and II.

CONTRACTOR:

By: ____________________________
   (Signature)

Subscribed and sworn to before me this _______ day of ____________, 20____.

Notary Public: ____________________________
   (Signature)
   (SEAL)

My commission expires: ____________________________
• Part III - Consent of Surety (if any)

As Surety on the Contract referenced above, the undersigned hereby acknowledges the claims and unpaid bills listed hereon, consents to the making of final payment to CONTRACTOR, and agrees that final payment shall not relieve the Surety of any obligations to OWNER as set forth in the bonds.

Surety:
(SEAL)

By: ____________________________________________
(Signature of Authorized Representative)

Date: ____________________________________________

• Part IV - Supporting Documents

The following documents must be attached to this Final Payment Release:

[X] For each item listed in Part II:

- **Status**
  - Paid in Full
  - Waived
  - Conditional Upon Receipt of Final Payment
  - Pending Resolution

- **Attach**
  - Receipt
  - Signed Waiver
  - Conditional release
  - Documents showing current status and bond or waiver

[] Insurance certificates covering the insurance (including completed operations insurance) that is required by the Contract Documents to remain in force after final payment.

[] Maintenance bond covering CONTRACTOR’s warranty and maintenance obligations.
Performance Bond

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):

CONTRACT
Date:
Amount:
Description (Name and Location):

BOND
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Performance Bond to be duly executed on its behalf by its authorized officer, agent or representative.

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)
Signature: __________________________
Name and Title:

SURETY
Company: (Corp. Seal)
Signature: __________________________
Name and Title:
(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)
Signature: __________________________
Name and Title:

SURETY
Company: (Corp. Seal)
Signature: __________________________
Name and Title:

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, and the American Institute of Architects.
1. The CONTRACTOR and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner for the performance of the Contract, which is incorporated herein by reference.

2. If the CONTRACTOR performs the Contract, the Surety and the CONTRACTOR have no obligation under this Bond, except to participate in conferences as provided in paragraph 3.1.

3. If there is no OWNER Default, the Surety's obligation under this Bond shall arise after:

3.1. The OWNER has notified the CONTRACTOR and the Surety at the addresses described in paragraph 10 below, that the OWNER is considering declaring a CONTRACTOR Default and has requested and attempted to arrange a conference with the CONTRACTOR and the Surety to be held not later than fifteen days after receipt of such notice to discuss methods of performing the Contract. If the OWNER, the CONTRACTOR and the Surety agree, the CONTRACTOR shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive the OWNER's right, if any, subsequently to declare a CONTRACTOR Default; and

3.2. The OWNER has declared a CONTRACTOR Default and formally terminated the CONTRACTOR's right to complete the Contract. Such CONTRACTOR Default shall not be declared earlier than twenty days after the CONTRACTOR and the Surety have received notice as provided in paragraph 3.1; and

3.3. The OWNER has agreed to pay the Balance of the Contract Price to:

3.3.1. The Surety in accordance with the terms of the Contract;

3.3.2 Another contractor selected pursuant to paragraph 4.3 to perform the Contract.

4. When the OWNER has satisfied the conditions of paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

4.1. Arrange for the CONTRACTOR, with consent of the OWNER, to perform and complete the Contract; or

4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the OWNER, for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by the OWNER and the CONTRACTOR selected with the OWNER's concurrence, to be executed with performance and payment bonds executed by a qualified surety equivalent to the Bonds issued on the Contract, and pay to the OWNER the amount of damages as described in paragraph 5 in excess of the Balance of the Contract Price incurred by the OWNER resulting from the CONTRACTOR Default; or

4.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances;

4.4.1 After investigation, determine the amount for which it may be liable to the OWNER and, as soon as practicable after the amount is determined, tender payment therefor to the OWNER; or

4.4.2 Deny liability in whole or in part and notify the OWNER citing reasons therefor.

5. If the Surety does not proceed as provided in paragraph 4 with reasonable promptness, the Surety shall be deemed to be in default on this Bond fifteen days after receipt of an additional written notice from the OWNER to the Surety demanding that the Surety perform its obligations under this Bond, and the OWNER shall be entitled to enforce any remedy available to the OWNER. If the Surety proceeds as provided in paragraph 4, and the OWNER refuses the payment tendered or the Surety has denied liability, in whole or in part, without further notice the OWNER shall be entitled to enforce any remedy available to the OWNER.

6. After the OWNER has terminated the CONTRACTOR's right to complete the Contract, and if the Surety elects to act under paragraph 4.1, 4.2, or 4.3 above, then the responsibilities of the Surety to the OWNER shall not be greater than those of the CONTRACTOR under the Contract, and the responsibilities of the OWNER to the Surety shall not be greater than those of the OWNER under the Contract. To a limit of the amount of this Bond, but subject to commitment by the OWNER of the Balance of the Contract Price to mitigation of costs and damages on the Contract, the Surety is obligated without duplication for:

6.1. The responsibilities of the CONTRACTOR for correction of defective Work and completion of the Contract;

6.2. Additional legal, design professional and delay costs resulting from the CONTRACTOR's Default, and resulting from the actions or failure to act of the Surety under paragraph 4; and

6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of the CONTRACTOR.

7. The Surety shall not be liable to the OWNER or others for obligations of the CONTRACTOR that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the OWNER or its heirs, executors, administrators, or successors.

8. The Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders and other obligations.

9. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located and shall be instituted within two years after CONTRACTOR Default or within two years after the CONTRACTOR ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to the Surety, the OWNER or the CONTRACTOR shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the Contract was performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted here from and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12. Definitions.

12.1 Balance of the Contract Price: The total amount payable by the OWNER to the CONTRACTOR under the Contract after all proper adjustments have been made, including allowance to the CONTRACTOR of any amounts received or to be received by the OWNER in settlement of Insurance or other Claims for damages to which the CONTRACTOR is entitled, reduced by all valid and proper payments made to or on behalf of the CONTRACTOR under the Contract.

12.2 Contract: The agreement between the OWNER and the CONTRACTOR identified on the signature page, including all Contract Documents and changes thereto.

12.3 CONTRACTOR Default: Failure of the CONTRACTOR, which has neither been remedied nor waived, to perform or otherwise comply with the terms of the Contract.

12.4 OWNER Default: Failure of the OWNER, which has neither been remedied nor waived, to pay the CONTRACTOR as required by the Contract or to perform and complete or comply with the other terms thereof.
Payment Bond

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address): 

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):

CONTRACT
Date:
Amount:
Description (Name and Location):

BOND
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Payment Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL
Company: 
(Corp. Seal) 
Signature: 
Name and Title:

SURETY
Company: 
(Corp. Seal) 
Signature: 
Name and Title: 
(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

CONTRACTOR AS PRINCIPAL
Company: 
(Corp. Seal) 
Signature: 
Name and Title:

SURETY
Company: 
(Corp. Seal) 
Signature: 
Name and Title:

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, the American Institute of Architects, the American Subcontractors Association, and the Associated Specialty Contractors.

PAB-1
1. The CONTRACTOR and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the OWNER to pay for labor, materials and equipment furnished for use in the performance of the Contract, which is incorporated herein by reference.

2. With respect to the OWNER, this obligation shall be null and void if the CONTRACTOR:

2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and

2.2. Defends, indemnifies and holds harmless the OWNER from all claims, demands, liens or suits by any person or entity who furnished labor, materials or equipment for use in the performance of the Contract, provided the OWNER has promptly notified the CONTRACTOR and the Surety (at the addresses described in paragraph 12) of any claims, demands, liens or suits and tendered defense of such claims, demands, liens or suits to the CONTRACTOR and the Surety, and provided there is no OWNER Default.

3. With respect to Claimants, this obligation shall be null and void if the CONTRACTOR promptly makes payment, directly or indirectly, for all sums due.

4. The Surety shall have no obligation to Claimants under this Bond until:

4.1. Claimants who are employed by or have a direct contract with the CONTRACTOR have given notice to the Surety (at the addresses described in paragraph 12) and sent a copy, or notice thereof, to the OWNER, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

4.2. Claimants who do not have a direct contract with the CONTRACTOR:

1. Have furnished written notice to the CONTRACTOR and sent a copy, or notice thereof, to the OWNER, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stated, with substantial accuracy, the amount of the claim and the name of the party to whom the materials were furnished or supplied or for whom the labor was done or performed; and

2. Have either received a rejection in whole or in part from the CONTRACTOR, or not received within 30 days of furnishing the above notice any communication from the CONTRACTOR by which the CONTRACTOR had indicated the claim will be paid directly or indirectly; and

3. Not having been paid within the above 30 days, have sent a written notice to the Surety and sent a copy, or notice thereof, to the OWNER, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to the CONTRACTOR.

5. If a notice required by paragraph 4 is given by the OWNER to the CONTRACTOR or to the Surety, that is sufficient compliance.

6. When the Claimant has satisfied the conditions of paragraph 4, the Surety shall promptly and at the Surety's expense take the following actions:

6.1. Send an answer to the Claimant, with a copy to the OWNER, within 45 days after receipt of the claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed.

6.2. Pay or arrange for payment of any undisputed amounts.

7. The Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by the Surety.

8. Amounts owed by the OWNER to the CONTRACTOR under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any Performance Bond. By the CONTRACTOR furnishing and the OWNER accepting this Bond, they agree that all funds earned by the CONTRACTOR in the performance of the Contract are dedicated to satisfy obligations of the CONTRACTOR and the Surety under this Bond, subject to the OWNER's priority to use the funds for the completion of the Work.

9. The Surety shall not be liable to the OWNER, Claimants or others for obligations of the CONTRACTOR that are unrelated to the Contract. The OWNER shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. The Surety hereby waives notice of any change, including changes of time, to the Contract or to related Subcontracts, purchase orders and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by paragraph 4.1 or paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to the Surety, the OWNER or the CONTRACTOR shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by the Surety, the OWNER or the CONTRACTOR, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statute or other legal requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statute or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is, that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, the CONTRACTOR shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. DEFINITIONS

15.1. Claimant: An individual or entity having a direct contract with the CONTRACTOR or with a Subcontractor of the CONTRACTOR to furnish labor, materials or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of the CONTRACTOR and the CONTRACTOR's Subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials or equipment were furnished.

15.2. Contract: The agreement between the OWNER and the CONTRACTOR identified on the signature page, including all Contract Documents and changes thereto.

15.3. OWNER Default: Failure of the OWNER, which has neither been remedied nor waived, to pay the CONTRACTOR as required by the Contract or to perform and complete or comply with the other terms thereof.

(FOR INFORMATION ONLY--Name, Address and Telephone)

AGENCY or BROKER: OWNER'S REPRESENTATIVE (Engineer or other party):
<table>
<thead>
<tr>
<th>Article or Paragraph Number</th>
<th>Article or Paragraph Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptance of Insurance</td>
<td>...................................................... 5.15</td>
</tr>
<tr>
<td>Access to Work</td>
<td>...................................................... 13.2</td>
</tr>
<tr>
<td>Addenda--definition of (see definition of Specifications)</td>
<td>1</td>
</tr>
<tr>
<td>Agreement--definition of</td>
<td>...................................................... 1</td>
</tr>
<tr>
<td>Application for Final Payment</td>
<td>................................................. 14.12</td>
</tr>
<tr>
<td>Application for Partial Payment</td>
<td>............................................. 14.2</td>
</tr>
<tr>
<td>Authorized Variations in Work</td>
<td>.................................................... 9.5</td>
</tr>
<tr>
<td>Availability of Lands</td>
<td>...................................................... 4.1</td>
</tr>
<tr>
<td>Award, Notice of--definition of</td>
<td>.................................................. 1</td>
</tr>
<tr>
<td>Before Starting Construction</td>
<td>................................................... 2.5-2.7</td>
</tr>
<tr>
<td>Bid--definition of</td>
<td>...................................................... 1</td>
</tr>
<tr>
<td>Bonds and Insurance--in general</td>
<td>.................................................. 5</td>
</tr>
<tr>
<td>Bonds--definition of</td>
<td>...................................................... 1</td>
</tr>
<tr>
<td>Bonds, Delivery of</td>
<td>................................................... 2.1, 5.1</td>
</tr>
<tr>
<td>Bonds, Performance and Other</td>
<td>.................................................. 5.1-5.2</td>
</tr>
<tr>
<td>Change Order--definition of</td>
<td>...................................................... 1</td>
</tr>
<tr>
<td>Change Orders--to be executed</td>
<td>.................................................. 10.4</td>
</tr>
<tr>
<td>Changes in the Work</td>
<td>...................................................... 10</td>
</tr>
<tr>
<td>Claims, Waiver of--on Final Payment</td>
<td>14.16</td>
</tr>
<tr>
<td>Clarifications and Interpretations</td>
<td>............................................ 9.4</td>
</tr>
<tr>
<td>Cleaning</td>
<td>...................................................... 6.16</td>
</tr>
<tr>
<td>Completion</td>
<td>...................................................... 14</td>
</tr>
<tr>
<td>Completion, Substantial</td>
<td>..................................................... 14.8-14.9</td>
</tr>
<tr>
<td>Conference, Preconstruction</td>
<td>.................................................... 2.8</td>
</tr>
<tr>
<td>Conflict, Error, Discrepancy--Contractor to Report</td>
<td>2.5, 3.3</td>
</tr>
<tr>
<td>Construction Machinery, Equipment, etc</td>
<td>............................................. 6.4</td>
</tr>
<tr>
<td>Construction Project Manager--definition of</td>
<td>1</td>
</tr>
<tr>
<td>Construction Project Manager--provision for</td>
<td>.............................................. 9.3</td>
</tr>
<tr>
<td>Continuing the Work</td>
<td>...................................................... 6.28</td>
</tr>
<tr>
<td>Contract Documents--amending and supplementing</td>
<td>.............................................. 3.5</td>
</tr>
<tr>
<td>Contract Documents--definition of</td>
<td>.................................................. 1</td>
</tr>
<tr>
<td>Contract Documents--Intent</td>
<td>..................................................... 3.1-3.3</td>
</tr>
<tr>
<td>Contract Documents--Reuse of</td>
<td>.................................................... 3.6</td>
</tr>
<tr>
<td>Contract Price, Change of</td>
<td>...................................................... 11</td>
</tr>
<tr>
<td>Contract Price--definition of</td>
<td>.................................................. 1</td>
</tr>
<tr>
<td>Contract Times, Change of</td>
<td>...................................................... 12</td>
</tr>
<tr>
<td>Contract Times, Commencement of</td>
<td>................................................ 2.3</td>
</tr>
<tr>
<td>Contract Times--definition of</td>
<td>.................................................. 1</td>
</tr>
<tr>
<td>Contractor--definition of</td>
<td>...................................................... 1</td>
</tr>
<tr>
<td>Contractor May Stop Work or Terminate</td>
<td>.............................................. 15.4</td>
</tr>
<tr>
<td>Contractor's Continuing Obligation</td>
<td>............................................ 14.15</td>
</tr>
<tr>
<td>Contractor's Duty to Report Discrepancy in Document</td>
<td>2.5, 3.3</td>
</tr>
<tr>
<td>Contractor's Fee--Cost Plus</td>
<td>.................................................. 11.4.5.6, 11.5.1, 11.6-11.7</td>
</tr>
<tr>
<td>Contractor's Liability Insurance</td>
<td>.................................................. 5.3</td>
</tr>
<tr>
<td>Contractor's Responsibilities--in general</td>
<td>................................................ 6</td>
</tr>
<tr>
<td>Contractor's Warranty of Title</td>
<td>.................................................. 14.7</td>
</tr>
<tr>
<td>Contractors--other</td>
<td>...................................................... 7</td>
</tr>
<tr>
<td>Contractual Liability Insurance</td>
<td>.................................................. 5.4</td>
</tr>
<tr>
<td>Coordination</td>
<td>...................................................... 7.4</td>
</tr>
<tr>
<td>Copies of Documents</td>
<td>...................................................... 2.2</td>
</tr>
<tr>
<td>Correction or Removal of Defective Work</td>
<td>............................................. 13.10</td>
</tr>
<tr>
<td>Correction Period, One Year</td>
<td>..................................................... 13.11</td>
</tr>
<tr>
<td>Correction, Removal or Acceptance of Defective Work--in general</td>
<td>13.10-13.13</td>
</tr>
<tr>
<td>Cost of the Work</td>
<td>..................................................... 11.4.11.5</td>
</tr>
<tr>
<td>Costs, Supplemental</td>
<td>..................................................... 11.4.5</td>
</tr>
<tr>
<td>Day--definition of</td>
<td>..................................................... 1, 17.2.2</td>
</tr>
<tr>
<td>Defective--definition of</td>
<td>...................................................... 1</td>
</tr>
<tr>
<td>Defective Work, Acceptance of</td>
<td>.................................................. 13.12</td>
</tr>
<tr>
<td>Defective Work, Correction or Removal of</td>
<td>.............................................. 13.10</td>
</tr>
<tr>
<td>Defective Work--in general</td>
<td>..................................................... 13, 14.11</td>
</tr>
<tr>
<td>Defective Work, Rejecting</td>
<td>...................................................... 9.6</td>
</tr>
<tr>
<td>Definitions</td>
<td>...................................................... 1</td>
</tr>
<tr>
<td>Delivery of Bonds</td>
<td>...................................................... 2.1</td>
</tr>
<tr>
<td>Determinations for Unit Prices</td>
<td>.................................................. 9.10</td>
</tr>
<tr>
<td>Disputes</td>
<td>...................................................... 16</td>
</tr>
<tr>
<td>Documents, Copies of</td>
<td>...................................................... 2.2</td>
</tr>
<tr>
<td>Documents, Record</td>
<td>...................................................... 6.18</td>
</tr>
<tr>
<td>Documents, Reuse</td>
<td>...................................................... 3.6</td>
</tr>
<tr>
<td>Drawings--definition of</td>
<td>...................................................... 1</td>
</tr>
<tr>
<td>Article or Paragraph Number</td>
<td>Article or Paragraph Number</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Easements</td>
<td>..4.1</td>
</tr>
<tr>
<td>Effective date of Agreement--definition of</td>
<td>..1</td>
</tr>
<tr>
<td>Electrical Power for Construction Purposes</td>
<td>..17.8</td>
</tr>
<tr>
<td>Emergencies</td>
<td>..6.22</td>
</tr>
<tr>
<td>Engineer--definition of</td>
<td>..9.11-9.14</td>
</tr>
<tr>
<td>Engineer's Status During Construction-- in general</td>
<td>..9</td>
</tr>
<tr>
<td>Engineer's Responsibilities, Limitations on</td>
<td>..9.11-9.14</td>
</tr>
<tr>
<td>Engineer's--Notice Work is Acceptable</td>
<td>..14.13</td>
</tr>
<tr>
<td>Engineer's Recommendation of Payment</td>
<td>..14.4, 14.13</td>
</tr>
<tr>
<td>Engineer's Responsibilities, Limitations on</td>
<td>..9.11-9.14</td>
</tr>
<tr>
<td>Equipment, Labor, Materials and</td>
<td>..6.3-6.5</td>
</tr>
<tr>
<td>Equal Employment Opportunities</td>
<td>..17.3</td>
</tr>
<tr>
<td>Equivalent of Materials and Equipment</td>
<td>..6.7</td>
</tr>
<tr>
<td>Explorations of Physical Conditions</td>
<td>..4.2</td>
</tr>
<tr>
<td>Fee, Contractor's--Costs Plus</td>
<td>..11.6</td>
</tr>
<tr>
<td>Field Order--definition of</td>
<td>..1</td>
</tr>
<tr>
<td>Field Order--issued by Engineer</td>
<td>..3.5.1, 9.5</td>
</tr>
<tr>
<td>Final Application for Payment</td>
<td>..14.12</td>
</tr>
<tr>
<td>Final Inspection</td>
<td>..14.11</td>
</tr>
<tr>
<td>Final Payment and Acceptance</td>
<td>..14.13</td>
</tr>
<tr>
<td>Final Payment, Recommendation of</td>
<td>..14.13-14.14</td>
</tr>
<tr>
<td>Gaseous Hazards and Confined Spaces</td>
<td>..17.5</td>
</tr>
<tr>
<td>Giving Notice</td>
<td>..17.1</td>
</tr>
<tr>
<td>Hazardous Communications Programs</td>
<td>..6.21</td>
</tr>
<tr>
<td>Hazardous Substances--definition of</td>
<td>..1</td>
</tr>
<tr>
<td>Hazardous Substances OWNER's Responsibility</td>
<td>..4.5</td>
</tr>
<tr>
<td>Hierarchical Tiers</td>
<td>..11.8</td>
</tr>
<tr>
<td>Horizontal and Vertical Control Points</td>
<td>..4.4</td>
</tr>
<tr>
<td>Indemnification</td>
<td>..6.30-6.32</td>
</tr>
<tr>
<td>Inspection, Final</td>
<td>..14.11</td>
</tr>
<tr>
<td>Inspection, Tests and</td>
<td>..13.3-13.6</td>
</tr>
<tr>
<td>Insurance, Bonds and--in general</td>
<td>..5</td>
</tr>
<tr>
<td>Insurance, Certificates of</td>
<td>..2.7, 5</td>
</tr>
<tr>
<td>Insurance--Completed Operations</td>
<td>..5.3</td>
</tr>
<tr>
<td>Insurance, Contractor's Liability</td>
<td>..5.3</td>
</tr>
<tr>
<td>Insurance, Contractual Liability</td>
<td>..5.4</td>
</tr>
<tr>
<td>Insurance, Property</td>
<td>..5.7</td>
</tr>
<tr>
<td>Insurance--Waiver of Rights</td>
<td>..5.12</td>
</tr>
<tr>
<td>Interpretations and Clarifications</td>
<td>..9.4</td>
</tr>
<tr>
<td>Investigations of Physical Conditions</td>
<td>..4.2</td>
</tr>
<tr>
<td>Labor, Material and Equipment</td>
<td>..6.3-6.5</td>
</tr>
<tr>
<td>Laws and Regulations--definition of</td>
<td>..1</td>
</tr>
<tr>
<td>Laws and Regulations--general</td>
<td>..6.13</td>
</tr>
<tr>
<td>Liability Insurance--Contractor's</td>
<td>..5.3</td>
</tr>
<tr>
<td>Limitation on Engineer's Responsibilities</td>
<td>..9.11-9.14</td>
</tr>
<tr>
<td>Materials and Equipment--furnished by Contractor</td>
<td>..6.3</td>
</tr>
<tr>
<td>Materials and Equipment--not incorporated in Work</td>
<td>..14.2.1</td>
</tr>
<tr>
<td>Materials or Equipment--equivalent</td>
<td>..6.7</td>
</tr>
<tr>
<td>Miscellaneous Provisions</td>
<td>..17</td>
</tr>
<tr>
<td>Multi--prime Contracts</td>
<td>..7</td>
</tr>
<tr>
<td>Notice, Giving of</td>
<td>..17.1</td>
</tr>
<tr>
<td>Notice of Acceptability of Project</td>
<td>..14.13</td>
</tr>
<tr>
<td>Notice of Award--definition of</td>
<td>..1</td>
</tr>
<tr>
<td>Notice to Proceed--definition of</td>
<td>..1</td>
</tr>
<tr>
<td>Notice to Proceed--giving of</td>
<td>..2.3</td>
</tr>
<tr>
<td>&quot;Or-Equal&quot; Items</td>
<td>..6.7</td>
</tr>
<tr>
<td>Other Contractors</td>
<td>..7</td>
</tr>
<tr>
<td>Other Work</td>
<td>..7</td>
</tr>
<tr>
<td>Overtime Work</td>
<td>..6.3</td>
</tr>
<tr>
<td>Owner--definition of</td>
<td>..1</td>
</tr>
<tr>
<td>Owner May Correct Defective Work</td>
<td>..13.13</td>
</tr>
<tr>
<td>Owner May Stop Work</td>
<td>..13.9</td>
</tr>
<tr>
<td>Owner May Suspend Work, Terminate</td>
<td>..15.1-15.4</td>
</tr>
<tr>
<td>Owner's Execution of Change Orders</td>
<td>..12.1</td>
</tr>
</tbody>
</table>
INDEX TO GENERAL CONDITIONS
(REVISED 04/09)

<table>
<thead>
<tr>
<th>Article or Paragraph Number</th>
<th>Article or Paragraph Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner's Representative--Engineer to serve as</td>
<td>9.1</td>
</tr>
<tr>
<td>Owner's Responsibilities--in general</td>
<td>8</td>
</tr>
<tr>
<td>Owner's Separate Representative at site</td>
<td>9.3</td>
</tr>
<tr>
<td>Partial Utilization</td>
<td>14.10</td>
</tr>
<tr>
<td>Partial Utilization--definition of</td>
<td>1</td>
</tr>
<tr>
<td>Partial Utilization--Property Insurance</td>
<td>5.16</td>
</tr>
<tr>
<td>Patent Fees and Royalties</td>
<td>6.11</td>
</tr>
<tr>
<td>Payments, Recommendations of</td>
<td>14.3-14.5, 14.13</td>
</tr>
<tr>
<td>Payments to Contractor--in general</td>
<td>14</td>
</tr>
<tr>
<td>Performance and Other Bonds</td>
<td>5.1-5.2</td>
</tr>
<tr>
<td>Permits and Licenses</td>
<td>6.12</td>
</tr>
<tr>
<td>Physical Conditions</td>
<td>4.2</td>
</tr>
<tr>
<td>Physical Conditions--Engineer's review</td>
<td>4.2.4</td>
</tr>
<tr>
<td>Physical Conditions--existing structures</td>
<td>4.2.1.2</td>
</tr>
<tr>
<td>Physical Conditions--explorations and reports</td>
<td>4.2.1</td>
</tr>
<tr>
<td>Physical Conditions--possible document change</td>
<td>4.2.5</td>
</tr>
<tr>
<td>Physical Conditions--price and time adjustments</td>
<td>4.2.6</td>
</tr>
<tr>
<td>Physical Conditions--notice of differing</td>
<td>4.2.3</td>
</tr>
<tr>
<td>Physical Conditions--Underground Facilities</td>
<td>4.3</td>
</tr>
<tr>
<td>Preconstruction Conference</td>
<td>2.8</td>
</tr>
<tr>
<td>Preliminary Matters</td>
<td>2</td>
</tr>
<tr>
<td>Premises, Use of</td>
<td>6.15-6.17</td>
</tr>
<tr>
<td>Price, Change of Contract</td>
<td>11</td>
</tr>
<tr>
<td>Price, Contract--definition of</td>
<td>1</td>
</tr>
<tr>
<td>Progress Payment, Applications for</td>
<td>14.1-14.2</td>
</tr>
<tr>
<td>Progress Payment--retainage</td>
<td>14.6</td>
</tr>
<tr>
<td>Progress Schedule</td>
<td>2.6, 2.8-2.9, 6.6, 6.28, 15.2.6</td>
</tr>
<tr>
<td>Project--definition of</td>
<td>1</td>
</tr>
<tr>
<td>Project Representation--provision for</td>
<td>9.3</td>
</tr>
<tr>
<td>Project, Starting the</td>
<td>2.4</td>
</tr>
<tr>
<td>Property Insurance</td>
<td>5.7</td>
</tr>
<tr>
<td>Property Insurance--Partial Utilization</td>
<td>5.16</td>
</tr>
<tr>
<td>Property Insurance--Receipt and Application of Proceeds</td>
<td>5.13-5.14</td>
</tr>
<tr>
<td>Punch List</td>
<td>14.11</td>
</tr>
<tr>
<td>Recommendation of Payment</td>
<td>14.4, 14.13</td>
</tr>
<tr>
<td>Record Documents</td>
<td>6.18</td>
</tr>
<tr>
<td>Regulations, Laws and</td>
<td>6.13</td>
</tr>
<tr>
<td>Rejecting Defective Work</td>
<td>9.6</td>
</tr>
<tr>
<td>Related Work at Site</td>
<td>7.1-7.3</td>
</tr>
<tr>
<td>Remedies Not Exclusive</td>
<td>16.6</td>
</tr>
<tr>
<td>Removal or Correction of Defective Work</td>
<td>13.10</td>
</tr>
<tr>
<td>Responsibilities, Contractor's--</td>
<td>6</td>
</tr>
<tr>
<td>Responsibilities, Engineer's--</td>
<td>9</td>
</tr>
<tr>
<td>Responsibilities, Owner's--</td>
<td>8</td>
</tr>
<tr>
<td>Retainage</td>
<td>14.6</td>
</tr>
<tr>
<td>Reuse of Documents</td>
<td>3.6</td>
</tr>
<tr>
<td>Rights of Way</td>
<td>4.1</td>
</tr>
<tr>
<td>Royalties, Patent Fees and</td>
<td>6.11</td>
</tr>
<tr>
<td>Safety and Protection</td>
<td>6.19-6.20</td>
</tr>
<tr>
<td>Samples</td>
<td>6.23-6.27</td>
</tr>
<tr>
<td>Sanitary Conveniences</td>
<td>17.4</td>
</tr>
<tr>
<td>Schedule of Progress</td>
<td>2.6, 2.8-2.9, 6.6, 6.28, 15.2.6</td>
</tr>
<tr>
<td>Schedule of Shop Drawing submissions</td>
<td>2.6, 6.23</td>
</tr>
<tr>
<td>Schedule of Values</td>
<td>2.6, 2.9, 14.1</td>
</tr>
<tr>
<td>Schedules, Finalizing</td>
<td>2.9</td>
</tr>
<tr>
<td>Shop Drawings and Samples</td>
<td>6.3-6.7</td>
</tr>
<tr>
<td>Shop Drawings--definition of</td>
<td>1</td>
</tr>
<tr>
<td>Site, Visits to--by Engineer</td>
<td>9.2</td>
</tr>
<tr>
<td>Specifications--definition of</td>
<td>1</td>
</tr>
<tr>
<td>Starting Construction, Before</td>
<td>2.5-2.7</td>
</tr>
<tr>
<td>Starting the Project</td>
<td>2.4</td>
</tr>
<tr>
<td>Stopping Work--by Contractor</td>
<td>15.4</td>
</tr>
<tr>
<td>Stopping Work--by Owner</td>
<td>13.09, 15</td>
</tr>
<tr>
<td>Subcontractor--definition of</td>
<td>1</td>
</tr>
<tr>
<td>Subcontractors--in general</td>
<td>6.8-6.10</td>
</tr>
<tr>
<td>Subcontracts--required provisions</td>
<td>5.11, 6.10, 11.4.3</td>
</tr>
<tr>
<td><strong>INDEX TO GENERAL CONDITIONS</strong>&lt;br&gt;<strong>(REVISED 04/09)</strong>&lt;br&gt;Article or Paragraph Number</td>
<td>Article or Paragraph Number</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Substantial Completion ................................................................. 14.8-14.9</td>
<td>Unit Prices ........................................................................ 11.3.1</td>
</tr>
<tr>
<td>Substantial Completion--definition of ............................................... 1</td>
<td>Unit Prices, Determinations for ......................................... 9.10</td>
</tr>
<tr>
<td>Substitute or &quot;Or-Equal&quot; Items .................................................................... 6.7</td>
<td>Use of Premises .................................................................... 6.15-6.17</td>
</tr>
<tr>
<td>Subsurface Conditions ........................................................................... 4.2-4.3</td>
<td>Utility Owners ...................................................................... 6.12, 6.19, 7.2</td>
</tr>
<tr>
<td>Supplemental Costs ................................................................................... 11.4.5</td>
<td>Values, Schedule of ................................................................ 2.6, 2.9, 14.1</td>
</tr>
<tr>
<td>Supplementary Conditions--definition of ..................................... 1</td>
<td>Variations in Work--Authorized ........................................ 6.26, 9.5</td>
</tr>
<tr>
<td>Supplementary Conditions--principal references to ................................. 2.2, 5.3, 5.7, 6.23</td>
<td>Visits to Site--by Engineer ................................................. 9.2</td>
</tr>
<tr>
<td>Supplementing Contract Documents ..................................................... 3.5</td>
<td>Work Change Directive--definition of .................................... 1</td>
</tr>
<tr>
<td>Supplier--definition of ........................................................................... 1</td>
<td>Work Change Directive--principal references to ................................. 3.4.3, 10.1-10.2</td>
</tr>
<tr>
<td>Supplier--principal references to ............................................................ 3.6, 6.5, 6.7-6.9, 6.19, 6.24, 9.11, 9.14, 13.4, 14.12</td>
<td>Work, Neglected by Contractor ............................................... 13.13</td>
</tr>
<tr>
<td>Surety--Engineer has no duty to ............................................................. 9.11</td>
<td>Work, Stopping by Contractor ............................................... 15.4</td>
</tr>
<tr>
<td>Surety--Notice to .................................................................................... 10.1, 10.5, 15.2</td>
<td>Work, Stopping by Owner ...................................................... 15.1-15.3</td>
</tr>
<tr>
<td>Surety--Qualification of ........................................................................ 5.1-5.2</td>
<td>Work, Stopping by Owner ...................................................... 15.1-15.3</td>
</tr>
<tr>
<td>Suspending Work, by Owner ................................................................. 15.1</td>
<td>Written Amendment--definition of ............................................. 1</td>
</tr>
<tr>
<td>Suspension of Work and Termination-- in general .................................... 15</td>
<td>Written Amendment--principal references to ................................ 3.4.1, 10.1, 11.2, 12.1</td>
</tr>
<tr>
<td>Superintendent--Contractor's ................................................................. 6.2</td>
<td></td>
</tr>
<tr>
<td>Supervision and Superintendence ......................................................... 6.1-6.2</td>
<td></td>
</tr>
<tr>
<td>Taxes--Payment by Contractor .............................................................. 6.14</td>
<td></td>
</tr>
<tr>
<td>Termination--by Contractor ................................................................. 15.4</td>
<td></td>
</tr>
<tr>
<td>Termination--by Owner ........................................................................ 15.2-15.3</td>
<td></td>
</tr>
<tr>
<td>Termination, Suspension of Work and-- in general .................................. 15</td>
<td></td>
</tr>
<tr>
<td>Tests and Inspections ............................................................................ 13.3-13.6</td>
<td></td>
</tr>
<tr>
<td>Times, Change of Contract ................................................................. 12</td>
<td></td>
</tr>
<tr>
<td>Time, Computation of ............................................................................ 17.2</td>
<td></td>
</tr>
<tr>
<td>Times, Contract--definition of ............................................................. 1</td>
<td></td>
</tr>
<tr>
<td>Uncovering Work .................................................................................. 13.7-13.8</td>
<td></td>
</tr>
<tr>
<td>Underground Facilities--definition of ................................................. 1</td>
<td></td>
</tr>
<tr>
<td>Underground Facilities--not shown or indicated .................................. 4.3.2</td>
<td></td>
</tr>
<tr>
<td>Underground Facilities--protection of .................................................. 4.3, 6.19</td>
<td></td>
</tr>
<tr>
<td>Underground Facilities--shown or indicated ......................................... 4.3.1</td>
<td></td>
</tr>
<tr>
<td>Underground Utility Service Lines ....................................................... 4.3.2</td>
<td></td>
</tr>
<tr>
<td>Unit Price Work--definition of ............................................................ 1</td>
<td></td>
</tr>
<tr>
<td>Unit Price Work--general .................................................................... 11.9, 14.1, 14.3</td>
<td></td>
</tr>
</tbody>
</table>
ARTICLE 1--DEFINITIONS

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

Addenda--Written or graphic instruments issued prior to the opening of Bids, which clarify, correct or change the Bidding Documents or the Contract Documents.

Agreement--The written Agreement between OWNER and CONTRACTOR covering the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein. Has the same meaning as "Contract."

Asbestos--Any material that contains more than one percent Asbestos and is friable or is releasing fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

Bid--The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

Bidder--Any person, firm or corporation submitting a Bid for the Work.

Bidding Documents--The Invitation to Bid, Instructions to Bidders, the Bid Form, and proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

Bidding Requirements--The Invitation to Bid, Instructions to Bidders, and the Bid Form.

Board--Has the same meaning as "OWNER."

Bonds--Bid, performance and payment bonds and other instruments of security.

Change Order--An agreement between OWNER and CONTRACTOR that authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Times or Contract Price, which is issued on or after the Effective Date of the Agreement.

Claim--A written demand for payment of money, extension of time, or other relief allowed by this Contract.

Construction Project Manager--The authorized representative of ENGINEER who is assigned to the site or any part thereof to observe the Work and to perform certain other obligations of ENGINEER.

Contract--Has the same meaning as "Agreement."

Contract Documents--The Agreement, Addenda, CONTRACTOR's Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, Notice to Proceed, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications and the Drawings identified as "Contract Documents" in the Agreement, together with all Written Amendments, modifications and supplements incorporated into a Change Order on or after the Effective Date of the Agreement, and any other documents that are designated "Contract Documents" by OWNER. No one part of the Contract Documents shall constitute the Contract or Agreement, but the whole taken together shall be the Agreement between the parties.

Contract Price--The moneys payable by OWNER to CONTRACTOR for completion of the Work in accordance with the Contract Documents as stated in the Agreement.

Contract Times--The number of days (computed as provided in Paragraph 17.2.) or the dates stated in the Agreement for the completion of the Work.
CONTRACTOR--The person, firm or corporation with whom OWNER has entered into the Agreement to perform the Work.

Day--Calendar day.

Defective--An adjective that when modifying the word Work refers to Work that is unsatisfactory, faulty or deficient, does not conform to the Contract Documents, does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to final payment (unless responsibility for the protection thereof has been assumed by OWNER in accordance with this Agreement).

Denver Water--The property and personnel under control of the City and County of Denver, acting by and through its Board of Water Commissioners.

Director of Engineering--The person so designated by Denver Water to lead its Division of Engineering and Construction.

Drawings--The Drawings that show the scope, extent and character of the Work to be furnished and performed by CONTRACTOR, which have been prepared or approved by ENGINEER and are referred to in the Contract Documents. Shop Drawings are not Drawings as so defined.

Effective Date of the Agreement--The date indicated in the Agreement on which it becomes effective, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

ENGINEER--The Director of Engineering or his authorized representative.

Field Order--A written order issued by ENGINEER that orders minor changes in the Work in accordance with Paragraph 9.5. but does not involve a change in the Contract Price or the Contract Times.

Hazardous Substances--Hazardous Substances shall mean all Hazardous Substances, Hazardous Materials and Hazardous Wastes as defined by the U.S. Occupational Health and Safety Administration (OSHA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and shall include, but not be limited to, Asbestos, PCBs, Petroleum, Hazardous Waste and Radioactive Material.

Hazardous Waste--The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903).

Laws or Regulations--Any and all applicable laws, rules, regulations, ordinances, codes and orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction.

Milestone--A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

Notice of Award--The written notice by OWNER to the apparent successful Bidder stating that upon compliance by the apparent Successful Bidder with the conditions precedent enumerated therein, within the time specified, OWNER will sign and deliver the Agreement.

Notice to Proceed--A written notice given by OWNER to CONTRACTOR fixing the date on which the Contract Times will commence to run and on which CONTRACTOR shall start to perform CONTRACTOR's obligations under the Contract Documents.
OWNER--The Board of Water Commissioners of the City and County of Denver, which is formally designated as the City and County of Denver, a municipal corporation of the State of Colorado, acting by and through its Board of Water Commissioners, and which is sometimes also referred to as "Board" or "Denver Water."

OWNER's Consultant--The person, firm or corporation retained by OWNER to provide engineering services as OWNER's independent professional associate or consultant for the Work.

Partial Utilization--Use by OWNER of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion for all the Work.

PCBs--Polychlorinated biphenyls.

Petroleum--Petroleum, including crude oil or any fraction thereof that is liquid at standard conditions of temperature and pressure [60 degrees Fahrenheit (15.6 degrees Celsius) and 14.7 pounds per square inch absolute (100 kilo Pascals)], such as oil, Petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene and oil mixed with other non-Hazardous Wastes and crude oils.

Plans--When used in Contract Documents, shall have the same meaning as "Drawings."

Project--The total construction of the Work to be provided under the Contract Documents or a part of the Work as indicated elsewhere in the Contract Documents.

Radioactive Material--Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) and as regulated by the Colorado Department of Public Health and Environment.

Samples--Physical examples of materials, equipment or workmanship that are representative of some portion of the Work and establish standards by which such portion of the Work will be judged.

Shop Drawings--All drawings, diagrams, illustrations, schedules and other data or information that are specifically prepared or assembled by or for CONTRACTOR and submitted by CONTRACTOR to illustrate some portion of the Work.

Specifications--Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

Subcontractor--An individual, firm or corporation having a contract with CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the site.

Submittals--Shop Drawings, Samples, drafts, information, manuals, warranties, documents and the like furnished to ENGINEER by CONTRACTOR or Supplier through CONTRACTOR as required by the Contract Documents.

Substantial Completion--The Work (or a specified part thereof) has progressed to the point that it can be utilized for the purposes for which it is intended, as further specified in Article 14. The terms "substantially complete" and "substantially completed" as applied to any Work refer to Substantial Completion thereof. A certificate of occupancy alone is not evidence of Substantial Completion.

Supplementary Conditions--The part of the Contract Documents that amends or supplements these General Conditions.

Supplier--A manufacturer, fabricator, supplier, distributor, materialman or vendor having a contract with CONTRACTOR or any Subcontractor to furnish materials or equipment to be incorporated in the Work by CONTRACTOR or any Subcontractor.
SURETY--A corporate entity authorized to do business in the State of Colorado, which executes as Surety thereon any Bond filed with the OWNER pursuant to these Contract Documents by Bidder or CONTRACTOR.

Underground Facilities--All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities that have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems, or water.

Unit Price Work--Work to be paid for on the basis of unit prices.

Work--The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing services, furnishing labor, furnishing and incorporating materials and equipment into the construction, performing or furnishing services, and furnishing documents, all as required by the Contract Documents.

Work Change Directive--A written directive to CONTRACTOR, issued on or after the Effective Date of the Agreement and signed by the Construction Project Manager, ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen physical conditions under which the Work is to be performed as provided in the Agreement or responding to emergencies under the Agreement. A Work Change Directive may not change the Contract Price or the Contract Times, but it is evidence that the parties expect that the change directed or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times as provided in the Agreement.

Written Amendment--A change to the Contract Documents that is signed by OWNER and CONTRACTOR on or after the Effective Date of the Agreement and normally addresses non-engineering or non-technical rather than strictly Work-related aspects of the Contract Documents. A Written Amendment may also add Work to the scope of the Contract.

ARTICLE 2--PRELIMINARY MATTERS

Delivery of Bonds:

2.1. When CONTRACTOR delivers the executed Agreements to the ENGINEER, CONTRACTOR shall also deliver to ENGINEER such Bonds and Certificates of Insurance as CONTRACTOR may be required to furnish in accordance with Article 5.

Copies of Documents:

2.2. The ENGINEER shall furnish to CONTRACTOR up to ten (10) copies (unless otherwise specified in the Supplementary Conditions) of the Contract Documents as are reasonably necessary for the execution of the Work. Additional copies will be furnished, upon request, at the cost of reproduction.

Commencement of Contract Times; Notice to Proceed:

2.3. The Contract Times will commence on the Day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within forty-five (45) days after the Effective Date of the Agreement.
Starting the Project:

2.4. CONTRACTOR shall start to perform the Work on the date when the Contract Times commence, but no Work shall be done at the site prior to the date on which the Contract Times commence. CONTRACTOR shall perform the Work in accordance with Contract Documents that are “Conformed” and Drawings that are marked “Final for Construction” only.

Before Starting Construction:

2.5. Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents, and check and verify pertinent figures shown thereon and all applicable field measurements. CONTRACTOR shall within seven (7) days report in writing to the Construction Project Manager any conflict, error or discrepancy that CONTRACTOR may discover and shall obtain a written interpretation or clarification from the Construction Project Manager before proceeding with any Work affected thereby; however, CONTRACTOR shall not be liable to OWNER for failure to report any conflict, error or discrepancy in the Contract Documents, unless CONTRACTOR had actual knowledge thereof or should reasonably have known thereof.

2.6. Within ten (10) days after the date of the Notice to Proceed to commence the Work, CONTRACTOR shall submit to the Construction Project Manager for review:

2.6.1. A progress schedule, including the critical path schedule, indicating the times (number of days or dates) for starting and completing the various stages of the Work, including Milestones specified in the Contract Documents;

2.6.2. A schedule of Shop Drawings, O&M Manuals, Spare Parts, and Sample Submittals that will list each required Submittal and the times for submitting, reviewing and processing such Submittal;

2.6.3. A schedule of values for all Work that will include quantities and prices of items aggregating the Contract Price and will subdivide the Work into component parts in sufficient detail to serve as the basis for progress payments and additions or deletions to the Work during construction. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.6.4 A preliminary cost sheet indicating predicted change order pricing including labor rates and burdens, equipment rates, markups, overhead and profit, insurance and bond costs.

2.7. Before the Notice to Proceed is issued, CONTRACTOR shall deliver to ENGINEER certificates (and other evidence of insurance requested by OWNER) that CONTRACTOR is required to purchase and maintain in accordance with Article 5.

Preconstruction Conference:

2.8. Before CONTRACTOR starts the Work at the site, a conference attended by CONTRACTOR, the Construction Project Manager, ENGINEER and others considered appropriate by the parties will be held to discuss the schedules referred to in Paragraph 2.6., to discuss procedures for handling Shop Drawings and other Submittals and for processing Applications for Payment, and to establish a working understanding between the parties as to the Work.
Finalizing Schedules:

2.9. At least 10 days before submission of the first Partial Payment Application, a conference attended by CONTRACTOR, ENGINEER and others as appropriate will be held to finalize the schedules submitted in accordance with Paragraph 2.6. The finalized progress schedule shall provide an orderly progression of the Work to completion within the Contract Times, but ENGINEER’S review of the schedule will neither impose on ENGINEER responsibility for the progress or scheduling of the Work nor relieve CONTRACTOR from any responsibility therefor. Such submittal of progress schedules by CONTRACTOR shall be a prerequisite for any extension of Contract Times pursuant to Article 12. The finalized schedule of Shop Drawing submissions shall provide a workable arrangement for processing the submissions. The finalized schedule of values shall be reasonably consistent with the Bidding Documents.

ARTICLE 3--CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

Intent:

3.1. The Contract Documents comprise the entire Agreement between OWNER and CONTRACTOR concerning the Work. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the laws of the State of Colorado. This Contract is and shall be deemed to be performable in the City and County of Denver, notwithstanding that the parties may find it necessary to take action in furtherance of or compliance with the Contract outside said City and County. Resolution of any and all disputes between OWNER and CONTRACTOR shall be by administrative hearing as set forth in Article 16 herein.

CONTRACTOR shall not utilize the Contract Documents for purposes unrelated to performing Work hereunder and shall not make the Contract Documents available to the general public including availability through CONTRACTOR’s promotional materials or web site. CONTRACTOR shall immediately inform OWNER if CONTRACTOR becomes aware that any of its subcontractors or employees has so disclosed any of the Contract Documents.

3.2. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work, materials or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be furnished and performed whether or not specifically stated. When words or phrases that have a well-known technical or construction industry or trade meaning are used to describe Work, materials or equipment, such words or phrases shall be interpreted in accordance with that meaning. Clarifications and interpretations of the Contract Documents shall be issued by ENGINEER as provided in Paragraph 9.4.

3.3. Reference to Standards and Specifications of Technical Societies: Reporting and Resolving Discrepancies:

3.3.1. Reference to standards, Specifications, manuals or codes of any technical society, organization or association, or to Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard, Specification, manual, code, or Law or Regulation in effect at the time of opening the Bids (or, on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

3.3.2. If, during the performance of the Work, CONTRACTOR discovers any conflict, error, ambiguity or discrepancy within the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any
such standard, Specification, manual or code or of any instruction of any Supplier referred to in Paragraph 6.5., CONTRACTOR shall report it to the Construction Project Manager in writing within 48 hours, and CONTRACTOR shall not proceed with the Work effected thereby (except in an emergency as authorized by Paragraph 6.22.) until a Written Amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.4. or 3.5.; provided, however, that CONTRACTOR shall not be liable to OWNER for failure to report any such conflict, error, ambiguity or discrepancy unless CONTRACTOR knew or reasonably should have known thereof.

3.3.3. Except as otherwise specifically stated in the Contract Documents or as may be provided by Written Amendment or supplement thereto issued by one of the methods indicated in Paragraph 3.4. or 3.5., the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the provisions of the Contract Documents and:

3.3.3.1. The provisions of any such standard, Specification, manual, code or instruction (whether or not specifically incorporated by reference in the Contract Documents), or

3.3.3.2. The provisions of any such Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Laws or Regulations).

No provision of any such standard, Specification, manual, code or instruction shall be effective to change the duties and responsibilities of OWNER, CONTRACTOR or ENGINEER, or any of their Subcontractors, consultants, agents, or employees, from those set forth in the Contract Documents, nor shall it be effective to assign to OWNER, ENGINEER or any of OWNER’s Consultants, agents or employees any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of Paragraph 9.13. or any other provision of the Contract Documents.

In the case of a conflict between the Specifications and Drawings, the Specifications shall govern. Figure dimensions on Drawings shall govern over scale dimensions, and detailed Drawings shall govern over general Drawings.

Amending and Supplementing Contract Documents:

3.4. The Contract Documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways:

3.4.1. A formal Written Amendment,

3.4.2. A Change Order (pursuant to Paragraph 10.4.), or

3.4.3. A Work Change Directive (pursuant to Paragraph 10.1.).

3.5. In addition, the requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, in one or more of the following ways:

3.5.1. A Field Order issued pursuant to Paragraph 9.5.,
GENERAL CONDITIONS
(Continued)

3.5.2. ENGINEER's approval of a Shop Drawing or Sample pursuant to Paragraphs 6.25. and 6.26., or

3.5.3. ENGINEER's written interpretation or clarification pursuant to Paragraph 9.4.

Reuse of Documents:

3.6. Neither CONTRACTOR nor any Subcontractor or Supplier or other person or organization performing or furnishing any of the Work under a direct or indirect contract with OWNER shall have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents (or copies of any thereof) prepared by or bearing the seal of ENGINEER; and they shall not reuse any of them on extensions of the Project or any other project without written consent of ENGINEER and OWNER's Consultant(s) (where applicable), which consent may be conditioned upon specific written verification or adaptation by ENGINEER and OWNER's Consultant(s) (where applicable).

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

Availability of Lands:

4.1. OWNER shall furnish, as indicated in the Contract Documents, the lands upon which the Work is to be performed, rights-of-way and easements for access thereto, and such other lands which are designated for the use of CONTRACTOR. OWNER shall identify any encumbrances or restrictions not of general application but specifically related to use of lands so furnished with which CONTRACTOR will have to comply in performing the Work. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by OWNER, unless otherwise provided in the Contract Documents. CONTRACTOR is responsible for acquiring any additional lands for construction that it may desire outside the limits of that provided by OWNER. CONTRACTOR shall also provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.2. Subsurface and Physical Conditions:

4.2.1. CONTRACTOR shall refer to the following information regarding subsurface and physical conditions.

4.2.1.1. For Subsurface Conditions, CONTRACTOR shall refer to those reports of explorations and tests of subsurface conditions at or contiguous to the site that have been utilized by ENGINEER in preparing the Contract Documents; and

4.2.1.2. For Physical Conditions, CONTRACTOR shall refer to those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the site (except Underground Facilities) that have been utilized by ENGINEER in preparing the Contract Documents.

4.2.2. CONTRACTOR reliance on technical data. CONTRACTOR may rely upon the general accuracy of the “technical data” contained in the reports and drawings referenced above, but such reports and drawings are not themselves Contract Documents unless specifically identified as such. Such “technical data” is identified in appropriate sections of the Contract Documents. Except for such reliance on such “technical data,” CONTRACTOR may not rely upon or make any Claim against OWNER, ENGINEER or any of OWNER's Consultants with respect to:
4.2.2.1. The completeness of such reports and drawings for CONTRACTOR’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto, or

4.2.2.2. Other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings, or

4.2.2.3. Any CONTRACTOR interpretation of or conclusion drawn from any “technical data” or any such data, interpretations, opinions or information.

4.2.3. Notice of Differing Subsurface or Physical Conditions. If CONTRACTOR believes that any subsurface or physical condition of the site that is uncovered or revealed is any of the following:

4.2.3.1. of such a nature as to establish that any “technical data” on which CONTRACTOR is entitled to rely as provided in Paragraphs 4.2.1. and 4.2.2. is materially inaccurate; or

4.2.3.2. materially different from that shown or indicated in the Contract Documents, or

4.2.3.3. of an unusual nature and materially different from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then CONTRACTOR shall, promptly (but no later than 5 days) after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as permitted by Paragraph 6.22.), notify the Construction Project Manager in writing about such condition. CONTRACTOR shall not further disturb such conditions or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

4.2.4. ENGINEER’s Review. Upon receipt of the CONTRACTOR’s written notice referenced above, ENGINEER will promptly review the pertinent conditions, determine the necessity of obtaining additional exploration or tests with respect thereto and advise CONTRACTOR in writing of ENGINEER’s findings and conclusions.

4.2.5. Possible Contract Documents Change. If ENGINEER concludes that a change in the Contract Documents is required as a result of a condition that meets one or more of the categories in Paragraph 4.2.3., a Work Change Directive or a Change Order will be issued as provided in Article 10 to reflect and document the consequences of such change.

4.2.6. Possible Price and Times Adjustments. If ENGINEER concludes that an equitable adjustment in the Contract Price or in the Contract Times, or both, is required as a result of a condition that meets one or more of the categories in Paragraph 4.2.3 and causes an increase or decrease in CONTRACTOR’s cost of, or time required for performance of, the Work, a Work Change Directive or a Change Order will be issued as provided in this Agreement, subject, however, to the following:

4.2.6.1. Such condition must meet any one or more of the categories described in Paragraphs 4.2.3.1. through 4.2.3.3., inclusive;

4.2.6.2. A change in the Contract Documents pursuant to Paragraph 4.2.5. will not be an automatic authorization of nor a condition precedent to entitlement to any such adjustment;
4.2.6.3. With respect to Work that is paid for on a Unit Price Basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.10. and 11.9.; and

4.2.6.4. CONTRACTOR shall not be entitled to any adjustment in the Contract Price or Times if:

4.2.6.4.1. CONTRACTOR knew of the existence of such conditions at the time CONTRACTOR made a final commitment to OWNER in respect of Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated Contract; or

4.2.6.4.2. The existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test or study of the site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for CONTRACTOR prior to CONTRACTOR’s making such final commitment; or

4.2.6.4.3. CONTRACTOR failed to give the written notice within the time and as required by Paragraph 4.2.3 or a schedule required elsewhere in the Contract Documents.

If ENGINEER and CONTRACTOR are unable to agree on entitlement to or the extent of an equitable adjustment in the Contract Price or Contract Times related to the occurrence of the above conditions, a Claim may be initiated as provided in Article 16. However, OWNER, ENGINEER and OWNER’s Consultants shall not be liable to CONTRACTOR for any costs, losses or damages sustained by CONTRACTOR on or in connection with any other project or anticipated project due to any alleged delay associated with the Work.

4.3. Physical Conditions specifically consisting of Underground Facilities. In addition to the foregoing Paragraph 4.2, the following shall apply to Physical Conditions of the site that consist specifically of Underground Facilities.

4.3.1. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the site is based on information and data furnished to ENGINEER by the OWNER or by the owners of such Underground Facilities or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

4.3.1.1. OWNER shall not be responsible for the accuracy or completeness of any such information or data; and,

4.3.1.2. CONTRACTOR shall have full responsibility for reviewing and checking all such information and data, for locating all Underground Facilities shown or indicated in the Contract Documents, for coordination of the Work with the owners of such Underground Facilities during construction, for the safety and protection thereof as provided in Paragraph 6.19, and for repairing any damage thereto resulting from the Work, the cost of all of which will be considered as having been included in the Contract Price. CONTRACTOR shall perform this review, checking and locating shown or indicated Underground Facilities prior to construction, with sufficient lead time to allow OWNER or the owners of Underground Facilities to correct or mitigate interferences with the Work.
4.3.2. **Not Shown or Not Indicated:** If an Underground Facility exists at or contiguous to the site that was not shown or indicated in the Contract Documents and that CONTRACTOR could not reasonably have been expected to be aware of, CONTRACTOR shall, promptly (but no later than forty-eight (48) hours) after becoming aware thereof and before performing any Work affected thereby (except in an emergency as permitted by Paragraph 6.22.), identify the owner of such Underground Facility and give written notice thereof to that owner and to the Construction Project Manager. ENGINEER will promptly review the Underground Facility to determine the extent to which the Contract Documents should be modified to reflect and document the consequences of the existence of the Underground Facility, and the Contract Documents shall be amended or supplemented to the extent necessary. During such time, CONTRACTOR shall be responsible for the safety and protection of such Underground Facility as provided in Paragraph 6.19.

CONTRACTOR shall expect normal utility service lines to all commercial and residential properties, which include water, sewer, telephone, cable television, gas and electric. Such lines will not normally be shown in the Contract Documents, and CONTRACTOR shall not be entitled to any adjustment of Contract Price or Contract Times associated with work to locate, avoid, relocate or repair such services. The fact that some or any of the service lines are shown on the Drawings is not a representation that all service lines are shown or indicated.

**Reference Points:**

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

4.5. **Hazardous Substances:**

4.5.1. OWNER shall be responsible for any Hazardous Substances (i.e. Asbestos, PCBs, Petroleum, Hazardous Waste or Radioactive Material) uncovered or revealed at the site that were not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work and that may present a substantial danger to persons or property exposed thereto in connection with the Work at the site. OWNER shall not be responsible for any such materials brought to the site by CONTRACTOR, Subcontractor, Suppliers or anyone else for whom CONTRACTOR is responsible.

4.5.2. Upon the discovery of a Hazardous Substance, CONTRACTOR shall immediately (i) stop all Work in connection with such Hazardous Substance and in any area affected thereby (except in an emergency as required by Paragraph 6.22.) and (ii) notify ENGINEER (and thereafter confirm such notice in writing). ENGINEER shall promptly determine the necessity for OWNER to retain a qualified expert to evaluate such Hazardous Substance or take corrective action, if any. CONTRACTOR shall not be required to resume Work in connection with such Hazardous Substance or in any such affected area until after OWNER has obtained any required permits related thereto and delivered to CONTRACTOR special written notice (i) specifying that any affected area is or has been rendered safe for the resumption of Work or (ii) specifying any special conditions under which such Work may be resumed safely. If ENGINEER and CONTRACTOR cannot
agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of such Work stoppage or such special conditions under which Work will be resumed, ENGINEER shall make the determination, and CONTRACTOR may dispute said determination through a Claim as provided in Article 16.

4.5.3. If after receipt of such special written notice CONTRACTOR does not agree to resume such Work based on a reasonable belief it is unsafe or does not agree to resume such Work under special conditions, then OWNER may order such portion of the Work that is in connection with such Hazardous Substance or in such affected area to be deleted from the Work. If ENGINEER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of deleting such portion of the Work, then ENGINEER shall make the determination, and CONTRACTOR may dispute said determination through a Claim as provided in Article 16. OWNER may have such deleted portion of the Work performed by OWNER's own forces or others in accordance with Article 7.

4.5.4. To the fullest extent permitted by Laws or Regulations, OWNER shall indemnify and hold harmless CONTRACTOR, Subcontractors, Consultants and the officers, directors, employees, agents, other Consultants and Subcontractors of each and any of them from and against all Claims, costs, losses and damages arising out of or resulting from such Hazardous Substance, provided that (i) any such Claim, cost, loss or damage is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom and (ii) nothing in this subparagraph 4.5.4 shall obligate OWNER to indemnify any person or entity from and against the consequences of that person's or entity's own negligence.

4.5.5. The provisions of Paragraphs 4.2. and 4.3. shall not apply to Hazardous Substances uncovered or revealed at the site.

ARTICLE 5--BONDS AND INSURANCE

Performance and Other Bonds:

5.1. CONTRACTOR shall furnish Performance and Payment Bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until one (1) year after the date when final payment becomes due, except as otherwise provided by Laws or Regulations or by any and all requirements imposed by the Contract Documents. All Bonds shall be in the forms prescribed by Laws or Regulations or by the Contract Documents, executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (as amended) by the Audit Staff Bureau of Accounts, U.S. Treasury Department, and rated "A-" or better by A. M. Best Company. All Bonds signed by an agent must be accompanied by a certified copy of the authority to act. The Bid package must include proof of A. M. Best ratings.

Under unique or unusual circumstances, if the CONTRACTOR wishes to use another company as the provider of any Bond required hereunder, CONTRACTOR must obtain written approval from the OWNER prior to Bid.

5.2. If the Surety on any Bond furnished by CONTRACTOR is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.1., CONTRACTOR
shall within five (5) days thereafter substitute another Bond and Surety, both of which must be acceptable to OWNER.

CONTRACTOR's Insurance:

5.3. Throughout the time CONTRACTOR is performing Work pursuant to this Agreement, CONTRACTOR shall maintain, and ensure that its subcontractors maintain, insurance that meets the requirements set forth below.

5.3.1. Workers compensation insurance as required under the workers' compensation laws of the State of Colorado.

5.3.2. Commercial general liability insurance with limits of not less than $2,000,000 per occurrence. Such insurance shall include “The City and County of Denver, Acting By and Through its Board of Water Commissioners” as additional insured and shall be primary and non-contributing with respect to any insurance or self-insurance program of the Board. CONTRACTOR shall maintain this insurance for two years after final payment and for the duration of the applicable Colorado statute of repose.

5.3.3. Business automobile insurance with limits of not less than $1,000,000 per occurrence. Such insurance shall include coverage for owned, non-owned, and hired vehicles utilized in the performance of this Agreement.

5.3.4. Professional liability insurance with a limit of not less than $1,000,000 per claim covering all licensed professionals performing architectural, engineering or survey services in the performance of this Agreement.

5.3.5. “All Risks” builder’s risk insurance at least as broad in scope as the Insurance Services Office (“ISO”) “Cause of Loss – Special Form.” Such insurance shall:

5.3.5.1 Cover the full projected value of the completed Project;

5.3.5.2 Not include coinsurance requirements;

5.3.5.3 Include soft cost coverage for additional accounting fees, legal fees, and any other increase in expense incurred due to an insured event;

5.3.5.4 Include equipment breakdown coverage or its equivalent;

5.3.5.5 Continue in force until final completion and OWNER acceptance;

5.3.5.6 Include “The City and County of Denver, Acting By and Through its Board of Water Commissioners” as insured as its interests may appear.

5.3.6. OTHER REQUIREMENTS AND PROVISIONS

5.3.6.1 CONTRACTOR's insurers shall maintain an A.M. Best rating of A-, VII or better.

5.3.6.2 All self-insured retentions or deductibles must be declared and approved by the Board, and shall be paid solely by CONTRACTOR without reimbursement by OWNER.
5.3.6.3 Thirty days’ advance notice of cancellation shall be provided to the Board.

5.3.6.4 OWNER may modify these requirements at its discretion.

Evidence of Insurance:

5.4. CONTRACTOR shall provide to the Board certificates of insurance (and renewals thereof) demonstrating that all insurance requirements have been met. Certificates of insurance shall contain a clause in this form: The above-described policies shall not be canceled, modified or amended or coverage reduced without the issuing company providing 30 days’ advance written notice to the certificate holder.

5.5. CONTRACTOR shall provide copies of insurance policies upon request of the Board.

Colorado Governmental Immunity Act:

5.6. Any language contained herein notwithstanding, the OWNER continues to rely upon, and has not waived, the monetary limits ($150,000 per person, $600,000 per occurrence) and all other rights, immunities and protections provided by the Colorado Governmental Immunity Act, Colorado Revised Statutes, Section 24-10-101, et seq. The OWNER carries no commercial general or automobile liability insurance, and its exposure to liability, therefore, whether directly by reason of its own negligence, or indirectly through indemnification, contract, subrogation, or otherwise, is $150,000 per person and $600,000 per occurrence.

ARTICLE 6--CONTRACTOR’S RESPONSIBILITIES

Supervision and Superintendence:

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

6.2. CONTRACTOR shall designate in writing a competent project manager and keep on the Work at all times during its progress a competent resident superintendent who shall not be replaced without written notice to the Construction Project Manager except under extraordinary circumstances. The superintendent will be CONTRACTOR’s representative at the site and shall have authority to act on behalf of CONTRACTOR. All communications given to the superintendent shall be as binding as if given to CONTRACTOR. The CONTRACTOR shall immediately remove from the Work any person employed, including CONTRACTOR’s superintendent, on the Work whom ENGINEER determines to be uncooperative or disorderly. At a minimum, OWNER and ENGINEER may require CONTRACTOR, Subcontractors and Suppliers to provide the names of employees entering OWNER’s sites, and they may also require those employees to provide identification in order to access such sites.

Labor, Materials and Equipment:

6.3. CONTRACTOR shall provide competent, suitably qualified personnel to survey and lay out the Work given the horizontal and vertical control provided by the OWNER and to perform construction as required by the Contract Documents. CONTRACTOR shall at all times
maintain good discipline and order at the site. Except in connection with the safety or protection of persons or the Work or property at the site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the site shall be performed during regular working hours. CONTRACTOR’s (and Subcontractor’s) regular working hours consist of eight (8) working hours within a nine (9)-hour period between 7:00 am and 4:00 pm, on a regularly scheduled basis, excluding Sundays and holidays. ENGINEER may permit longer hours, but the CONTRACTOR shall notify the ENGINEER by noon of the intent to work longer hours on a particular day and shall bear all of CONTRACTOR’s resulting cost increases. Weekend or OWNER-recognized holiday or evening work (as may be required by permitting restrictions) shall require a twenty-four (24)-hour advance notice to the ENGINEER, and CONTRACTOR will not permit overtime Work or the performance of Work on Sunday or any legal holiday without ENGINEER's written consent given after prior written notice to Construction Project Manager.

OWNER-Recognized Holidays consist of the following days:

New Year’s Day (January 1st)
Martin Luther King Day (3rd Monday in January)
President’s Day (3rd Monday in February)
Cesar Chavez Day (Last Monday in March)
Memorial Day (Last Monday in May)
Independence Day (July 4th)
Labor Day (1st Monday in September)
Veteran’s Day (November 11th or observed weekday)
Thanksgiving Day (4th Thursday in November)
Christmas Day (December 25th)

6.4. Unless otherwise specified in the Contract Documents, CONTRACTOR shall furnish and assume full responsibility for all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the furnishing and installing, performance, testing, start-up and completion of the Work.

6.5. All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. If required by ENGINEER, CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. All materials and equipment shall be applied, installed, erected, used, cleaned and conditioned in accordance with the instructions of the applicable Supplier except as otherwise provided in the Contract Documents.

Progress Schedule:

6.6. CONTRACTOR shall adhere to the progress schedule as it may be adjusted from time to time as provided below:

6.6.1. CONTRACTOR shall submit to the Construction Project Manager proposed adjustments in the progress schedule that will not change the Contract Times (or Milestones). Such adjustments will conform generally to the progress schedule then in
6.6.2. Proposed adjustments in the progress schedule that will change the Contract Times (or Milestones) shall be submitted in accordance with the requirements of Paragraph 12.1. Such adjustments may only be made by a Change Order or Written Amendment in accordance with Article 12.

6.7. Substitute or "Or-Equal" Items:

6.7.1. Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the naming of the item is intended to establish the type, function and quality required. Unless the technical specifications indicate that no substitution is permitted, materials or equipment of other Suppliers may be accepted by ENGINEER if sufficient information is submitted by CONTRACTOR to allow ENGINEER to determine that the material or equipment proposed is equivalent or equal to that named. The procedure for review by ENGINEER will follow the guidelines below and as they may be supplemented in the Supplementary Conditions. Requests for review of substitute items of material and equipment will not be accepted by ENGINEER from anyone other than CONTRACTOR. If CONTRACTOR wishes to furnish or use a substitute item of material or equipment, CONTRACTOR shall make written application to ENGINEER for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified, and be suited to the same use as that specified. The application will state that the evaluation and acceptance of the proposed substitute will not prejudice CONTRACTOR's achievement of Substantial Completion on time, whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents (or in the provisions of any other contract with OWNER for Work on the Project) to adapt the design to the proposed substitute, and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty. All variations of the proposed substitute from that specified will be identified in the application, and available maintenance, repair and replacement service will be indicated. The application will also contain an itemized estimate of all costs that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which shall be considered by ENGINEER in evaluating the proposed substitute. ENGINEER may require CONTRACTOR to furnish at CONTRACTOR's expense additional data about the proposed substitute.

6.7.2. If a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents, CONTRACTOR may furnish or utilize a substitute means, method, sequence, technique or procedure of construction acceptable to ENGINEER, if CONTRACTOR submits sufficient information to allow ENGINEER to determine that the substitute proposed is equivalent to that indicated or required by the Contract Documents. The procedure for review by ENGINEER will be similar to that provided in Paragraph 6.7.1. as applied by ENGINEER and as may be supplemented in the Supplementary Conditions.

6.7.3. ENGINEER shall evaluate each proposed substitute within a reasonable time. ENGINEER will be the sole judge of acceptability, and no substitute will be ordered, installed or utilized without ENGINEER's prior written acceptance, which will be evidenced by either a Change Order or an approved Shop Drawing. OWNER, acting through ENGINEER, may require CONTRACTOR to furnish at CONTRACTOR's expense a special performance guarantee or other surety with respect to any substitute. ENGINEER will record time required by ENGINEER and OWNER's Consultant in evaluating substitutions proposed by CONTRACTOR and in making changes in the Contract.
Documents occasioned thereby. Whether or not ENGINEER accepts a proposed substitute, OWNER may require CONTRACTOR to reimburse OWNER for the charges of ENGINEER and OWNER’s Consultant for evaluating each proposed substitute.

6.8. Concerning Subcontractors, Suppliers and Others:

6.8.1. CONTRACTOR shall not employ any Subcontractor, Supplier or other person or organization against whom OWNER or ENGINEER have reasonable objection. CONTRACTOR shall not be required to employ any Subcontractor, Supplier or other person or organization to furnish or perform any of the Work against whom CONTRACTOR has reasonable objection.

6.8.2. CONTRACTOR shall provide to ENGINEER, within 10 days of the Effective Date of Agreement, a complete listing including addresses and telephone numbers of all Subcontractors and Suppliers proposed for use (including those who are to furnish the principal items of materials and equipment) for acceptance by ENGINEER. OWNER’s or ENGINEER’s acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier or other person or organization so identified may be revoked on the basis of reasonable objection after due investigation, in which case CONTRACTOR shall submit an acceptable substitute, the Contract Price will be increased by the difference in the cost occasioned by such substitution, and an appropriate Change Order will be issued, including overhead and profit as appropriate. No acceptance by OWNER or ENGINEER of any such Subcontractor, Supplier or other person or organization shall constitute a waiver of any right of OWNER or ENGINEER to reject Defective Work.

6.8.3. CONTRACTOR shall be fully responsible to OWNER for all acts and omissions of the Subcontractors, whether selected by CONTRACTOR or by OWNER, Suppliers and other persons and organizations performing or furnishing any of the Work for CONTRACTOR just as CONTRACTOR is responsible for CONTRACTOR’s own acts and omissions. Nothing in the Contract Documents shall create any contractual relationship between OWNER and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of OWNER to pay or to see to the payment of any moneys due any such Subcontractor, Supplier or other person or organization except as may otherwise be required by Laws or Regulations.

6.8.4. CONTRACTOR shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work for CONTRACTOR. CONTRACTOR shall require all Subcontractors, Suppliers and any such persons or organizations performing or furnishing any of the Work to communicate with the ENGINEER through CONTRACTOR.

6.9. The divisions and sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

6.10. All Work performed for CONTRACTOR by a Subcontractor will be pursuant to an appropriate agreement between CONTRACTOR and the Subcontractor that specifically binds the Subcontractor to the applicable terms and conditions of the Contract Documents for the benefit of OWNER.
Patent Fees and Royalties:

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

Permits and Licenses:

6.12. Unless otherwise provided, CONTRACTOR shall obtain and pay for all construction permits and licenses required in the execution of the Work. OWNER may obtain any permits and licenses OWNER deems necessary to expedite the Work, and any permits and licenses so obtained will be identified in the appropriate sections of the Contract Documents. An appropriate adjustment to Contract Price will be made for any permits and licenses obtained by OWNER that the Contract Documents required the CONTRACTOR to obtain. CONTRACTOR shall pay all applicable charges and inspection fees necessary for the prosecution of the Work, which are required at the time of opening of Bids, or if there are no Bids, on the Effective Date of the Agreement. CONTRACTOR shall acquire any occupancy permit if such is required for the OWNER to utilize the Work. CONTRACTOR shall pay all charges of utility owners for connections to the Work, and OWNER shall pay all charges of such utility owners for capital costs related thereto such as plant investment fees. CONTRACTOR shall comply with the requirements of all permits and licenses obtained by the OWNER and/or CONTRACTOR.

6.13. Laws and Regulations:

6.13.1. CONTRACTOR shall give all notices and comply with all Laws or Regulations applicable to furnishing and performance of the Work. Except where otherwise expressly required by applicable Laws or Regulations, neither OWNER, ENGINEER, nor OWNER'S Consultant shall be responsible for monitoring CONTRACTOR's compliance with any Laws or Regulations. The CONTRACTOR shall certify that it has complied, and during the term of this Agreement will continue to comply, with the Immigration Reform and Control Act of 1986.

6.13.2. If CONTRACTOR observes that the Specifications or Drawings are at variance with any Laws or Regulations, CONTRACTOR shall give the Construction Project Manager prompt written notice thereof, and any necessary changes shall be made by one of the methods indicated in Paragraph 3.5. If CONTRACTOR performs any Work knowing or having reason to know that it is contrary to such Laws or Regulations, and without such notice, CONTRACTOR shall bear all costs arising therefrom.

Sales and Use Taxes (Excise Taxes):

6.14. CONTRACTOR shall pay all sales, consumer, use and other similar taxes required to be paid by CONTRACTOR in accordance with the Laws or Regulations of the place of the Project that are applicable during the performance of the Work.
The Bid prices shall include all such taxes, in accordance with the following.

6.14.1. Colorado State Taxes. The State of Colorado will not impose sales and use taxes upon construction and building materials purchased by CONTRACTOR and Subcontractors for use in the building, erection, alteration, or repair of structures, highways, roads, streets, and other public works owned and used by the OWNER. In order to qualify for this exemption, an application for a certificate of exemption must be filed with the Department of Revenue, State of Colorado, by CONTRACTOR and Subcontractors engaged in the Project. Bids shall not include any such taxes in the computation.

6.14.2. Local Taxes. CONTRACTOR and each Subcontractor is required to pay the sales and use taxes imposed by any political subdivision of the State of Colorado on purchases of any tangible personal property to be built into the Work. Each proposal shall include all such taxes with no adjustment for any refund that the OWNER may subsequently receive.

6.14.3. Federal Taxes. As a political subdivision of the State of Colorado, the OWNER is exempt from the payment of most federal excise taxes. Bids shall not include federal excise tax of any kind in the computation. An exemption certificate will be provided by OWNER for those items to which the exemption applies. The CONTRACTOR will be reimbursed for payment of any federal excise tax for which the OWNER is unable to provide an exemption certificate.

Use of Premises:

6.15. CONTRACTOR shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the site and land and areas identified in and permitted by the Contract Documents and other land and areas permitted by Laws or Regulations, rights-of-way, permits and easements, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment. CONTRACTOR shall assume full responsibility for any damage to any such land or area, or to the OWNER or occupant thereof or of any adjacent land or areas, resulting from the performance of the Work. Should any Claim be made by any such owner or occupant because of the performance of the Work, CONTRACTOR shall promptly settle with such other party by negotiation or otherwise resolve the Claim by other dispute resolution proceeding or at law. CONTRACTOR shall, to the fullest extent permitted by Laws or Regulations, indemnify and hold harmless OWNER, ENGINEER, OWNER's Consultant and anyone directly or indirectly employed by any of them from and against all Claims, costs, losses and damages arising out of or resulting from any Claim or action, legal or equitable, brought by any such owner or occupant against OWNER, ENGINEER or any other party indemnified hereunder to the extent caused by or based upon CONTRACTOR's or a Subcontractor's performance of the Work.

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

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

6.18. CONTRACTOR shall maintain in a safe place at the site one record copy of all Drawings, Specifications, Addenda, Written Amendments, Change Orders, Work Change Directives, Field Orders and written interpretations and clarifications (issued pursuant to Paragraph 9.4.) in good order and annotated to show all changes made during construction. These record documents together with all approved Samples and Shop Drawings will be available to ENGINEER for reference. Upon completion of the Work, these record documents, Samples and Shop Drawings will be delivered to the Construction Project Manager.

Safety and Protection:

6.19. CONTRACTOR shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

6.19.1. All employees on the Work and other persons and organizations who may be affected thereby;

6.19.2. All the Work and materials and equipment to be incorporated therein, whether in storage on or off the site; and

6.19.3. Other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities and Underground Facilities not designated for removal, relocation or replacement in the course of construction.

CONTRACTOR shall comply with all applicable Laws or Regulations of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss, and shall erect and maintain all necessary safeguards for such safety and protection. CONTRACTOR shall notify owners of adjacent property and of Underground Facilities and utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation and replacement of their property. All damage, injury or loss to any property referred to in Paragraph 6.19.2. or 6.19.3. caused, directly or indirectly, in whole or in part, by CONTRACTOR, any Subcontractor, Supplier or any other person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of OWNER or ENGINEER, OWNER's Consultant or anyone employed by any of them or anyone for whose acts any of them may be liable). CONTRACTOR's duties and responsibilities for the safety and protection of the Work shall continue until such time as all the Work is completed and ENGINEER has issued a notice to CONTRACTOR in accordance with Paragraph 14.13. that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.20. CONTRACTOR shall designate a responsible representative at the site when work is occurring whose duty shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs. This person shall be CONTRACTOR's superintendent unless otherwise designated in writing by CONTRACTOR to the Construction Project Manager.

Hazard Communication Programs:

6.21. CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the site in accordance with Laws or Regulations.
Emergencies:

6.22. In emergencies affecting the safety or protection of persons or the Work or property at the site or adjacent thereto, CONTRACTOR, without special instruction or authorization from ENGINEER, is obligated to act to prevent threatened damage, injury or loss. CONTRACTOR shall give ENGINEER prompt written notice if CONTRACTOR believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby. If ENGINEER determines that a change in the Contract Documents is required because of the action taken in response to an emergency, a Work Change Directive or Change Order will be issued to document the consequences of the changes or variations.

Submittal Procedures:

Shop Drawings and Samples:

6.23. After checking and verifying all field measurements and after complying with applicable procedures specified herein, CONTRACTOR shall submit four (4) copies (unless otherwise specified) of all Shop Drawings to the Construction Project Manager for ENGINEER to review in accordance with the accepted schedule of Shop Drawing submissions (see Paragraph 2.9.), or for other appropriate action if so indicated in the Supplementary Conditions. All Shop Drawings shall bear a stamp or specific written indication that CONTRACTOR has satisfied CONTRACTOR's responsibilities under the Contract Documents with respect to the review of the submission. All submissions will be identified as required in the specifications. The data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to enable ENGINEER to review the information as required.

6.24. CONTRACTOR shall also submit to the Construction Project Manager for the ENGINEER to review with such promptness as to cause no delay in Work, all Samples required by the Contract Documents. All Samples will have been checked and accompanied by a specific written indication that CONTRACTOR has satisfied CONTRACTOR's responsibilities under the Contract Documents with respect to the review of the submission and will be identified clearly as to material, Supplier, pertinent data such as catalog numbers and the use for which intended.

6.24.1. Before submission of each Shop Drawing or Sample, CONTRACTOR shall have determined and verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar data with respect thereto and reviewed or coordinated each Shop Drawing or Sample with other Shop Drawings and samples and with the requirements of the Work and the Contract Documents.

6.24.2. At the time of each submission, CONTRACTOR shall give ENGINEER specific written notice of each variation that the Shop Drawings or Samples may have from the requirements of the Contract Documents, and, in addition, shall cause a specific notation of each such variation to be made on each Shop Drawing submitted for review and approval.

6.25. ENGINEER or OWNER's Consultant will review with reasonable promptness, as defined elsewhere in the Contract Documents, Shop Drawings and Samples, but ENGINEER's review will be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereto. The review of a separate item as such will not indicate approval of the assembly in which the item functions. CONTRACTOR shall make corrections required by ENGINEER and shall return the required
number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. CONTRACTOR shall direct specific attention in writing to revisions other than the corrections called for by ENGINEER on previous Submittals.

6.26. ENGINEER's or OWNER's Consultant's review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to each such variation at the time of submission as required by Paragraph 6.24.2. and ENGINEER has given written approval of each such variation by a specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample approval; nor will any approval by ENGINEER relieve CONTRACTOR from responsibility for errors or omissions in the Shop Drawings or from responsibility for having complied with the provisions of Paragraph 6.24.1.

6.27. Where a Shop Drawing or Sample is required by the Specifications, any related Work performed prior to ENGINEER's or OWNER's Consultant's review and approval of the pertinent submission will be at the sole expense and responsibility of CONTRACTOR.

Continuing the Work:

6.28. CONTRACTOR shall carry on the Work and adhere to the progress schedule during all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.4. or as CONTRACTOR and ENGINEER may otherwise specifically agree to in writing.

CONTRACTOR's General Warranty and Guarantee:

6.29. CONTRACTOR warrants and guarantees to OWNER, ENGINEER and OWNER's Consultants that all Work will be in accordance with the Contract Documents and said Work will not be Defective. The CONTRACTOR's obligation to perform and complete all Work in accordance with the Contract Documents shall be absolute.

The CONTRACTOR’s warranty and guarantee hereunder excludes liability for defects caused by abuse, operation by persons other than the CONTRACTOR, Subcontractors and Suppliers or by normal wear and tear under normal usage.

None of the following occurrences shall constitute an acceptance of Work that is not in strict compliance with the Contract Documents:

6.29.1. Inspections and observations by ENGINEER;

6.29.2. Recommendation of any progress payment or final payment;

6.29.3. Issuance of a letter certifying Substantial Completion;

6.29.4. Any payment to CONTRACTOR under the Contract;

6.29.5. Use or occupancy of the Work or any part thereof by OWNER;

6.29.6. Any acceptance by OWNER or failure to do so;

6.29.7. Any inspection, test, or approval by others as well as review and/or approval of Shop Drawings, as-builts, Samples or issuance of notice of acceptability by ENGINEER; or

6.29.8. Any notice or demand by OWNER or ENGINEER to correct Defective Work.
Indemnification:

6.30. To the fullest extent permitted by Laws or Regulations, CONTRACTOR shall indemnify, defend and hold harmless OWNER and OWNER's Consultant(s), their officers, directors, agents and employees from and against all Claims, damages, losses and expenses, direct, indirect or consequential (including but not limited to fees and charges of engineers, architects, attorneys, and other professionals and court proceedings or other alternative dispute resolution costs) arising out of or resulting from the performance of the Work, provided that any such Claim, damage, loss or expense (a) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself) including the loss of use resulting therefrom and (b) is caused in whole or in part by any negligent act or omission of CONTRACTOR, any Subcontractor, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, regardless of whether or not it is caused in part by a party indemnified hereunder or arises by or is imposed by Laws or Regulations and regardless of the negligence of any such person or entity.

6.31. In any and all Claims against OWNER and OWNER's Consultant(s), their officers, directors, agents and employees by any employee of CONTRACTOR, any Subcontractor, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.30. shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for CONTRACTOR or any such Subcontractor or other person or organization under workers' compensation acts, disability benefit acts or other employee benefit acts.

6.32. The indemnification obligations of CONTRACTOR under Paragraph 6.30. shall not extend to the liability of ENGINEER and OWNER's Consultants, officers, directors, employees or agents caused by the professional negligence, errors or omissions of any of them.

Survival of Obligations:

6.33. All representations, indemnifications, warranties and guarantees made in, required by or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion and acceptance of the Work and termination or completion of the Agreement.

Damage to Work:

6.34. Except as provided in Article 14 of the General Conditions and in the Supplementary Conditions, CONTRACTOR shall be responsible for all damage to the Work until final payment is made by OWNER or until Partial Utilization of a portion of the Work by OWNER. If OWNER uses portions of the Work in accordance with the provisions of the Contract Documents concerning Partial Utilization, CONTRACTOR shall be relieved from responsibility for damages only for those portions of the Work utilized by OWNER.

6.35. Should CONTRACTOR cause damage to the Work or property of any separate contractor at the site, or should any Claim arising out of CONTRACTOR's performance of the Work at the site be made by any separate contractor against CONTRACTOR, OWNER, OWNER's Consultant or any other person, CONTRACTOR shall promptly attempt to settle with such other contractor by Agreement or to otherwise resolve the dispute. CONTRACTOR shall, to the fullest extent permitted by Laws or Regulations, indemnify, defend, and hold OWNER and OWNER's Consultant harmless from and against all Claims, damages, losses, and expenses (including, but not limited to, fees of engineers, architects, attorneys, and other professionals and court proceedings or other alternative dispute resolution costs) arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any separate contractor against OWNER or OWNER's Consultant to the extent based on a Claim arising out of CONTRACTOR's
performance of the Work. Should a separate contractor cause damage to the Work or property of CONTRACTOR or should the performance of Work by any separate contractor at the site give rise to any other Claim, CONTRACTOR shall not institute any action, legal or equitable, against OWNER or OWNER's Consultant or permit any action against them to be maintained and continued in its name or for its benefit in any court or before any arbitrator that seeks to impose liability on or to recover damages from OWNER or OWNER's Consultant on account of any such damage or Claim. If CONTRACTOR is delayed at any time in performing or furnishing Work by any act or neglect of a separate contractor, and OWNER and CONTRACTOR are unable to agree as to the extent of any adjustment in Contract Times attributable thereto, CONTRACTOR may make a Claim for an extension of time in accordance with Article 12. An extension of the Contract Times shall be CONTRACTOR's exclusive remedy with respect to OWNER and OWNER's Consultant for any delay, disruption, interference, or hindrance caused by a separate contractor. This paragraph does not prevent recovery from OWNER or OWNER's Consultant for activities that are their respective responsibilities.

ARTICLE 7--OTHER WORK

Related Work at Site:

7.1. OWNER may perform other Work related to the Project at the site by OWNER's own forces, let other direct contracts therefor that shall contain General Conditions similar to these, or have other Work performed by utility owners. If the fact that such other Work is to be performed was not noted in the Contract Documents, then (i) written notice thereof will be given to CONTRACTOR prior to starting any such other Work, and (ii) CONTRACTOR may make a Claim therefor as provided in Articles 11 and 12 if such performance will involve additional expense to CONTRACTOR or requires additional time and the parties are unable to agree as to the amount or extent thereof.

7.2. CONTRACTOR shall afford each utility owner and each other contractor who is a party to such a direct contract (or OWNER, if OWNER is performing the additional Work with OWNER's employees) proper and safe access to the site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such Work, and CONTRACTOR shall properly connect and coordinate the Work with theirs. CONTRACTOR shall do all cutting, fitting and patching of the Work that may be required to make its several parts come together properly and integrate with such other Work. CONTRACTOR shall not endanger any Work of others by cutting, excavating or otherwise altering their Work and will only cut or alter their Work with the written consent of ENGINEER and the others whose Work will be affected. The duties and responsibilities of CONTRACTOR under this paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of CONTRACTOR in said direct contracts between OWNER and such utility owners and other contractors.

7.3. If the proper execution or results of any part of CONTRACTOR's Work depends upon Work performed by others under this Article 7, CONTRACTOR shall inspect such other Work and promptly report to the Construction Project Manager in writing any delays, defects or deficiencies in such other Work that render it unavailable or unsuitable for the proper execution and results of CONTRACTOR's Work. CONTRACTOR's failure so to report will constitute an acceptance of such other Work as fit and proper for integration with CONTRACTOR's Work except for latent defects in such other Work.

Coordination:

7.4. OWNER reserves the right to let other contracts in connection with the completion of this Project. Performance of other Contracts may be simultaneous with this Contract and within the same general area. The CONTRACTOR agrees to properly connect and coordinate
the Work with that to be performed under other Contracts or with Work done by OWNER. Any dispute whatsoever between separate contractors shall be resolved as set forth in Article 16 hereunder.

7.4.1. If the CONTRACTOR delays the Work of the OWNER or other contractors by not properly coordinating the Work or by not affording them sufficient opportunity or facility to perform Work as may be specified, the CONTRACTOR shall in that case pay all costs and expenses incurred by such parties due to any such delays, and CONTRACTOR hereby authorizes OWNER to deduct the amount of such costs and expenses from any payments due or to become due the CONTRACTOR under this Contract. Nothing contained in this paragraph shall, however, relieve said CONTRACTOR from any liability resulting to the OWNER on account of such delay or delays.

7.4.2. The OWNER agrees to include this Article in all other contracts under its control affecting the Work or other work performed in the same general area as the Work under this Contract.

ARTICLE 8--OWNER'S RESPONSIBILITIES

8.1. OWNER shall issue all communications to CONTRACTOR through ENGINEER unless specified otherwise herein.

8.2. OWNER shall furnish the data required of OWNER under the Contract Documents promptly and shall make payments to CONTRACTOR promptly after they are due as provided herein.

8.3. OWNER shall provide lands, easements, engineering surveys to establish reference points, copies of reports of explorations, and tests of subsurface conditions as provided herein.

8.4. OWNER shall be liable within the limits set forth in Paragraph 5.9.

8.5. OWNER shall execute Change Orders as indicated in Paragraph 10.4.

8.6. OWNER shall be responsible for certain inspections, tests and approvals as set forth in Paragraph 13.4.

8.7. OWNER shall have the right to stop Work, suspend Work, and terminate Work of CONTRACTOR as set forth herein.

8.8. OWNER shall not supervise, direct or have control or authority over, nor be responsible for, CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws or Regulations applicable to the furnishing or performance of the Work. Nor shall OWNER be responsible for CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

8.9. OWNER shall be responsible for undisclosed Hazardous Substances uncovered or revealed at the site as set forth in Paragraph 4.5.
ARTICLE 9—ENGINEER'S RESPONSIBILITIES

OWNER's Representative:

9.1. ENGINEER will be OWNER's representative during the construction period. The duties and responsibilities of ENGINEER as OWNER's representative during construction are set forth in the Contract Documents.

Visits to Site:

9.2. ENGINEER generally will have continuous on-site representation to observe the progress and quality of the executed Work and to determine, in general, if the Work is proceeding in accordance with the Contract Documents. ENGINEER's efforts will be directed toward providing for OWNER a greater degree of confidence that the completed Work will conform to the Contract Documents. On the basis of such observations, ENGINEER will keep OWNER informed of the progress of the Work and will endeavor to guard OWNER against defects and deficiencies in the Work.

9.2.1. OWNER's Consultant will not be required to make exhaustive or continuous on-site inspections or visits to check the quality or quantity of the Work.

Project Representation:

9.3. ENGINEER will name a Construction Project Manager to observe the execution of the Work and to perform certain other obligations of ENGINEER.

Clarifications and Interpretations:

9.4. ENGINEER will issue with reasonable promptness such written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as are reasonably necessary. If CONTRACTOR believes that a written clarification or interpretation justifies an increase in the Contract Price or an extension of the Contract Times and the parties are unable to agree to the amount or extent thereof, CONTRACTOR may make a Claim therefor as provided in Article 11 or Article 12.

Authorized Variations in Work:

9.5. ENGINEER may authorize minor variations in the Work from the requirements of the Contract Documents that do not involve an adjustment in the Contract Price or the Contract Times and are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order and will be binding on OWNER and also on CONTRACTOR who shall perform the Work involved promptly. If CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or an extension of the Contract Times and the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a Claim therefor as provided in Article 11 or Article 12.

Rejecting Defective Work:

9.6. ENGINEER may disapprove or reject Work that ENGINEER believes to be Defective and will also have authority to require special inspection or testing of the Work as provided in Article 13, whether or not the Work is fabricated, installed or completed. No inspection, failure to reject, or acceptance of all or a part of the Work, nor any payments for any portion of the Work, nor any extensions of time, nor any possession or occupancy by OWNER shall operate as a waiver of any provision of the Contract Documents or as a waiver of the OWNER's absolute right to have the provisions fully performed. No waiver or breach of the requirements of the Contract Documents shall be held to be a waiver of any other requirement.
GENERAL CONDITIONS
(Continued)

Shop Drawings, Change Orders and Payments:

9.7. In connection with ENGINEER's responsibilities with regard to Shop Drawings and Samples, see Paragraphs 6.23. through 6.27. inclusive.

9.8. In connection with ENGINEER's responsibilities with regard to Change Orders, see Articles 10, 11, and 12.

9.9. In connection with ENGINEER's responsibilities with regard to Applications for Payment, etc., see Article 14.

Determinations for Unit Prices:

9.10. ENGINEER will determine the actual quantities and classifications of Unit Price Work performed by CONTRACTOR. ENGINEER will review with CONTRACTOR the ENGINEER's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). ENGINEER's written decisions thereon will be final and binding upon CONTRACTOR, unless, within 10 days after the date of such decision, CONTRACTOR delivers to ENGINEER written objection to such a decision.

Limitations on ENGINEER's Responsibilities:

9.11. Neither ENGINEER's authority to act under this Article 9 or elsewhere in the Contract Documents nor any decision made by ENGINEER in good faith either to exercise or not exercise such authority shall give rise to any duty or responsibility of ENGINEER to CONTRACTOR, any Subcontractor, any Supplier, or any other person or organization performing any of the Work, or to any surety for any of them.

9.12. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "as approved" or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory" or adjectives of like effect or import are used to describe a requirement, direction, review or judgment of ENGINEER as to the Work, it is intended that such requirement, direction, review or judgment will be solely to evaluate the Work for compliance with the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to ENGINEER any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.13. or 9.14.

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

9.14. ENGINEER will not be responsible for the acts or omissions of CONTRACTOR or of any Subcontractor, any Supplier, or of any other person or organization performing or furnishing any of the Work.

ARTICLE 10--CHANGES IN THE WORK

10.1. Without invalidating the Agreement and without notice to any Surety, OWNER may, acting through the ENGINEER, at any time or from time to time, order additions, deletions or revisions in the Work, which will be authorized by a Written Amendment, a Change Order, or a Work Change Directive. Upon receipt of any such document, CONTRACTOR shall promptly proceed with the Work involved that will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).
10.2. If the ENGINEER and CONTRACTOR are unable to agree as to the extent, if any, of an increase or decrease in the Contract Price or an extension or shortening of the Contract Times that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Article 11 or Article 12.

10.3. CONTRACTOR shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any Work performed that is not required by the Contract Documents except in the case of an emergency as provided in Paragraph 6.22, and except in the case of uncovering Work as provided in Paragraphs 13.7 and 13.8.

10.4. OWNER and CONTRACTOR shall execute appropriate Change Orders (or Written Amendments) regarding:

10.4.1. Changes in the Work that are ordered by OWNER pursuant to Paragraph 10.1 and are required because of acceptance of Defective Work under Paragraph 13.12, or correcting Defective Work under Paragraph 13.13, or are agreed to by the parties;

10.4.2. Changes in the Contract Price or Contract Times that are agreed to by the parties; and

10.4.3. Changes in the Contract Price or Contract Times that embody the substance of any written decision pursuant to Paragraph 9.11.

10.5. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times) is required by the provisions of any Bond to be given to a Surety, the giving of any such notice will be CONTRACTOR's responsibility, and the amount of each applicable Bond will be adjusted accordingly. A copy of each such notice to the Surety shall be provided to the Construction Project Manager.

ARTICLE 11--CHANGE OF CONTRACT PRICE

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

11.2. The Contract Price may only be changed by a Change Order or by a Written Amendment. Any Claim for an increase or decrease in the Contract Price shall be based on written notice delivered by the party making the Claim to the other party as set forth in Article 16 below.

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

11.3.1. Where the Work involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved (subject to the provisions of Paragraphs 11.9.1. through 11.9.3., inclusive).

11.3.2. By mutual acceptance of a lump sum (which may include an estimate of overhead and profit not necessarily in accordance with Paragraph 11.6.2.1.).

11.3.3. On the basis of the Cost of the Work (determined as provided in Paragraphs 11.4. and 11.5.) plus a CONTRACTOR's Fee for overhead and profit (determined as provided in Paragraphs 11.6. and 11.7.).
GENERAL CONDITIONS
(Continued)

Cost of the Work:

11.4. The term Cost of the Work means the sum of all costs necessarily incurred and paid by CONTRACTOR in the proper performance of the Work. Except as otherwise may be agreed to in writing by ENGINEER, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any of the costs itemized in Paragraph 11.5.: 

11.4.1. Payroll costs for employees in the direct employ of CONTRACTOR in the performance of the Work under schedules of job classifications agreed upon by ENGINEER and CONTRACTOR. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, and vacation and holiday pay applicable thereto. Such employees shall include superintendents and foremen at the site. The expenses of performing Work after regular working hours, on Saturday, Sunday or legal holidays, may not be included in the above unless otherwise agreed to by CONTRACTOR and ENGINEER.

11.4.2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof and Suppliers' field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR, unless OWNER deposits funds with CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to OWNER. All trade discounts, rebates and refunds, and all returns from sale of surplus materials and equipment shall accrue to OWNER, and CONTRACTOR shall make provisions so that they may be obtained.

11.4.3. Payments made by CONTRACTOR to the Subcontractors for Work performed by Subcontractors. If required by ENGINEER, CONTRACTOR shall obtain competitive Bids from Subcontractors acceptable to CONTRACTOR and shall deliver such Bids to ENGINEER who will then determine which Bid(s) will be accepted. If a subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work Plus a fee, the Subcontractor's Cost of the Work shall be determined in the same manner as CONTRACTOR's Cost of the Work. All subcontracts shall be subject to the other provisions of the Contract Documents insofar as applicable.

11.4.4. Costs of CONTRACTOR's Consultants (including but not limited to engineers, architects, testing laboratories, surveyors, and accountants) employed for services specifically related to the Work.

11.4.5. Supplemental costs including the following:

11.4.5.1. The proportion of necessary transportation, travel and subsistence expenses of CONTRACTOR's employees incurred in discharge of duties connected with the Work.

11.4.5.2. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost less market value of such items used but not consumed that remain the property of CONTRACTOR.
11.4.5.3. Rentals of all construction equipment and machinery and the parts thereof to the extent they are used in performance of the Work, whether rented from CONTRACTOR or others, and the costs of transportation, loading, unloading, installation, dismantling and removal thereof.

11.4.5.4. Sales, consumer, use or similar taxes related to the Work, and for which CONTRACTOR is liable, imposed by Laws or Regulations.

11.4.5.5. Deposits lost for causes other than negligence of CONTRACTOR, any Subcontractor or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

11.4.5.6. Losses and damages (and related expenses), not compensated by insurance or otherwise, to the Work or otherwise sustained by CONTRACTOR in connection with the performance and furnishing of the Work (except losses and damages within the deductible amounts of property insurance established by Owner in accordance with Paragraph 5.10.), provided they have resulted from causes other than the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of ENGINEER. No such losses, damages and expenses shall be included in the Cost of the Work for the purpose of determining CONTRACTOR's Fee. If, however, any such loss or damage requires reconstruction and CONTRACTOR is placed in charge thereof, CONTRACTOR shall be paid for services a fee proportionate to that stated in Paragraph 11.6.2.

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

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

11.4.5.9. Cost of premiums for additional Bonds and Insurance required because of changes in the Work and premiums for property insurance coverage within the limits of the deductible amounts established in accordance with Paragraph 5.10.

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

11.5.1. Payroll costs and other compensation of CONTRACTOR's officers, executives, principals (of partnerships and sole proprietorships), general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks and other personnel employed by CONTRACTOR whether at the site or in CONTRACTOR's principal or a branch office for general administration of the Work and not specifically included in the agreed-upon schedule of job classifications referred to in Paragraph 11.4.1. or specifically covered by 11.4.4., all of which are to be considered administrative costs covered by the CONTRACTOR's fee.

11.5.2. Expenses of CONTRACTOR's principal and branch offices other than CONTRACTOR's office at the site.

11.5.3. Any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent payments.
11.5.4. Cost of premiums for all Bonds and for all insurance whether or not CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except for the cost of premiums covered by Subparagraph 11.4.5.9. above).

11.5.5. Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to the correction of Defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

11.5.6. Other overhead or general expense costs of any kind, including information technology and general accounting expenses, extended overhead, and the costs of any item not specifically and expressly included in Paragraph 11.4.

**CONTRACTOR's Fee:**

11.6. The CONTRACTOR's fee allowed to CONTRACTOR for overhead and profit shall be one of the following two alternatives:

11.6.1. a mutually acceptable fixed fee; or

11.6.2. if no fixed fee is mutually acceptable, a fee based on the following percentages of the various portions of the Cost of the Work:

11.6.2.1. For costs incurred under Paragraphs 11.4.1. and 11.4.2., the CONTRACTOR's fee shall be limited to fifteen percent (15%);

11.6.2.2. For costs incurred under Paragraph 11.4.3., the Subcontractor performing the work shall be paid a mutually acceptable fixed fee; or if none can be agreed upon, Cost of the Work plus a maximum of fifteen percent (15%) for overhead and profit; the CONTRACTOR's fee shall be five percent (5%) of this total; there shall be no payment of fees to intermediate tiers;

11.6.2.3. No fee shall be payable on the basis of costs itemized under Paragraphs 11.4.4., 11.4.5. and 11.5.;

11.6.2.4. The amount of credit to be allowed by CONTRACTOR to OWNER for any change that results in a net decrease in cost will be the amount of the actual net decrease plus a deduction in CONTRACTOR's fee by an amount equal to ten percent (10%) of the net decrease; and

11.6.2.5. When both additions and credits are involved in any one change, the adjustment in CONTRACTOR's fee shall be computed on the basis of the net change in accordance with Paragraphs 11.6.2.1. through 11.6.2.4., inclusive.

11.6.3. This Fee shall include small tools, safety programs, and all other overhead costs; there shall be no other fee or mark-up.

11.7. Whenever the cost of any Work is to be determined pursuant to Paragraph 11.4. or 11.5., CONTRACTOR will submit to the Construction Project Manager an itemized cost breakdown together with supporting data.
Hierarchical Tiers:

11.8. Regardless of the number of sub-Subcontractors, (reference 11.6.2.2. above), the five percent (5%) increase above the Subcontractor's total cost, which includes allowances for overhead and profit, may be applied one time only for each separate Work transaction.

11.9. Unit Price Work:

11.9.1. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the established unit prices for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by CONTRACTOR will be made in accordance with Paragraph 9.10.

11.9.2. Each unit price will be deemed to include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.

11.9.3. If the actual quantity of any item of Unit Price Work varies by more than twenty-five percent (25%) above or below the estimated quantity, an equitable adjustment in the Contract Price shall be made upon request of either the CONTRACTOR or the OWNER. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation above one-hundred twenty-five percent (125%) or below seventy-five percent (75%) of the estimated quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the CONTRACTOR may request, in writing, an extension of time in accordance with Article 12.

ARTICLE 12--CHANGE OF CONTRACT TIMES

12.1. The Contract Times (or Milestones) may only be changed by a Change Order or a Written Amendment. Any Claim for an extension or shortening of the Contract Times (or Milestones) shall be made as set forth in Article 16 below.

12.2. Time is of the essence with regard to all time limits stated in the Contract Documents.

12.3. Where CONTRACTOR is prevented from completing any part of the Work within the Contract Times or Milestones due to delay beyond the control of CONTRACTOR, the Contract Times or Milestones will be extended in an amount equal to the time lost due to such delay if a Claim is made as set forth in Article 16 below. Delays beyond the control of CONTRACTOR shall include, but not be limited to, acts or neglect by OWNER or other contractors performing other Work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions or acts of God. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of CONTRACTOR. An extension of Contract Times shall be CONTRACTOR's sole and exclusive remedy for delay unless acts or omissions of the OWNER or ENGINEER caused said delay. In no event shall OWNER be liable to CONTRACTOR, any Subcontractor, any Supplier, any other person or organization, or to any Surety for or employee or agent of any of them, for damages not actually incurred or for damages arising out of or resulting from (i) delays not caused by OWNER or ENGINEER or (ii) delays beyond the control of both parties including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God, or acts or neglect by utility owners or other contractors performing other Work as contemplated by Article 7.

Revised 04-09

GC-32
In addition to the requirements of Article 16, any CONTRACTOR claim for an extension of Contract Times due to abnormal weather conditions must be supported by data substantiating that weather conditions were abnormal for the period of time and location, could not have been reasonably anticipated, and adversely affected the scheduled construction.

ARTICLE 13—TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

Notice of Defects:

13.1. ENGINEER shall deliver to CONTRACTOR prompt notice of all known defects in the Work. All Defective Work, whether or not in place, may be rejected, corrected or accepted as provided in this Article 13.

Access to Work:

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

Tests and Inspections:

13.3. CONTRACTOR shall give ENGINEER timely notice (at least forty-eight (48) hours unless otherwise specified in the Contract Documents) of readiness of the Work for all required inspections, tests or approvals, unless ENGINEER, in writing, deems additional time for notice is required.

13.4. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) to specifically be inspected, tested or approved, CONTRACTOR shall assume full responsibility therefor, pay all costs in connection therewith and furnish ENGINEER the required certificates of inspection, testing or approval. CONTRACTOR shall also be responsible for and shall pay all costs in connection with any inspection or testing required in connection with ENGINEER's acceptance of a Supplier of materials or equipment proposed to be incorporated in the Work or of materials or equipment submitted for approval prior to CONTRACTOR's purchase thereof for incorporation in the Work. The cost of all inspections, tests and approvals, in addition to the above, which are required by the Contract Documents, shall be paid by OWNER (unless otherwise specified).

13.5. All inspections, tests or approvals other than those required by Laws or Regulations of any public body having jurisdiction shall be performed by organizations acceptable to ENGINEER and CONTRACTOR. Materials testing by ENGINEER is for the benefit of OWNER and is intended for verification of compliance with the Contract Documents. Any additional testing shall be performed by CONTRACTOR.

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

Uncovering Work:

13.7. If any Work (including the Work of others) that is to be inspected, tested or approved is covered without written concurrence of ENGINEER, it must, if requested by ENGINEER, be uncovered for observation. Such uncovering and subsequent replacement shall be at CONTRACTOR's expense unless CONTRACTOR has given the Construction Project Manager
timely notice of CONTRACTOR's intention to cover the same and ENGINEER has not acted with reasonable promptness in response to such notice.

13.8. If ENGINEER has issued a written concurrence with CONTRACTOR's written request for the covering of Work (including the work of others) in accordance with the provisions of Paragraph 13.7., and ENGINEER subsequently considers it necessary or advisable that said covered Work be observed by ENGINEER or inspected or tested by others, CONTRACTOR, at ENGINEER's written request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as ENGINEER may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment. If it is found that such Work is Defective, CONTRACTOR shall bear all direct, indirect and consequential costs of such uncovering, exposure, observation, inspection and testing, and of satisfactory reconstruction (including but not limited to fees and charges of engineers, architects, attorneys and other professionals), and OWNER shall be entitled to an appropriate decrease in the Contract Price; if the parties are unable to agree as to the amount thereof, ENGINEER shall make the determination, and CONTRACTOR may dispute said determination through a Claim as provided in Article 16. If, however, such Work is not found to be Defective, CONTRACTOR may be allowed an increase in the Contract Price or an extension of the Contract Times, or both directly attributable to such uncovering, exposure, observation, inspection, testing and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a Claim therefor as provided in Article 16.

OWNER May Stop the Work:

13.9. If the Work is Defective, or CONTRACTOR fails to supply sufficient skilled workers or suitable materials or equipment or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contract Documents, ENGINEER may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of OWNER to stop the Work shall not give rise to any duty on the part of OWNER, acting through the ENGINEER, to exercise this right for the benefit of CONTRACTOR or any other party.

Correction or Removal of Defective Work:

13.10. If required by ENGINEER, CONTRACTOR shall promptly, as directed, either correct all Defective Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by ENGINEER, remove it from the site and replace it with non-Defective Work. CONTRACTOR shall bear all direct, indirect and consequential costs of such correction or removal (including but not limited to fees and charges of engineers, architects, attorneys and other professionals) made necessary thereby.

13.11. One Year Correction Period:

13.11.1. If within one (1) year after the date of Substantial Completion or such longer period of time as may be prescribed by Laws or Regulations or by the terms of any applicable special guarantee required by the Contract Documents or by any specific provision of the Contract Documents, any Work is found to be Defective, CONTRACTOR shall promptly, without cost to OWNER and in accordance with OWNER's written instructions, (i) correct such Defective Work, or, if it has been rejected by OWNER, remove it from the site and replace it with Work that is not Defective and (ii) satisfactorily correct or remove and replace any damage to other work or the work of others resulting therefrom. If CONTRACTOR does not promptly comply with the terms of such instructions, or in an emergency in which delay would cause serious risk of loss or damage, OWNER may have the Defective Work corrected or the rejected Work removed and replaced, and all Claims, costs, losses and damages caused by or resulting from such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by CONTRACTOR.
13.11.2. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications or by Written Amendment.

13.11.3. Where Defective Work (and damage to other Work resulting therefrom) has been corrected, removed or replaced, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

13.11.4. Where notification of Defective Work has been given prior to the expiration of the one (1) year warranty period, and correction is not performed by the date of expiration, CONTRACTOR will be held responsible for correction of such defects.

Acceptance of Defective Work:

13.12. If instead of requiring correction or removal and replacement of Defective Work, ENGINEER (prior to recommendation of final payment) prefers to accept it, ENGINEER may do so. CONTRACTOR shall bear all reasonable direct, indirect and consequential costs attributable to ENGINEER's evaluation of and determination to accept such Defective Work (such costs to be approved by ENGINEER as to reasonableness and to include but not be limited to fees and charges of engineers, architects, attorneys and other professionals). If any such acceptance occurs prior to final payment, ENGINEER shall provide written notice of said costs to CONTRACTOR and prepare a proposed Change Order incorporating the necessary revisions in the Contract Documents and decreasing the Contract Price accordingly. If the parties are unable to agree as to the amount thereof, OWNER may make a Claim therefor in like manner to the process set forth in Article 16. If the acceptance occurs after final payment, then an appropriate amount will be paid by CONTRACTOR to OWNER.

OWNER May Correct Defective Work:

13.13. If CONTRACTOR fails within a reasonable time after written notice of ENGINEER to correct Defective Work or to remove and replace rejected Work as required by ENGINEER in accordance with Paragraph 13.11., or if CONTRACTOR fails to perform the Work in accordance with the Contract Documents, or if CONTRACTOR fails to comply with any other provision of the Contract Documents, OWNER, acting through the ENGINEER, may, after seven (7) days' written notice to CONTRACTOR, correct and remedy any such deficiency. In exercising the rights and remedies under this paragraph OWNER shall proceed expeditiously. To the extent necessary to complete corrective and remedial action, OWNER may exclude CONTRACTOR from all or part of the site, take possession of all or part of the Work, and suspend CONTRACTOR's services related thereto, take possession of CONTRACTOR's tools, appliances, construction equipment and machinery at the site, and incorporate in the Work all materials and equipment stored at the site or for which OWNER has paid CONTRACTOR but which are stored elsewhere. CONTRACTOR shall allow OWNER, OWNER's representatives, agents and employees such access to the site as may be necessary to enable OWNER to exercise the rights and remedies under this paragraph. All direct, indirect and consequential costs of OWNER in exercising such rights and remedies will be charged against CONTRACTOR, and a Change Order will be issued by the ENGINEER incorporating the necessary revisions in the Contract Documents with respect to the Work. OWNER shall be entitled to an appropriate decrease in the Contract Price therefor; and, if the parties are unable to agree as to the amount thereof, OWNER may make a Claim therefor as provided in Article 11. Such direct, indirect and consequential costs will include but not be limited to fees and charges of engineers, architects, attorneys and other professionals, all court proceedings and other alternative dispute resolution costs, and all costs of repair and replacement of Work of others destroyed or damaged by correction, removal or replacement of CONTRACTOR's Defective Work. CONTRACTOR shall not be allowed an extension of the Contract Times because of any
delay in performance of the Work attributable to the exercise by OWNER of OWNER's rights and remedies hereunder.

ARTICLE 14--PAYMENTS TO CONTRACTOR AND COMPLETION

Progress Payments:

14.1. On or before the 20th day of each calendar month, CONTRACTOR shall prepare on CONTRACTOR's template and submit to the Construction Project Manager a Draft Partial Payment Application. This Draft shall be based upon the schedule of values as provided in Paragraph 2.9 unless the Construction Project Manager advises CONTRACTOR that a more detailed schedule will be required for the Work. Progress payments relating to Unit Price Work will be based on the number of units completed. This Draft shall be based upon the quantity of Work performed and completed during the payment period, which is defined as the 21st day of the preceding calendar month through the end of the 20th day of the current calendar month. The Draft shall also conform to Paragraph 14.2.1 below.

14.2. If the Construction Project Manager agrees with the CONTRACTOR'S Draft Partial Payment Application, ENGINEER will, within ten (10) days after receipt of such Draft, issue preliminary approval or denial of such Draft.

Preliminary approval by ENGINEER of the Draft Partial Payment Application shall occur as follows. The Construction Project Manager shall fill out and sign two duplicate, preliminary copies of the Partial Payment Application form and attach any supporting documentation required by the Contract Documents that CONTRACTOR has provided to the Construction Project Manager. The Construction Project Manager shall then present the duplicate Partial Payment Applications to CONTRACTOR for CONTRACTOR'S signature. CONTRACTOR shall sign both copies of the Partial Payment Application and return them to the Construction Project Manager for final approval and processing of payment by ENGINEER. CONTRACTOR must sign the duplicates of the Partial Payment Application prior to the 30th day of each month to ensure timely payment. Payment to CONTRACTOR typically occurs on the third Thursday of each calendar month.

Preliminary denial of CONTRACTOR's Draft Partial Payment Application and any denial of final approval by ENGINEER of the Partial Payment Application shall occur as follows. ENGINEER shall provide to CONTRACTOR a written explanation of the portion denied and the basis for such denial, which shall be based upon the reasons set forth in this Article. CONTRACTOR may then accept payment for approved portions while electing to resubmit any denied portions or initiate a Claim for denied portions as provided in Article 16.

Necessary Documentation:

14.2.1. CONTRACTOR's Draft Partial Payment Application shall be accompanied by the documentation specified herein.

If payment is requested for materials and equipment not incorporated in the Work but delivered and suitably stored at the site or at a bonded warehouse agreed to in writing, the Partial Payment Application shall be accompanied by evidence of OWNER's title to the material and equipment and of sufficient insurance. (Note that payments for such materials and equipment shall be at the sole discretion of ENGINEER and shall be based only upon the actual cost of the materials and equipment to CONTRACTOR and shall not include any overhead or profit to CONTRACTOR.)

Each Partial Payment Application shall be accompanied by CONTRACTOR's updated schedule of operations and progress report with Shop Drawing schedules, submittals schedules, procurement schedules, value of materials on hand included in the
ENGINEER'S Review and Approval of Partial Payment Applications:

14.3. ENGINEER's approval of any payment will constitute a representation by ENGINEER, based on ENGINEER's on-site observations of the Work in progress and on ENGINEER's review of the Partial Payment Application and the accompanying data and schedules, that the Work has progressed to the point indicated, that, to the best of ENGINEER's knowledge, information and belief, the quality of the Work is in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, subject to the results of any subsequent tests called for in the Contract Documents, subject to a final determination of quantities and classifications for Unit Price Work under Paragraph 9.10., and subject to any other qualifications stated in the recommendation), and that CONTRACTOR is entitled to payment of the amount recommended. However, by approving any such payment, ENGINEER will not thereby be deemed to have represented that exhaustive or continuous on-site inspections have been made to check the quality or the quantity of the Work beyond the responsibilities specifically assigned to ENGINEER in the Contract Documents or that there may not be other matters or issues between the parties that might entitle CONTRACTOR to be paid additionally by OWNER or OWNER to withhold payment or receive a credit from CONTRACTOR.

14.4. ENGINEER's recommendation of a final Partial Payment Application will constitute an additional representation by ENGINEER to OWNER that the conditions precedent to CONTRACTOR's being entitled to final payment as set forth in Paragraph 14.12. have been fulfilled.

14.5. ENGINEER may refuse to approve the whole or any part of any payment if, in ENGINEER's opinion, it would be incorrect to make the representations to OWNER that are referenced in the paragraphs above. ENGINEER may also refuse to approve any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, may nullify any such payment previously approved to the extent necessary to protect OWNER from loss because:

14.5.1. the Work is Defective, or completed Work has been damaged requiring correction or replacement;

14.5.2. the Contract Price has been reduced by Written Amendment or Change Order;

14.5.3. OWNER has been required to correct Defective Work or complete Work in accordance with Paragraph 13.13.;

14.5.4. of the occurrence of any of the events enumerated in Paragraphs 15.2.1. through 15.2.9. inclusive; or

14.5.5. ENGINEER has reason to believe a Claim or lien relating to the Work has been or will be filed against CONTRACTOR.

ENGINEER may also refuse to approve a Partial Payment Application because claims have been made against OWNER and/or CONTRACTOR on account of CONTRACTOR's performance or furnishing of the Work or liens have been filed in connection with the Work or there are other items entitling OWNER to a set-off against the amount for which CONTRACTOR applied.

Retainage:

14.6. Retainage from progress payments shall be withheld as stated in the Agreement. Any such funds so retained shall not be subject to substitution by CONTRACTOR with securities or any arrangements involving an escrow or custodianship therefor, except as allowed by
Colorado Revised Statutes, Section 38-26-108, et seq. OWNER further reserves the right to apply retainage not subject to verified claims of subcontractors and suppliers to any liquidated damages due to OWNER and to 150% of the costs estimated by ENGINEER to remedy incomplete or defective Work. By executing the Agreement Form, CONTRACTOR expressly waives his right to any entitlement to the benefits of the provisions of Colorado Revised Statutes, Section 24-91-101, et seq.

**CONTRACTOR's Warranty of Title:**

14.7. CONTRACTOR warrants and guarantees that title to all Work, materials and equipment covered in any Partial Payment Application, whether incorporated in the Project or not, will pass to OWNER no later than the time of payment free and clear of all liens.

**Substantial Completion:**

14.8. When CONTRACTOR considers the entire Work ready for its intended use, CONTRACTOR shall notify the Construction Project Manager in writing that the entire Work is substantially complete (except for items specifically listed by CONTRACTOR as incomplete) and request that ENGINEER issue a letter certifying Substantial Completion. Within a reasonable time thereafter, CONTRACTOR and ENGINEER shall make an inspection of the Work to determine the status of completion. If ENGINEER does not consider the Work substantially complete, ENGINEER will notify CONTRACTOR in writing giving the reasons therefor; any disputes regarding this determination shall be resolved as set forth in Article 16. If ENGINEER considers the Work substantially complete, ENGINEER will prepare and deliver to CONTRACTOR a letter certifying Substantial Completion, which shall fix the date of Substantial Completion. At the time of delivery of the letter certifying Substantial Completion, ENGINEER will deliver to CONTRACTOR a written statement as to division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities, insurance, and warranties. ENGINEER's aforesaid letter will be binding on OWNER and CONTRACTOR until final payment.

14.9. OWNER shall have the right to exclude CONTRACTOR from certain portions of the Work after the date of Substantial Completion, but OWNER shall allow CONTRACTOR reasonable access to complete the remaining Work.

**Partial Utilization:**

14.10. Use by OWNER of any finished part of the Work, which has specifically been identified in the Contract Documents, or which ENGINEER and CONTRACTOR agree constitutes a separately functioning and usable part of the Work that can be used by OWNER without significant interference with CONTRACTOR's performance of the remainder of the Work, may be accomplished prior to Substantial Completion of all the Work subject to the following:

14.10.1. ENGINEER at any time may request CONTRACTOR in writing to permit OWNER to use any such part of the Work that ENGINEER believes to be ready for its intended use and substantially complete. If CONTRACTOR agrees, CONTRACTOR will certify to ENGINEER that said part of the Work is substantially complete and request ENGINEER to issue a letter certifying Substantial Completion for that part of the Work. CONTRACTOR at any time may notify ENGINEER in writing that CONTRACTOR considers any such part of the Work ready for its intended use and substantially complete and request ENGINEER to issue a letter certifying Substantial Completion for that part of the Work. Within a reasonable time after either such request, CONTRACTOR and ENGINEER shall make an inspection of that part of the Work to determine its status of completion. If ENGINEER does not consider that part of the Work to be substantially complete, ENGINEER will notify CONTRACTOR in writing giving the reasons therefor. If ENGINEER considers that part of the Work to be substantially complete, the provisions of
Paragraphs 14.8. and 14.9. will apply with respect to the letter certifying Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto. Prior to the Substantial Completion of all Work, OWNER reserves the right to refuse to grant CONTRACTOR's requests for letters of Substantial Completion for portions of the Work CONTRACTOR considers substantially complete.

14.10.2. ENGINEER may at any time request CONTRACTOR in writing to permit OWNER to take over operation of any such part of the Work although it is not substantially complete. Within a reasonable time thereafter, CONTRACTOR and ENGINEER shall make an inspection of that part of the Work to determine its status of completion and will prepare a list of the items remaining to be completed or corrected thereon before final payment. If CONTRACTOR does not object in writing to ENGINEER that such part of the Work is not ready for separate operation by OWNER, ENGINEER will finalize a punch list of items to be completed or corrected and will deliver such punch list to CONTRACTOR together with a written statement as to the division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, utilities, insurance, warranties and guarantees for that part of the Work, which will become binding upon OWNER and CONTRACTOR at the time when OWNER takes over such operation (unless they shall have otherwise agreed in writing and so informed ENGINEER). During such operation and prior to Substantial Completion of such part of the Work, OWNER shall allow CONTRACTOR reasonable access to complete or correct such items on said list and to complete other related Work.

14.10.3. No occupancy or separate operation of part of the Work will be accomplished prior to compliance with the requirements of Paragraph 5.16. in respect of property insurance.

Final Inspection:

14.11. Upon written notice from CONTRACTOR that the entire Work or an agreed-upon portion thereof is complete, ENGINEER will make a final inspection with CONTRACTOR and will notify CONTRACTOR in writing of all particulars in which this inspection reveals that the Work is incomplete or Defective. CONTRACTOR shall immediately take such measures as are necessary to remedy such deficiencies.

Application for Final Payment:

14.12. After CONTRACTOR has completed all corrections to the satisfaction of ENGINEER and delivered all maintenance and operating instructions, occupancy permits, schedules, guarantees, Bonds, certificates of inspection, marked-up record documents (as provided in Paragraph 6.18.) and other documents and permits as required by the Contract Documents, and after ENGINEER has indicated that the Work is acceptable (subject to the provisions of Paragraph 14.16.), CONTRACTOR may make application for final payment following the procedure for progress payments set forth above. The application for final payment shall be accompanied by all documentation called for in the Contract Documents, together with complete and legally effective releases or waivers (satisfactory to ENGINEER) of all liens and verified claims arising out of or filed in connection with the Work. In lieu thereof and as approved by ENGINEER, CONTRACTOR may furnish receipts or releases in full and an affidavit from CONTRACTOR that the releases and receipts include all labor, services, material and equipment for which a Claim could be filed and that all payrolls, material and equipment bills, and other indebtedness connected with the Work for which OWNER or OWNER's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish a release or receipt in full, CONTRACTOR may furnish a Bond or other collateral satisfactory to OWNER to indemnify OWNER against any Claim. A Final Payment Release form is included in the Contract Documents for the purposes of satisfying these requirements.
Final Payment and Acceptance:

14.13. If, on the basis of ENGINEER's observation of the Work during construction and final inspection and ENGINEER's review of the application for final payment and accompanying documentation as required by the Contract Documents, ENGINEER is satisfied that the Work has been completed and CONTRACTOR's other obligations under the Contract Documents have been fulfilled, ENGINEER will present the final Partial Payment Application to OWNER for payment. Thereupon ENGINEER will give written notice to CONTRACTOR that the Work is acceptable subject to the provisions of Paragraph 14.16. Otherwise, ENGINEER will deny payment according to the procedures set forth above. After presentation to OWNER of the Application and accompanying documentation, and with ENGINEER's recommendation and notice of acceptability, the amount recommended by ENGINEER will be paid by OWNER to CONTRACTOR. Final payment shall be made in accordance with the law and particularly in compliance with Colorado Revised Statutes, Section 38-26-107.

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

CONTRACTOR's Continuing Obligation:

14.15. CONTRACTOR's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. Neither approval of any progress payment, nor recommendation for final payment by ENGINEER, nor the issuance of a letter certifying Substantial Completion, nor any payment by OWNER to CONTRACTOR under the Contract Documents, nor any use or occupancy of the Work or any part thereof by OWNER, nor any act of acceptance by OWNER nor any failure to do so, nor any review and approval of a Shop Drawing or Sample submission, nor the issuance of a notice of acceptability by ENGINEER pursuant to Paragraph 14.13., nor any correction of Defective Work by OWNER will constitute an acceptance of Work not in accordance with the Contract Documents (except as provided in Paragraph 14.16.).

Waiver of Claims:

14.16. The making and acceptance of final payment will constitute both:

14.16.1. A waiver of all Claims by OWNER against CONTRACTOR, except Claims arising from unsettled liens, arising from Defective Work appearing after final inspection pursuant to Paragraph 14.11., or arising from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, but it will not constitute a waiver by OWNER of any rights in respect of CONTRACTOR's continuing obligations under the Contract Documents or of any Claims previously made in writing against CONTRACTOR and still unsettled; and

14.16.2. A waiver of all Claims by CONTRACTOR against OWNER other than those previously made in writing and still unsettled.
ARTICLE 15--SUSPENSION OF WORK AND TERMINATION

OWNER May Suspend Work:

15.1. OWNER may, acting through the ENGINEER, at any time and without cause, suspend the Work or any portion thereof for a period of not more than ninety (90) days by notice in writing to CONTRACTOR, which will fix the date on which Work will be resumed. CONTRACTOR shall resume the Work on the date so fixed. CONTRACTOR may be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to any suspension if CONTRACTOR makes an approved Claim therefor as provided in Article 16.

OWNER May Terminate Work:

15.2. OWNER may terminate work by CONTRACTOR for cause as set forth below upon the occurrence of any one or more of the following events:

15.2.1. If CONTRACTOR commences a voluntary case under any chapter of the Bankruptcy Code (Title 11, United States Code), as now or hereafter in effect, or if CONTRACTOR takes any equivalent or similar action by filing a petition or otherwise under any other federal or state law in effect at such time relating to bankruptcy or insolvency;

15.2.2. If a petition is filed against CONTRACTOR under any chapter of the Bankruptcy Code as now or hereafter in effect at the time of filing, or if a petition is filed seeking any such equivalent or similar relief against CONTRACTOR under any other federal or state law in effect at the time relating to bankruptcy or insolvency;

15.2.3. If CONTRACTOR makes a general assignment for the benefit of creditors;

15.2.4. If a trustee, receiver, custodian or agent of CONTRACTOR is appointed under applicable law or under Contract, whose appointment or authority to take charge of property of CONTRACTOR is for the purpose of enforcing a lien against such property or for the purpose of general administration of such property for the benefit of CONTRACTOR's creditors;

15.2.5. If CONTRACTOR admits in writing an inability to pay its debts generally as they become due;

15.2.6. If CONTRACTOR persistently fails to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficiently skilled workers or suitable materials or equipment or failure to adhere to the progress schedule established under Paragraph 2.9. as revised from time to time);

15.2.7. If CONTRACTOR disregards Laws or Regulations of any public body having jurisdiction;

15.2.8. If CONTRACTOR disregards the authority of ENGINEER; or

15.2.9. If CONTRACTOR otherwise violates in any substantial way any provisions of the Contract Documents.

OWNER may, after giving CONTRACTOR and Surety seven (7) days' written notice and to the extent permitted by Laws or Regulations, terminate work by CONTRACTOR, exclude CONTRACTOR from the site and take possession of the Work and of all CONTRACTOR's tools, appliances, construction equipment and machinery at the site and use the same to the full extent they could be used by CONTRACTOR (without liability to CONTRACTOR for trespass or...
conversion), incorporate in the Work all materials and equipment stored at the site or for which OWNER has paid CONTRACTOR but are stored elsewhere, and finish the Work as OWNER may deem expedient. In such case CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds the direct, indirect and consequential costs of completing the Work (including but not limited to reasonable fees and charges of engineers, architects, and other professionals and court costs) such excess will be paid to CONTRACTOR. If such costs exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such costs incurred by OWNER will be incorporated in a Change Order, but when exercising any rights or remedies under this paragraph, OWNER shall not be required to obtain the lowest price for the Work performed.

Where CONTRACTOR's services have been so terminated by OWNER, the termination will not affect any rights or remedies of OWNER against CONTRACTOR then existing or that may thereafter accrue. Any retention or payment of moneys due CONTRACTOR by OWNER will not release CONTRACTOR from liability. Where CONTRACTOR's services have been terminated by OWNER and OWNER has declared CONTRACTOR in default pursuant to the performance bond, if it is determined that OWNER's declaration of default and/or termination was invalid or that CONTRACTOR's delay was excusable, then said termination shall be deemed an OWNER termination pursuant to Paragraph 15.3 except that CONTRACTOR shall not be paid consequential costs.

15.3. Upon 7 days' written notice to CONTRACTOR, OWNER may terminate work by CONTRACTOR without cause. In such case, CONTRACTOR shall be paid for all Work executed and any expense sustained, plus reasonable termination expenses, which will include but not be limited to direct and indirect costs.

CONTRACTOR May Suspend or Terminate Work:

15.4. If for a period of more than ninety (90) days, through no act or fault of CONTRACTOR, the Work is suspended by OWNER, the Work is suspended under an order of court or other public authority, or ENGINEER persistently fails to act in accordance with the payment procedures set forth in Article 14, then CONTRACTOR may, upon seven (7) days' written notice to OWNER through the Construction Project Manager, terminate Work and recover from OWNER payment for all Work executed and any expense sustained plus reasonable termination expenses, which will include but not be limited to, direct and indirect costs. The provisions of this paragraph shall not relieve CONTRACTOR of the obligation to carry on the Work in accordance with the progress schedule and without delay during disputes and disagreements with OWNER.

ARTICLE 16--CLAIMS AND DISPUTES

All claims and disputes arising hereunder shall be resolved as set forth below. The rights and remedies of the OWNER hereunder are in addition to and separate from the provisions of Chapter 8 of Article 20 of Title 13, Colorado Revised Statutes, as they may be amended.

16.1 Sole Claims Process

It is expressly agreed that the following process is the sole means of preserving the parties' respective rights and claims under the Contract. Although other communications related to issues during the Work are also likely to occur, they cannot waive the provisions of this Article, which set forth the only dispute resolution mechanism for claims, regardless of the theory of entitlement asserted by the parties, subcontractors or suppliers.

Failure to meet the requirements of this Article in a timely and complete manner shall constitute a waiver of all remedies and related rights and claims, either by administrative review or by any other action at law or equity.
Pending resolution of any Claim, the parties shall proceed diligently with performance of the Contract. CONTRACTOR's failure to proceed with the Work shall be considered a breach of the Contract and/or grounds for suspension or termination of the Contract.

16.2 Notice of Intent to Submit Claim

If the CONTRACTOR has complied with the requirements herein, and if the CONTRACTOR receives and disagrees with a decision regarding the issuance of a requested Written Amendment, Change Order, a Field Order, or a Work Change Directive, regarding an equitable adjustment in compensation or time, regarding liquidated damages or other charges, or regarding any other event that may give rise to a claim under the Contract, and the CONTRACTOR intends to submit a claim therefor, the CONTRACTOR must submit to the Construction Project Manager a written Notice of Intent to Submit Claim. The Notice of Intent to Submit Claim shall be clearly titled as such, signed and dated. If the CONTRACTOR has previously submitted such a Notice, subsequent notices shall be numbered sequentially “Second Notice of Intent to Submit Claim,” etc. The Notice of Intent to Submit Claim must also contain, at a minimum, the following information, clearly designated:

- Board Contract Number and Project Name;
- Date of the event giving rise to the Claim;
- A description of the Claim and the events giving rise to the Claim, including the original request and related decisions or denials;
- The reasons why the CONTRACTOR believes its request is appropriate;
- An accounting, including documentation, or estimate of all additional costs associated with the Claim (If an estimate is provided, documentation must be provided with the Claim as described below.); and
- CONTRACTOR's plan for mitigating costs or delays associated with the Claim.

CONTRACTOR shall submit the Notice of Intent to Submit Claim described above within twenty (20) days of the decision or denial that gives rise to the claim. However, no claim for a change in Contract Times based on claimed abnormal weather may be made more than twenty (20) days after the conclusion of the weather event claimed to be abnormal.

CONTRACTOR waives any claims not submitted within these time frames.

16.3 Submittal of the Claim

The CONTRACTOR shall, within fifteen (15) days after it submits a Notice of Intent to Submit Claim, submit to the Director of Engineering, Denver Water, 1600 W. 12th Avenue, Denver, Colorado 80204, with a copy to the Construction Project Manager, a complete and itemized written Claim in the form described below.

(The CONTRACTOR shall have an extension of time to submit the Claim, if, and only if, within fifteen (15) days of submitting a Notice of Intent to Submit Claim, the CONTRACTOR submits in writing to the Director of Engineering at the address above a Statement of Good Cause for Extension to Submit Claim. This Statement shall set forth the CONTRACTOR's good cause for the extension, and good cause shall include only extraordinary circumstances and not ordinary business matters such as scheduling and staffing. The extension shall continue for so long as the condition comprising the good cause continues.)
The written Claim shall be clearly titled as such, signed and dated. If the CONTRACTOR has previously submitted such a Claim, subsequent Claims shall be numbered sequentially “Second Claim,” etc. The Claim must include, at minimum, the information required above with regard to the Notice of Intent to Submit Claim and supporting detail sufficient for evaluation of the basis of and costs associated with the Claim. A Claim for an increase in Contract Price should be based on actual costs rather than an estimate or opinion, shall be supported by invoices, time cards, and other business records commonly accepted in the industry, and shall comply with the requirements of this Agreement. The Claim shall include specific references to Contract Documents and any other documents supporting the Claim and shall also include a summary of any legal and factual theories supporting the Claim. The Claim must include copies of any relevant documents except that copies of Contract Documents are not required. A Claim for time extension must be accompanied by a revision to the progress schedule described in Paragraph 2.6.1 that also shows the effects of the delay on the completion of critical path activities and must be accompanied by a description of actions the CONTRACTOR has taken or proposes to take to minimize the effects of the delay. The Claim shall also identify any measures it believes OWNER or ENGINEER can take to minimize the Claim. Finally, the Claim shall include a notarized certificate, executed under penalties of perjury, that:

- the Claim is made in good faith;
- all supporting data are accurate and complete to the best of the CONTRACTOR’s knowledge and belief;
- the amount requested accurately reflects the total adjustment or relief that will be requested by the CONTRACTOR related to the described event; and
- the prices stated for material and equipment are the lowest reasonably available to the CONTRACTOR and include all available discounts.

If the CONTRACTOR is an individual, the certification shall be executed by that individual; if the CONTRACTOR is not an individual, the certification shall be executed by an officer or general partner of the CONTRACTOR.

The CONTRACTOR shall furnish at no cost, upon request, all additional information and data relevant to the Claim including the CONTRACTOR’s books, correspondence, records, electronic files and databases. Failure to submit requested information may be a basis for denial of the Claim.

Failure to submit the Claim in writing within the time and in the manner described above shall constitute a waiver by the CONTRACTOR of any right, equitable or otherwise, to make such Claim. Neither OWNER nor ENGINEER is obligated to inform the CONTRACTOR of CONTRACTOR’s failure to comply with this process or to assist CONTRACTOR in submitting a Claim.

CONTRACTOR may amend a previously submitted claim by submitting to the Director of Engineering, with a copy to the Construction Project Manager, a complete and itemized written Amended Claim in the same form as the Claim described above. If the CONTRACTOR has previously submitted such an Amended Claim, subsequent Amended Claims shall be numbered sequentially “Second Amended Claim,” etc. However, an Amended Claim will not revive a claim that has been waived as described in the preceding paragraph.

16.4 Resolution of the Claim

The Director of Engineering shall investigate, review, and evaluate the Claim and make a written, dated determination regarding the claim within sixty (60) days of receipt of a Claim that meets the requirements stated above unless special circumstances exist or the Claim is unusually complex, in which case the Director of Engineering will notify CONTRACTOR in writing that an
extended period of time is required and shall state the reasons that an extended period of time is required and how much time is required. If the Director of Engineering does not make a written determination within sixty (60) days of receipt of the Claim or within sixty (60) days of an extended period of time, the claim is deemed to be denied. Any written decision shall be transmitted to the CONTRACTOR immediately.

If the CONTRACTOR agrees with any determination or resolution by the Director of Engineering, such determination or resolution shall be processed as a Change Order or Written Amendment.

If the CONTRACTOR disagrees with the Director of Engineering’s written determination, then CONTRACTOR may, within thirty (30) days of the date of such determination, initiate an appeal of said determination by sending to the Director of Engineering a written Notice of Intent to Appeal to 1600 W. 12th Avenue, Denver, Colorado 80204 and a copy thereof to General Counsel, 1600 W. 12th Avenue, Denver, Colorado 80204. The Notice of Intent to Appeal shall contain a copy of the written determination being appealed, if any, and a short statement of the basis of the appeal. The conduct of the Appeal shall conform to the process described below.

16.5 Administrative Hearing

The Notice of Intent to Appeal and the conduct of the Appeal shall comply with the hearing and appeal procedures set forth at Chapter 17 of the Board’s Operating Rules, available at www.denverwater.org.

If a question arises concerning whether any issue or claim raised in an administrative hearing is within the scope of the Contract’s dispute resolution provisions, such question shall be decided by the hearing officer assigned to the administrative hearing.

All disputes of any nature whatsoever regarding the Contract, including without limitation claims for additional compensation or extensions of time, and disputes involving claimed breach of or default under the Contract, shall be resolved by the process described in this Article. The determination of the hearing officer on appeal shall be considered a final order and action of the Board and may be reviewed under Rule 106(a)(4) of the Colorado Rules of Civil Procedure only.

16.6 General

Should OWNER or CONTRACTOR suffer injury or damage to person or property because of any error, omission or act of the other party or of any of the other party's employees or agents or others for whose acts the other party is legally liable, notice will be made in writing to the other party within a reasonable time of the first observance of such injury or damage. The provisions of this Paragraph 16.6. shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitations or repose.

The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and, in particular but without limitation, the warranties, guarantees and obligations imposed upon CONTRACTOR by Paragraphs 6.30., 13.1., 13.11., 13.13., 14.7. and 15.2. and all of the rights and remedies available to OWNER and ENGINEER thereunder, are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them that are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee or by other provisions of the Contract Documents, and the provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right and remedy to which they apply. All representations, warranties and guarantees made in the Contract Documents will survive final payment and termination or completion of the Agreement. Notwithstanding the foregoing, the parties agree that no profits that CONTRACTOR might realize from other work are within the scope of the parties’ agreement, and they further agree that CONTRACTOR waives any
right to recover and will not be compensated for any such lost profits or other consequential damages related to any breach by OWNER hereunder.

ARTICLE 17--MISCELLANEOUS

Giving Notice:

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

17.2. Computation of Time:

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

17.2.2. A calendar day of 24 hours measured from midnight to the next midnight shall constitute a day.

17.2.3. All references to days in the Contract Documents shall mean calendar days.

Equal Employment Opportunities:

17.3. The CONTRACTOR agrees not to discriminate against any employee, applicant for employment, or potential subcontractor or supplier because of race, color, religion, age, national origin, gender, sexual orientation, military status, marital status, or disability. The CONTRACTOR agrees to comply with all applicable state and federal laws with regard to Equal Employment Opportunity.

Sanitary Conveniences:

17.4. The CONTRACTOR shall provide sanitary conveniences for use of all persons employed on the Work. All sanitary conveniences shall be satisfactory to the ENGINEER and conform to the regulations of public authority having jurisdiction over such matters. At the completion of the Work, such sanitary conveniences shall be removed and the premises left in such condition that they will not be unsanitary.

Gaseous Hazards and Confined Spaces:

17.5. The CONTRACTOR shall comply with all Laws or Regulations related to entry into confined spaces and shall provide and properly maintain all required safety equipment. In accordance with Article 6, CONTRACTOR shall instruct its personnel in the proper use of the equipment and required procedures for access to confined spaces.

17.6. Environmental Considerations:

17.6.1. The CONTRACTOR shall restrict its construction activities to those methods that will prevent the entrance or accidental spillage of contaminants, debris or other objectionable pollutants and wastes into storm sewers, streams, water courses, reservoirs, or underground water sources. Dewatering of trenches and structure
foundations shall be done in a manner so as to prevent muddy water or eroded material from entering any drainage facility or waterway. Turbidity increases in a stream or other bodies of water that are caused by the construction activity shall be limited to the increases above the natural turbidities permitted under the state water quality standards for that stream or body of water or by specific authorization from the appropriate governmental agency.

17.6.2. The CONTRACTOR shall conduct its construction activity in a manner that will maintain the noise level below the decibel limit set by the local governing authority. The CONTRACTOR shall comply with all applicable federal, state and local laws, orders or regulations concerning the prevention, control and abatement of excessive noise.

17.6.3. The CONTRACTOR shall comply with all applicable federal, state and local laws, orders or regulations concerning the prevention and abatement of air pollution. During construction, the CONTRACTOR shall utilize such practicable methods and devices that are available to control, prevent and otherwise minimize atmospheric emission of air contaminants.

Burning of materials resulting from the clearing of trees and brush, construction materials and other rubbish will not be permitted. Equipment and vehicles that show excessive emission of exhaust gases due to poor engine adjustments or inefficient operating conditions shall not be used until corrective repairs or adjustments are made.

17.6.4. During the performance of the Work required by these Specifications or of any operations appurtenant thereto, whether on right-of-way provided by the OWNER or elsewhere, the CONTRACTOR shall furnish all the labor, equipment, materials and means required, and shall carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance and to prevent dust that has originated from its operations from damaging dwellings or causing a nuisance to persons. The CONTRACTOR shall be liable for any damage resulting from dust originating from its operations under these Specifications in the streets, OWNER right-of-way or elsewhere. The cost of sprinkling or of other methods of reducing formation of dust shall be included in the price Bid in the schedule for other items of Work.

17.7. Water for Construction Purposes:

17.7.1. The OWNER will furnish water for construction purposes free of charge to the CONTRACTOR at hydrants located within the City and County of Denver or within total service and read and bill water districts. Hydrants located in Master Meter Water Districts are outside of the control of the OWNER, and the CONTRACTOR must make arrangements with the water districts in question and pay all fees or charges required by the districts. A list of hydrants that would be accessible to the CONTRACTOR but are located in a Master Meter area may be obtained from ENGINEER.

17.7.2. The CONTRACTOR will be required to obtain a hydrant permit listing each hydrant used and a water tank wagon permit for each tank wagon used from the OWNER. The permits are free of charge and shall be in possession of the CONTRACTOR at the hydrant during the time the hydrant is being used. The permits will be valid for a period of one (1) year from the time of issuance or until Contract completion, whichever occurs first. Any damage done to the hydrant by the CONTRACTOR will be repaired by the OWNER, with the actual cost of such repairs billed to the CONTRACTOR.

In accordance with the Board’s Engineering Standards and Operating Rules, CONTRACTOR shall provide and use the required, approved and properly supported fire hydrant meter, backflow prevention device and gate valve. CONTRACTOR is subject to OWNER’s hydrant use rules, regulations and fines for violation.
17.7.3. The OWNER will furnish to the CONTRACTOR free of charge all water required for testing and all chlorine required for sterilization. The OWNER may perform all labor necessary to fill the facility requiring testing with water and will insert the chlorine into the facility for final sterilization, but the CONTRACTOR must perform all other labor.

17.8. Electrical Power for Construction Purposes:

17.8.1. The CONTRACTOR shall make all necessary arrangements and shall provide all electric power required for its construction purposes. This shall include providing all necessary transmission lines, distribution circuits, transformers and other electrical equipment required for distributing the power to the place or places of use by the CONTRACTOR.

17.8.2. At the termination of the Contract under these Specifications, the CONTRACTOR shall dismantle and remove all distribution lines and appurtenant equipment serving its installations or those of its Subcontractors that are not part of the permanent power installation.

17.8.3. In the event that the CONTRACTOR is working on properties owned by the OWNER, the CONTRACTOR will be allowed to take power from the nearest usable source where available. CONTRACTOR is responsible for obtaining any supplemental power or equipment upgrades necessary to perform the Work. The OWNER will not charge the CONTRACTOR for the power, but the CONTRACTOR will be responsible for installation and removal of all distribution lines and appurtenant equipment necessary for supplying the power to its place of use and for any measures that are necessary to protect OWNER’s facilities from faults.
SUPPLEMENTARY CONDITIONS

SC-1 SCOPE. These Supplementary Conditions amend or supplement the General Conditions and other provisions of the Contract Documents. All provisions not so amended or modified remain in full force and effect.

SC-2 ARTICLE 4—AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; REFERENCE POINTS. Delete Paragraph 4.3. in its entirety and replace it with the following:

4.3. Physical Conditions specifically consisting of Underground and Underwater Facilities. In addition to the foregoing Paragraph 4.2, the following shall apply to Physical Conditions of the site that consist specifically of Underground and Underwater Facilities.

4.3.1. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground and Underwater Facilities at or contiguous to the site is based on information and data furnished to ENGINEER by the OWNER or by the owners of such Underground and Underwater Facilities or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

4.3.1.1. OWNER shall not be responsible for the accuracy or completeness of any such information or data; and,

4.3.1.2. CONTRACTOR shall have full responsibility for reviewing and checking all such information and data, for locating all Underground and Underwater Facilities shown or indicated in the Contract Documents, for coordination of the Work with the owners of such Underground and Underwater Facilities during construction, for the safety and protection thereof as provided in Paragraph 6.19. and for repairing any damage thereto resulting from the Work, the cost of all of which will be considered as having been included in the Contract Price. CONTRACTOR shall perform this review, checking and locating shown or indicated Underground and Underwater Facilities prior to construction, with sufficient lead time to allow OWNER or the owners of Underground and Underwater Facilities to correct or mitigate interferences with the Work.

4.3.2. Not Shown or Not Indicated: If an Underground or Underwater Facility exists at or contiguous to the site that was not shown or indicated in the Contract Documents and that CONTRACTOR could not reasonably have been expected to be aware of, CONTRACTOR shall, promptly (but no later than forty-eight (48) hours) after becoming aware thereof and before performing any Work affected thereby (except in an emergency as permitted by Paragraph 6.22.), identify the owner of such Underground or Underwater Facility and give written notice thereof to that owner and to the Construction Project Manager. ENGINEER will promptly review the Underground or Underwater Facility to determine the extent to which the Contract Documents should be modified to reflect and document the consequences of the existence of the Underground or Underwater Facility, and the Contract Documents shall be amended or supplemented to the extent necessary. During such time, CONTRACTOR shall be responsible for the safety and protection of such Underground or Underwater Facility as provided in Paragraph 6.19.

CONTRACTOR shall expect normal utility service lines to all commercial and residential properties, which include water, sewer, telephone, cable television, gas and electric. Such lines will not normally be shown in the Contract Documents, and CONTRACTOR shall not be entitled to any adjustment of Contract Price or Contract Times associated with work to locate, avoid, relocate or repair such services. The fact that some or any of the service lines are shown on the Drawings is not a representation that all service lines are shown or indicated.
5.3.2. Commercial general liability insurance with limits of not less than $10,000,000 per occurrence. Such insurance shall include “The City and County of Denver, Acting By and Through its Board of Water Commissioners” as additional insured and shall be primary and non-contributing with respect to any insurance or self-insurance program of the Board. CONTRACTOR shall maintain this insurance for two years after final payment and for the duration of the applicable Colorado statute of repose.
SECTION 01 11 00
SUMMARY OF WORK

PART 1   GENERAL

1.1 SUMMARY
A. This Section covers Work under this Contract.

1.2 WORK COVERED BY CONTRACT DOCUMENTS
A. The City and County of Denver, acting by and through its Board of Water Commissioners (OWNER), has authorized this Project, entitled: Cheesman Dam Upstream Control Project Phase 1, located on the South Platte River in Jefferson County, Colorado.

1. Phase 1A work generally includes building construction, specialized equipment procurement and installation, and specialized electrical work. Other major portions of this project include:
   a. Demolish and remove old Shaft House building.
   b. Furnish and install reinforced concrete building and finishes including doors, windows, and insulation.
   c. Furnish and install control building mechanical equipment.
   d. Install OWNER furnished Hydraulic Power Unit and test.
   e. Start up testing of building mechanical and electrical equipment, including owner furnished equipment.
   f. Furnish and install electrical conduit and transmission lines within supplied rock bore hole, and lighting from the new Control Building to the existing Valve House, by routing through the manway.
   g. Furnish and install new electrical conduit and lighting in the dam manway tunnel.
   h. Furnish and install new electrical and control transmission from the flume to the valve house.
   i. Upgrade electrical panels, control panels, and appearances within the valve house.
   j. Upgrade electrical panels, control panels, and appearances within the caretakers office.

2. Phase 1B work generally includes underwater specialty construction:
   a. Demolition and removal of existing trashrack structure, including frames and structural steel supports, at the Auxiliary Slide Gate location.
   b. Installation of OWNER-furnished hydraulic power unit within control building.
   c. Controlled rock blasting at the tunnel entrance at the Auxiliary Intake location.
   d. Installation of OWNER-furnished stainless steel spool and slide gate at the Auxiliary Level Intake.
   e. Installation of OWNER-furnished trashrack (four sections each) at the Auxiliary Intake location.
   f. Drilling of a 16 inch inclined bore hole from the left dam abutment to the Auxiliary Level Intake.
   g. Hydraulic and air line assembly installation within the inclined bore hole, and hydraulic line installation from the bore hole exit to the auxiliary slide gate cylinder.
   h. Demolition and removal of existing trashrack structure, including frames and structural steel supports, at the Mid Level inlet.
   i. Controlled rock blasting within the Mid Level Intake location.
   j. Installation of OWNER-furnished stainless steel spool and slide gate at the Mid Level Intake.
   k. Installation of OWNER-furnished trashrack (four sections each) at the Mid Level Intake location.
l. Demolition and removal of existing trashrack structure, including frames and structural steel supports, at the Low Level location.
m. Controlled rock blasting within the Low Level Slide Intake location.
n. Installation of Low Level Slide Gate and Spool.
o. Installation of Low Level Trashrack and leveling concrete.
p. Drilling of a 16 inch inclined drill hole from the left dam abutment to the Mid Level Intake.
q. Installation of Hydraulic and air line assembly within the inclined bore hole, installation of the hydraulic lines and air lines from the bore hole exit to the mid-level and low level gate actuators, connection of hydraulic lines to the HPU, and connection of the air lines to the bubbler system compressor.
r. Functional and performance testing of Slide Gates.
s. Drilling of a 16 inch inclined drill hole from the left dam abutment to the Manway House located on the downstream left abutment of the dam.

1.3 OWNER-FURNISHED MATERIALS
A. Reference SECTION 13 00 50
B. Auxiliary Slide Gate and Spool
C. Mid Level Slide Gate and Spool
D. Low Level Slide Gate and Spool
E. Auxiliary Trashrack
F. Mid Level Trashrack
G. Low Level Trashrack
H. Hydraulic Power Unit

1.4 ACCESS TO SITE
A. The project is located in Jefferson County, Colorado in the Pike National Forest. The major access from Denver, Colorado is west on U.S. Highway 285 to Pine Junction, and south on Colorado Highway 126 approximately 20 miles to Forest Road 211, also known as Trough Road, then west for approximately 3 miles to the site. The Forest Service Road is a one and one half wide lane road with steep grades (up to 10%) and tight turning radii. Historically, large 18-wheel trucks have used this road to deliver equipment and materials to the dam site. The site is a secured site requiring pre-authorized security clearance.
B. Reference SECTION 01 31 00.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A.  Section Includes:
   1.  Submittals.
   2.  Schedule of Values.
   3.  Application for Payment.
   4.  Payment.
   5.  Nonpayment for rejected or unused products.
   6.  Partial payment for stored materials and equipment.

B.  Related Documents:
   1.  General Conditions.
   2.  Final Payment Release
   3.  Contract Agreement Form

C.  Related Sections:
   1.  SECTION 01 32 16 – PROGRESS SCHEDULES

1.2  SUBMITTALS

A.  Schedule of Values: Submit on ENGINEER approved form.

B.  Schedule of Estimated Progress Payments:
   1.  Submit with Schedule of Values.
   2.  Submit adjustments with Applications for Payment.

C.  Application for Payment: Submit monthly.

D.  Final Application for Payment: Submit in accordance with Final Payment Release.

1.3  SCHEDULE OF VALUES

A.  Prepare Schedule of Values for Work under Agreement in accordance with ARTICLE 2 and ARTICLE 14 of the General Conditions.

B.  Contract Schedule of Values indicates major categories of Work for purpose of comparative proposal analysis, payment breakdown for monthly progress payments, and additions or deductions. Items are not intended to be inclusive descriptions of work categories.

C.  Description of Items for Phase 1A Work:
   1.  Furnish and install Control Building, equipment, electrical, instrumentation and controls throughout the site, complete in place:
      a.  This item consists of demolition and removal of the old shaft house superstructure, furnish and install a cast-in-place control building and finishes, control building mechanical equipment, including the bubbler air compressors, standby generator, louvers, piping, ducts and miscellaneous material; furnishing and installing of control building electrical panels, control panels, lighting and wiring of all mechanical equipment; furnishing and installing new power transmission conduit and
wiring to the control building. New electrical conduit, wiring and controls throughout the Cheesman facility, including electrical conduit and wiring within the new drill hole and through the manway to the valve house, new lighting within the manway, new conduit, wiring, and control to the downstream measurement flume, new electrical and controls within the valve house, and new electrical and controls within the caretaker office.

b. Measurement: The unit of measurement for this item is Lump Sum.

D. Description of Items for Phase 1B Work:

1. Initial Underwater site survey/inspection:
   a. This item consists of detailed surveys and inspections of the three tunnels and tunnel entrances for a distance of 15 feet inside and either side of the tunnel portals after removal of the exiting trashracks and trashrack support beams prior to construction activities related to the new installations. This item includes all cost associated with performing all survey and inspection work including preparation of AutoCAD plan and section drawings of each location.
   b. Measurement: The unit of measurement for this item is Lump Sum.

2. Installation of OWNER-furnished hydraulic power unit:
   a. This item consists of installation of the OWNER-furnished hydraulic power unit.
   b. Measurement: The unit of measurement for this item is Lump Sum.

3. Demolish and Remove Auxiliary Level Trashrack:
   a. This item consists of the demolition and removal of the welded structural steel Trashrack at the Auxiliary Level intake. The work is to be completed underwater a depth as shown on the Drawings.
   b. Measurement: The unit of measurement for this item is Lump Sum.

4. Rock Blasting at Auxiliary Level:
   a. This item consists of rock blasting and disposal at the Auxiliary Level tunnel portal.
   b. Measurement: The unit of measurement for this item is cubic-feet removed from the tunnel area up to the B-line shown on the drawings. Any removal of rock beyond the B-Line is for the contractor’s convenience and will not be reimbursed by the OWNER.

5. Installation of OWNER-furnished Auxiliary Slide Gate and Spool:
   a. This item consists of the installation and anchoring of the Auxiliary Level Spool, backfill spool grouting, and installation of the slide gate.
   b. Measurement: The unit of measurement for this item is Lump Sum.

6. Installation of OWNER-furnished Auxiliary Level Trashrack:
   a. This item consists of the installation of the OWNER-furnished Auxiliary Level trashrack and leveling concrete.
   b. Measurement: The unit of measurement for this item is Lump Sum.

7. Drilling of Inclined Bore Hole to Auxiliary Level Intake:
   a. This item consists drilling a 16 inch diameter inclined bore hole, cased, cemented, and finished, from the left dam abutment to an area adjacent to the Auxiliary Level Intake.
   b. Measurement: The unit of measurement for this item is Lump Sum.

8. Furnish and Install Hydraulic and air line assembly within Auxiliary Inclined Bore Hole:
   a. This item consists of the installation of the hydraulic lines and air lines within the inclined rock boring, including all tubing, assembly pieces, grout lines, and finish grouting.
   b. Measurement: The unit of measurement for this item is lump sum.

9. Install Hydraulic Lines from Auxiliary Rock Bore Hole Outlet to the Auxiliary Slide Gate:
   a. This item consists of the installation of the hydraulic lines and air lines along the rock abutment face from the rock bore hole exit location to the
Auxiliary Slide Gate cylinder, connection of the hydraulic lines to the slide gate actuator, and installation of the air lines.

b. Measurement: The unit of measure for this item is Linear Feet of hydraulic line.

10. Demolish and Remove Mid Level Trashrack:
   a. This item consists of the demolition, removal, and disposal of the Mid Level Trashrack structural steel.
   b. Measurement: The unit of measure for this item is Lump Sum.

11. Rock Blasting at Mid Level:
   a. This item consists of controlled rock blasting within the interior of the tunnel to provide an adequate opening for the slide gate spool.
   b. Measurement: The unit of measure for this item is per cubic feet of removed rock up to the B-Line shown on the drawings. Any removal of rock beyond the B-Line is for the CONTRACTOR’s convenience and will not be reimbursed by the OWNER.

12. Installation of OWNER-furnished Mid Level Slide Gate and Spool:
   a. This item consists of installation and anchoring of the Mid Level Spool, backfill spool grouting, and installation of the slide gate.
   b. Measurement: The measurement of this item is Lump Sum.

13. Installation of OWNER-furnished Mid Level Trashrack:
   a. This item consists of installation of the OWNER-furnished Mid Level Trashrack structure, anchors, and leveling concrete.
   b. Measurement: The measurement of this item is Lump Sum.

14. Demolish and Remove Low Level Temporary Trashrack:
   a. This item consists of demolition, removal, and disposal, of the Low Level Trashrack structural steel, masonry, concrete, and embedments.
   b. Measurement: The measurement of this item is Lump Sum.

15. Rock Blasting at Low Level Intake:
   a. This item consists of controlled mortar and rock blasting above the tunnel portal and within the tunnel.
   b. Measurement: The measurement of this item is per cubic feet of mortar and rock removed up to the B-Line shown on the drawings. Any removal of rock beyond the B-Line is for the CONTRACTOR’s convenience and will not be reimbursed by the OWNER.

16. Installation of OWNER-furnished Low Level Slide Gate and Spool:
   a. This item consists of the installation and anchoring of the Low Level spool, backfill grouting, and installation of the slide gate.
   b. Measurement: The measurement of this item is Lump Sum.

17. Installation of OWNER-furnished Low Level Trashrack:
   a. This item consists of the installation of the Low Level Trashrack structure, anchors, and leveling concrete.
   b. Measurement: The measurement of this item is Lump Sum.

18. Drilling of Inclined Bore Hole to Mid Level Intake:
   a. This item consists drilling a 16 inch diameter inclined bore hole, cased, cemented, and finished from the left dam abutment to an area adjacent to the Mid Level intake.
   b. Measurement: The unit of measurement for this item is Lump Sum.

19. Furnish and Install Hydraulic and air line assemblies within Inclined Bore Hole Mid/Low Level
   a. This item consists of the furnishing and installation of the hydraulic lines and air bubbler lines within the existing 16 inch diameter rock bore hole servicing both the Mid and Low Level outlets, including all tubing, assembly pieces, grout lines, and finished grouting.
   b. Measurement: The unit of measurement for this item is Lump Sum.

20. Furnish and Install Hydraulic and air line assembly from Existing Mid/Low Level Rock Bore Hole Outlet to Mid Level Gate
   a. This item consists of the furnishing and installation of the hydraulic lines and air lines along the rock abutment face from the mid/low level rock bore hole exit location to the Mid Level Gate cylinder, connection of the
21. Furnish and Install Hydraulic and air line assembly from Existing Mid/Low Level Rock Bore Hole Outlet to Low Level Gate
   a. This item consists of the installation of the hydraulic lines and air lines along the rock abutment face from the mid/low level rock bore hole exit location to the Low Level Gate actuator, connection of the hydraulic lines to the slide gate actuator, and installation of the air line outlet.
   b. Measurement: The unit of measure for this item is linear feet of hydraulic lines.

22. Drilling of Inclined Bore Hole to downstream Manway House:
   a. This item consists drilling a 16 inch diameter inclined bore hole, cased, cemented, and finished, from the left dam abutment to the Manway House located on the downstream left abutment.
   b. Measurement: The unit of measurement for this item is Lump Sum.

23. Mobilization (not to exceed 15% of Total):
   a. Perform all operations in connection with preparatory work, including Performance Bond, mobilization and demobilization of personnel, equipment, and supplies, site specific work to launch barges and specialty equipment and supplies and establishment and removal of all necessary facilities for the execution of the Contract Work.
   b. Payment shall be based on a lump sum price bid, not to exceed the value stated on the Bid Form.
   c. Progress payments for mobilization will be made as the work progresses as follows:
      1) When 10% of the Contract amount is earned, 25% of the mobilization bid item will be paid.
      2) When 25% of the Contract amount is earned, 50% of the mobilization bid item, less previous payments, will be paid.
      3) When 50% of the Contract amount is earned, 75% of the mobilization bid item, less previous payments, will be paid.
      4) When 75% of the Contract amount is earned, 100% of the mobilization bid item, less previous payments, will be paid.
   d. Retainage as described in the Agreement shall also apply to progress payments for mobilization.

E. Unbalanced and front-end loaded schedules not acceptable.

F. Total of Schedule of Values shall equal Contract Price.

1.4 APPLICATION FOR PAYMENT
A. Use approved Application for Payment Form.

B. Submit on date stated in ARTICLE 14 of the General Conditions.
   1. Include accepted Schedule of Values.

C. Submit updated Project Schedule in accordance with SECTION 01 32 16 and the General Conditions with each Application for Payment.

D. Preparation:
   1. Round values to nearest dollar.
   2. List each Change Order and Written Amendment executed prior to date of submission as separate line item.
3. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment and include Request for Payment of Materials and Equipment on Hand.
4. Execute certification by authorized officer of CONTRACTOR.

1.5 PAYMENT

A. Progress payments will be made in accordance with the Contract Agreement Form and ARTICLE 14 of the General Conditions.

1.6 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:
   1. Loading, hauling, and disposing of rejected material.
   2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
   3. Rejected loads of material, including material rejected after it has been placed for failure to conform to provisions of Contract Documents.
   4. Material not unloaded from transporting vehicle.
   5. Defective Work not accepted by OWNER.
   6. Material remaining on hand after completion of Work.

1.7 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: Will be made for materials and equipment delivered or stored only if materials are accepted and the General Conditions requirements are met.

B. Final Payment: Will be made only for materials incorporated in Work; remaining materials, for which partial payments have been made, shall revert to CONTRACTOR unless otherwise agreed and partial payments made for those items will be deducted from final payment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY
A. This Section covers coordination required by the CONTRACTOR during construction.
B. Coordination of OWNER's Work by Others: Reference the General Conditions for coordination of OWNER's work by others, if any, and coordinate CONTRACTOR's Work with the ENGINEER.
C. Coordinate with the OWNER and ENGINEER to avoid delays to other contracts or other normal OWNER activities on or near the construction site. This includes, but is not limited to, hauling fill material to the site, vehicle traffic near the adjacent facilities, other onsite contractors, and reservoir operating level.

1.2 RELATED WORK AT SITE
A. Other work that is either directly or indirectly related to the scheduled performance of Work under these Contract Documents is anticipated to be performed at site by others.
B. Plan, schedule, and coordinate Work in a manner which will facilitate the simultaneous progress of the Work under this Contract and the work included under other contracts outside the scope of these Contract Documents.

1.3 UTILITIES
A. Coordinate Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work.
   1. Denver Water Department:
      a. Contact Person: Mr. Kjell Moe
      b. Telephone: 303-628-6200
B. OWNER will isolate gas, power and water.
C. Be responsible for bypass facilities and temporary connections required to maintain the OWNER's operations.
D. CONTRACTOR will not be allowed to operate any of the Cheesman Dam and Reservoir valves or gates. The Cheesman Caretaker will operate the valves at Cheesman Dam after receiving a written request from the CONTRACTOR, and after approval of the ENINEER. Coordinate Work that affects other CONTRACTORS with the ENGINEER and the affected entity before beginning any work that may interfere with the operations of CONTRACTORS.

1.4 PROJECT MEETINGS
A. General:
   1. Schedule physical arrangements for meetings throughout progress of Work, prepare meeting agenda with OWNER's Consultant and ENGINEER's input, and distribute with written notice of each meeting. Preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.
B. Preconstruction Conference:

1. **ENGINEER** will prepare agenda.
2. Be prepared to discuss the following subjects, as a minimum:
   a. Required schedules.
   b. Status of Bonds and insurance.
   c. Sequencing of critical path Work items.
   d. CONTRACTOR’s detailed Schedule of Values for Payment Applications.
   e. Project changes and clarification procedures.
   f. Use of site, access, office and storage areas, security and temporary facilities.
   g. Major product deliveries and priorities.
   h. CONTRACTOR’s safety plan and safety representative.
   i. Progress payment procedures.
3. Attendees may include but not be limited to:
   a. OWNER's representatives, including ENGINEER.
   b. CONTRACTOR's office representative.
   c. CONTRACTOR's resident superintendent.
   d. CONTRACTOR's quality control representative.
   e. CONTRACTOR's safety representative.
   f. CONTRACTOR's meeting notes recorder to take and distribute meeting notes.
   g. Subcontractors' representatives whom CONTRACTOR may desire or ENGINEER may request to attend.
   h. OWNER’s Consultant.
   i. Others as appropriate.

C. Preliminary Schedules Acceptability Review Meeting: As set forth in the General Conditions.

D. Progress Meetings:

1. **ENGINEER** will schedule weekly progress meetings at site that are conducted to review Work progress, progress schedule, shop drawing and sample submissions schedule, Applications for Payment, Contract modifications, and other matters needing discussion and resolution.
2. CONTRACTOR will record and distribute minutes.
3. Attendees will include:
   a. OWNER's representative(s), including ENGINEER, as appropriate.
   b. Cheesman Dam Caretaker
   c. CONTRACTOR and Subcontractors, as appropriate.
   d. Others as appropriate.

E. Quality Control and Coordination Meeting(s):

1. Scheduled by ENGINEER on a regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of Work and work of other contractors.
2. Attendees will include ENGINEER; CONTRACTOR; CONTRACTOR's designated quality control representative; selected Subcontractors and Suppliers; and OWNER’s Consultant, as requested by ENGINEER.

F. Pre-installation Meetings:

1. When required in individual Specification Sections, convene at site prior to commencing Work of that section.
2. Require attendance of entities directly affecting, or affected by, Work of that section.
3. Notify ENGINEER 10 days in advance of meeting date.
4. Provide suggested agenda to ENGINEER to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

G. Facility Startup Meetings:
1. Schedule and attend a minimum of one facility startup meeting prior to submitting the Facility Startup Plan, as specified in SECTION 01 75 16.
2. Agenda items shall include, but not be limited to, preliminary discussions regarding such plan, the content of the Facility Startup Plan, coordination needed between the various parties in attendance, and potential problems associated with the startup.
3. Attendees shall include:
   a. CONTRACTOR
   b. CONTRACTOR’s designated quality control representative.
   c. Subcontractors and equipment manufacturer’s representatives whom CONTRACTOR deems to be directly involved in the facility startup.
   d. ENGINEER’s representatives.
   e. OWNER’s operations personnel.
   f. OWNER’s consultant, as requested by the ENGINEER.
   g. Others as required by the Contract Documents or as deemed necessary by the CONTRACTOR.

H. Other Meetings: In accordance with Contract Documents and as may be required by ENGINEER.

1.5 MILESTONES
A. Include the Milestones and sequences of Work agreed to within the CONTRACTOR’s Project Execution Plan included as a part of the progress schedule required in SECTION 01 32 16.
B. Complete construction by the Milestone dates presented within the CONTRACTOR’s Project Execution Plan.

1.6 SEQUENCING AND OWNER OPERATION
A. The work requires sequenced construction activities in a manner that will not affect the operation of the facility. It is a requirement that completion and testing of either the Low and Mid Level Gates or the Auxiliary Gate be accepted by the OWNER prior to beginning work at other location(s). The Auxiliary Level will be in operation while work is performed at the Low and Mid Level intakes and the Low and Mid Level Gates shall be in operation prior to performing work on the Auxiliary Gate. The sequencing of work maybe reversed with the Auxiliary Gate construction preceding the Mid/Low Level Gate construction, as outlined within the CONTRACTOR's Project Execution Plan.
B. General:
   1. Continuous operation of OWNER’s facility is required
   2. Either the Primary, or the Auxiliary Intakes may be isolated for CONTRACTOR’s work, but not both simultaneously.
   3. At the CONTRACTOR’s option, a small amount of water may be released through the Outlet Works to keep floating debris and turbidity to a minimum. The minimum amount that can be continuously released is as follows:
      a. Primary Outlet Works: 5 CFS
      b. Auxiliary Outlet Works: 25 CFS
   4. For wintertime construction, a minimum of 1 CFS of water shall be allowed to pass through the Auxiliary Outlet Works in order to prevent valve freezing.
   5. Schedule shall provide for unanticipated difficulties.
6. Schedule shall provide ample time for Startup and Testing.
7. Schedule shall optimally use the available resources for the most efficient construction and shall be per SECTION 01 32 16.

C. It should be expected that reservoir elevation levels fluctuate during the work. The OWNER will make every effort to maintain a slow rate of reservoir rise or drop during construction. Historically, the reservoir level does not fluctuate over 1 foot in a 24-hour period, but instances of up to 5 feet of fluctuation in a 24-hour period have been recorded as a result of rainfall events. It is anticipated the reservoir fluctuations will remain below 1 foot per day during the construction, but the OWNER implies no guarantee as to the fluctuations during construction.

1.7 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at site is started, the CONTRACTOR and ENGINEER will conduct a pre-existing conditions survey. The initial pre-existing conditions survey is to include changed site conditions from the pre-bid walk and an underwater survey performed by the CONTRACTOR. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.
2. The pre-existing examination is to include discrepancies shown on the project drawings and the encountered site conditions. The underwater survey of a minimum will include inspection and survey of all three inlet intakes examining the size of the inlet tunnel entrances, conditions around and in front of the inlets, and conditions within the tunnels.
3. Record observations for signature of ENGINEER and CONTRACTOR.

B. Documentation:

1. Provide two copies of DVD recordings, divers daily log produced by the CONTRACTOR. Include other records documenting examination and underwater work activities to the ENGINEER.

1.8 OWNER'S OCCUPANCY

A. The OWNER's personnel will require access to the dam crest during the length of the project. The dam crest is to remain clear at all times, except for durations agreed upon 5-days in advance for loading or unloading of equipment and materials.

B. OWNER personnel will occupy the site, during the entire period of construction for the conduct of their normal operations.

C. OWNER personnel will occupy the existing buildings, and will use existing roads and parking areas during the Contract period.

D. Cooperate with OWNER’s personnel in all construction operations to minimize conflict and to facilitate OWNER usage of their facilities.

1.9 PARTIAL USE BY THE OWNER

A. Allow for OWNER’s occupancy of the site.

B. Unless agreed in writing prior to OWNER's use, the following conditions shall apply:

1. CONTRACTOR's Responsibilities:
   a. Allow access for OWNER's personnel.
2. OWNER's Responsibilities:
   a. Assume responsibility for isolating power and water.
b. Assume responsibility for security and fire protection in utilized areas, but not extending to protection of CONTRACTOR's operations, materials, and equipment in utilized areas.

1.10 PHYSICAL CONDITIONS

A. Exercise reasonable care to verify locations of existing subsurface structures and underground facilities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITIES

A. In the event of discrepancy in plans and Specifications provided by the ENGINEER, request clarification before proceeding with Work.

B. Maintain complete accurate log of Work as it progresses as a Record Document.

C. Notify ENGINEER at least 3 days in advance of time when grade and line to be provided by ENGINEER will be needed.

D. On request of ENGINEER, submit documentation of work described in this Section.

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY
A. This Section details the requirements for the initial and all subsequent Progress Schedules.

1.2 SUBMITTALS
A. These Specifications describe a portion of Work related to the overall Project. As such, only one Progress Schedule indicating the times (number of days or dates) for starting and completing the various stages of the Work for the entire Project is required to be submitted by the CONTRACTOR.

B. The requirements specified herein shall be followed for any adjustments to the initial Progress Schedule submitted for the entire Project and for each monthly Application for Payment for Work under this Bid Package.

C. Submit with Each Progress Schedule Submission:
   1. CONTRACTOR's certification that progress schedule submission is the actual schedule being utilized for execution of the Work and certification by all Subcontractors with 10% or more of Work that they concur with CONTRACTOR's progress schedule submission.
   2. Four legible copies of the progress schedule.

D. Progress Schedule:
   1. Submit within time specified in Paragraph 2.6 of the General Conditions and as provided in Paragraph 2.9 of the General Conditions.
   2. Submit adjusted schedule or confirm validity of current schedule with each monthly Application for Payment in accordance with the General Conditions, and at such other times as necessary to reflect:
      a. Progress of Work to within 5 days prior to submission.
      b. Changes in Work scope and activities modified since submission.
      c. Delays in Submittals or resubmittals, deliveries, or Work.
      d. Adjusted or modified sequences of Work.
      e. Other identifiable changes.
      f. Revised projections of progress and completion.

E. Narrative Progress Report: Submit with each monthly submission of progress schedule.

1.3 PROGRESS OF THE WORK
A. If CONTRACTOR fails to complete activity by its latest scheduled completion date and this failure extends Contract Times (or Milestones), submit a written statement within 7 days of such failure as to how CONTRACTOR intends to correct nonperformance and return to the acceptable current progress schedule. Actions by CONTRACTOR to complete Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.

B. CONTRACTOR may be required to increase plant, equipment, labor force or working hours if, due solely to the CONTRACTOR's own operations, if the CONTRACTOR fails to: (i) complete a critical scheduled activity by its latest Milestone completion date, or (ii) satisfactorily execute Work as necessary to prevent delay to the overall completion of the Project, at no additional cost to the OWNER.
1.4 PRELIMINARY PROGRESS SCHEDULE

A. As a minimum, submit two preliminary network analysis diagrams which follow the CONTRACTOR's Project Execution Plan and as follows:

1. 90-Day Plan: Show major initial activities including, but not limited to, mobilization, submittals for early product procurement and long lead time items, initial site work, and other activities anticipated in the first 90-day period of the Contract Time.
2. Project Overview Plan: Show major components of the Work and the sequence relations between major components and subdivisions of major components. The chart shall indicate the relationship and time frames in which the various facilities will be made substantially complete and placed into service in accordance with the Project Milestones. Sufficient detail shall be included for the identification of subdivisions of major components into such activities as:
   a. Mobilization schedule
   b. Submittal schedule
   c. Inclined drill hole boring schedule
   d. Control Building schedule
   e. Electrical schedule
   f. Instrumentation and control schedule
   g. Demolition and Blasting Schedule
   h. Hydraulic and Air Line Installation
   i. Control Building Substantial Completion (Dry-In)
   j. Hydraulic power unit installation
   k. Low Level Gate Installation
   l. Low Level Trashrack Installation
   m. Mid Level Gate Installation
   n. Mid Level Trashrack Installation
   o. Auxiliary Level Gate Installation
   p. Auxiliary Trashrack Installation
   q. Start-Up and Commissioning

B. Planned durations and start dates shall be indicated for each Work item subdivision. Each major component and subdivision component shall be accurately plotted on time scale sheets not to exceed 11 inches by 17 inches in size. Not more than four sheets shall be employed to represent this overview information.

C. Submit in accordance with Paragraphs 2.6 and 2.9 of the General Conditions.

D. The preliminary progress schedule, when accepted by the ENGINEER, will be the initially acceptable schedule.

1.5 PROGRESS SCHEDULE

A. General:

1. Schedule(s) shall reflect Work logic sequences, restraints, delivery windows, review times, Contract Times, and Milestones set forth in the Agreement and SECTION 01 31 00, and shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.

2. The schedule requirement herein is the minimum required. CONTRACTOR may prepare a more sophisticated schedule if such will aid CONTRACTOR in execution and timely completion of Work.

3. Base non-underwater construction schedule on either a 5-day week, and 10-hour work day.

4. Base underwater construction schedule on a 7-day Work week, and a 24-hour work day.

5. For network analysis schedules, use Primavera Project Planner (P3) latest version or a compatible and approved software.
6. Adjust or confirm schedules in accordance with Paragraph 6.6 of the General Conditions on a monthly basis.

7. Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.

8. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited, and use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of ENGINEER and CONTRACTOR.

9. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs which (i) impacts Project's critical path, (ii) consumes available float or contingency time, and (iii) extends Work beyond contract completion date.

10. If CONTRACTOR provides an accepted schedule with an early completion date, ENGINEER reserves the right to reduce Contract Times to match the early completion date by issuing a deductive Change Order at no change in Contract Price.


1. Show complete interdependence and sequence of construction and Project-related activities reasonable required to complete the Work, identifying Work of separate stages and other logically grouped activities, and clearly identify a singular critical path of activities.

2. Include at a Minimum: Subcontract Work; major and other equipment and critical material fabrication, delivery and installation times including OWNER-furnished equipment, move-in and other preliminary activities, Project closeout and cleanup, Substantial Completion dates, Submittals that may impact critical path, and testing, startup, and training activities that may impact critical path.

3. Indicate dates for early-and late-start, early- and late-finish, float and duration for all activities in the Progress Schedule.

4. Monthly Schedule Submissions: Include overall percent complete, projected and actual; and percent completion progress for each listed activity.

5. Bar chart schedule plotted by early start/finish date for all activities.

1.6 NARRATIVE PROGRESS REPORT

A. Include, as a minimum:

1. Summary of Work completed during the past period between Narrative Progress Reports.

2. Work planned during the next period.

3. Explanation of differences between summary of Work completed and Work planned in previously submitted Narrative Progress Report.

4. Current and anticipated delaying factors and their estimated impact on other activities and completion Milestones.

5. Corrective action taken or proposed.

1.7 CLAIMS FOR ADJUSTMENT OF CONTRACT TIMES

A. Reference ARTICLE 12 of the General Conditions.

B. Where ENGINEER has not yet rendered formal decision on CONTRACTOR's claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in progress schedule, CONTRACTOR shall reflect that amount of time adjustment in progress schedule as ENGINEER may accept as appropriate for
the interim. It is understood and agreed that such interim acceptance by ENGINEER will not be binding and will be made only for purpose of continuing to schedule Work, until such time as formal decision as to an adjustment, if any, of the Contract Times acceptable to the ENGINEER has been rendered. Revise progress schedule prepared thereafter in accordance with ENGINEER's formal decision.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. This Section details the requirements, scheduling, timing and content for Contract required submittals as set forth in the Specification Sections.

1.2 GENERAL

A. Inquiries: Direct to ENGINEER regarding procedure, purpose, or extent of Submittal.

B. Timeliness: Schedule and make submissions in accordance with requirements of individual Specification Sections and in such sequence as to cause no delay in Work or in work of other contractors.

C. ENGINEER will act upon CONTRACTOR's Submittal and transmit response to CONTRACTOR not later than 30 days after receipt. Identification of Submittals:

1. Complete, sign, and transmit with each Submittal package, one Transmittal of CONTRACTOR's Submittal Form. The Transmittal of CONTRACTOR’s Submittal Form is available on the on-line Project Procedures Manual (PPM).

2. Identify each Submittal with the following numbering and tracking system:
   a. Sequentially number each Submittal.
   b. Resubmission of a Submittal will have original number with sequential alphabetic suffix.

3. Format: Orderly, indexed with labeled tab dividers.

4. Show date of submission.

5. Show Project title and OWNER's contract identification and contract number.

6. Show names of CONTRACTOR, Subcontractor or Supplier, and manufacturer as appropriate.

7. Identify, as applicable, Contract Document section and paragraph to which Submittal applies.

8. Identify Submittal type; submit only one type in each Submittal package.

9. Identify and indicate each deviation or variation from Contract Documents.

D. Resubmissions: Clearly identify each correction or change made.

E. Incomplete Submittal Submissions:

1. ENGINEER will return the entire Submittal for CONTRACTOR's revision/correction and resubmission.

2. Submittals which do not clearly bear CONTRACTOR's specific written indication of CONTRACTOR review and approval of Submittal or which are transmitted with an unsigned or uncertified submission form or as may otherwise be required will be returned to CONTRACTOR unreviewed.

F. Nonspecified Submissions: Submissions not required under these Contract Documents and not shown on submissions will not be reviewed and will be returned to CONTRACTOR.

G. ENGINEER's Review: ENGINEER will act upon CONTRACTOR's Submittal and transmit response to CONTRACTOR not later than 30 days after receipt, unless otherwise specified. Resubmittals will be subject to the same review time.
H. Schedule Delays:

1. No adjustment of Contract Times or Price will be allowed due to ENGINEER's review of Submittals, unless all of the following criteria are met:
   a. CONTRACTOR has notified ENGINEER in writing that timely review of Submittal in question is critical to progress of Work, and has received ENGINEER's written acceptance to reflect such on current accepted submissions and progress schedule. Written agreement by the ENGINEER to reduce Submittal review time will be made only for unusual and CONTRACTOR-justified reasons. Acceptance of a progress schedule containing Submittal review times less than specified or less than agreed to in writing by ENGINEER will not constitute ENGINEER's acceptance of the review times.
   b. ENGINEER has failed to review and return first submission of a Submittal within agreed time indicated on current accepted schedule of submissions or, if no time is indicated thereon, within 30 days after receipt.
   c. CONTRACTOR demonstrates that delay in progress of Work is directly attributable to ENGINEER's failure to return Submittal within time indicated and accepted by ENGINEER.

2. No adjustment of Contract Times or Price will be allowed due to delays in progress of Work caused by rejection and subsequent resubmission of Submittals, including multiple resubmissions.

1.3 SHOP DRAWINGS AND SAMPLES

A. Copies:
   1. Shop Drawings and Product Data: Seven.
   2. Samples: One, unless otherwise specified in individual Specification Sections.

B. General: Submit to ENGINEER as required by individual Specification Sections.

C. Identify and Indicate:
   1. Pertinent Drawing sheet(s) and detail number(s), products, units and assemblies, and system or equipment identification or tag numbers.
   2. Critical field dimensions and relationships to other critical features of Work.
   3. Samples: Source, location, date taken, and by whom.
   4. Each deviation or variation from Contract Documents.

D. Design Data: When specified, provide Project-specific information as required and as necessary to clearly show calculations, dimensions, logic and assumptions, and referenced standards and codes upon which design is based.

E. Foreign Manufacturers: When proposed, include following additional information:
   1. Names and addresses of at least two companies closest to Project that maintain technical service representatives.
   2. Complete inventory of spare parts and accessories for each piece of equipment.

F. Preparation:
   1. Format: Whenever possible, schedule for and combine Shop Drawings and Samples required for submission in each Specification Section or division into a single Submittal package. Also combine product data for like items into a single Submittal package.
2. Present in a clear and thorough manner and of sufficient detail to show kind, size, arrangement, and function of components, materials, and devices and compliance with Contract Documents. Identify details by reference to sheet and detail, and schedule or room numbers shown on Drawings.

3. Product Data: Clearly mark each copy to identify pertinent products or models and show performance characteristics and capacities, dimensions and clearances required, wiring or piping diagrams and controls, and external connections, anchorages, and supports required.

4. Equipment and Component Titles: Identical to title shown on Drawings.

5. Manufacturer's standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to Work.
   b. Supplement standard information to provide information specifically applicable to Work.

G. Shop Drawing Disposition: ENGINEER will review, mark, and stamp as appropriate and distribute marked-up copies as noted:

1. Final for Construction (for incorporation in Work):
   a. One copy furnished ENGINEER.
   b. One copy furnished Construction Project Manager.
   c. One copy retained in OWNER’s Consultant’s file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR may begin to implement activities to incorporate specific product(s) or Work covered by Submittal.

2. Final for Construction, as corrected (for incorporation in Work):
   a. One copy furnished ENGINEER.
   b. One copy furnished Construction Project Manager.
   c. One copy retained in OWNER’s Consultant’s file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR may begin to implement activities to incorporate product(s) or Work covered by Submittal, in accordance with ENGINEER's notations.

3. For Correction and Resubmittal:
   a. One copy furnished ENGINEER.
   b. One copy furnished Construction Project Manager.
   c. One copy retained in OWNER’s Consultant’s file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall make corrections or develop replacement and resubmit (in same manner and quantity as specified for original submission).
   f. Submittal is not approved.

4. Rejected--Resubmit:
   a. One copy furnished ENGINEER.
   b. One copy furnished Construction Project Manager.
   c. One copy retained in OWNER’s Consultant’s file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall complete and resubmit or submit missing portions.
   f. Submittal is not approved.

H. Sample Disposition: Same as Shop Drawing disposition; samples will not be returned.

1.4 ADMINISTRATIVE SUBMITTALS

A. Copies: Submit four.

B. Description: Submittals that are not Shop Drawings or Samples, or that do not reflect quality of product or method of construction. May include, but not limited to those Submittals identified below.
C. Applications for Payment (and Cash Allowance Data and Values): Meet requirements of SECTION 01 29 00.

D. Progress Reports and Quantity Charts: As may be required in SECTION 01 32 16.

E. Schedules:
   1. Progress Schedule(s): Meet the requirements of SECTION 01 32 16.
   2. Schedule of Values: Meet requirements of SECTION 01 29 00.
   3. Schedule of Submittal Submissions:
      a. Prepare and submit, preliminary list of submissions grouped by Contract Document article/paragraph number or Specification Section number, with identification, numbering and tracking system as specified under Paragraph Identification of Submittals and as approved by ENGINEER.
      b. Include only the following required submissions:
         1) Shop Drawings and Samples.
         2) Test procedures.
         3) Record documents.
         4) Specifically required certificates, warranties, and service agreements.
      c. Coordinate with progress schedule and prepare submissions to show for each Submittal, at a minimum, the following:
         1) Estimated submission date to ENGINEER.
         2) Specifically requested and clearly identified ENGINEER review time if shorter than that set forth herein, with justification for such request and critical dates Submittals will be needed from ENGINEER.
         3) For first 6-month period from the date the Contract Times commence or following any update or adjustment of the submissions, the estimated submission date shall be week, month, and year; for submissions beyond 6-month time period, show closest month and year.
      d. Submit to ENGINEER monthly (i) updated list if changes have occurred, otherwise submit a written communication confirming existing list, and (ii) adjusted submissions reflecting submission activity planned for forthcoming 6-month time period and beyond. Coordinate with progress schedule updates.

F. Submittals Required by Laws, Regulations, and Governing Agencies:
   1. Submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
   2. Transmit to ENGINEER for OWNER's records one copy of correspondence and transmittals (to include enclosures and attachments) between CONTRACTOR and governing agency. Do not include any correspondence or transmittals that would be an invasion of privacy between the CONTRACTOR and its employees.

G. Disposition: ENGINEER will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:
   1. Final for Construction:
      a. Schedules: Acceptance will indicate that schedules provide for the orderly progression of the Work to completion within any specified milestones and the Contract Times, but such acceptance will neither impose on ENGINEER responsibility for the sequencing, scheduling, or progress of the Work nor interfere with or relieve CONTRACTOR from CONTRACTOR's full responsibility therefor.
      b. Acceptance of other Administrative Submittals will indicate that Submittal conforms to intent of Contract Documents as to form and substance.
c. CONTRACTOR may proceed to perform Submittal related Work.
d. One copy furnished ENGINEER.
e. One copy furnished Construction Project Manager.
f. One copy retained in OWNER’s Consultant’s file.
g. Remaining copies returned to CONTRACTOR appropriately annotated.

2. Final for Construction, as Corrected: This disposition is identical to Final for Construction, except CONTRACTOR may proceed to perform submittal-related Work, in accordance with ENGINEER’s notations.

3. For Correction and Resubmittal:
a. One copy furnished ENGINEER.
b. One copy furnished Construction Project Manager.
c. One copy retained in OWNER’s Consultant’s file.
d. Remaining copies returned to CONTRACTOR appropriately annotated.
e. CONTRACTOR shall make corrections or develop replacement and resubmit (in same manner and quantity as specified for original submission).
f. Submittal is not approved.

4. Rejected—Resubmit:
a. One copy furnished ENGINEER.
b. One copy furnished Construction Project Manager.
c. One copy retained in OWNER’s Consultant’s file.
d. Remaining copies returned to CONTRACTOR appropriately annotated.
e. CONTRACTOR shall complete and resubmit or submit missing portions.
f. Submittal is not approved.

1.5 QUALITY CONTROL SUBMITTALS

A. Certificates:

1. Manufacturer’s Certificate of Compliance:
   a. When specified in individual Specification Sections or where products are specified to a recognized standard or code, submit prior to shipment of product or material to the site.
   b. ENGINEER may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.
   c. Signed by product manufacturer certifying that materials, manufacture, and product specified conforms to or exceeds specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certifications as appropriate.
   d. May reflect recent or previous test results on material or product, but must be acceptable to ENGINEER.

2. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in the individual Specification Sections.

3. Coordinate with SECTION 01 75 16.

B. Statements of Qualification: Evidence of qualification, certification, or registration. As required in these Contract Documents to verify qualifications of professional land surveyors, engineers, materials testing laboratories, specialty Subcontractors, trades, specialists, consultants, installers, and other professionals.

C. Field Samples: Provide as required by individual Specifications and as may be required by ENGINEER during progress of Work.

D. Written Test Reports of Each Test and Inspection: As a minimum, include the following:

1. Date of test and date issued, Project title and number, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
2. Date and time of sampling or inspection and record of temperature and weather conditions.
3. Identification of product and Specification Section, location of Sample, test or inspection in the Project, type of inspection or test with referenced standard or code, certified results of test.
4. Compliance with Contract Documents, and identifying corrective action necessary to bring materials and equipment into compliance.
5. Provide an interpretation of test results, when requested by ENGINEER.

E. Disposition: ENGINEER will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:

1. Final for Construction:
   a. Acceptance will indicate that Submittal conforms to intent of Contract Documents as to form and substance.
   b. CONTRACTOR may proceed to perform Submittal related Work.
   c. One copy furnished ENGINEER.
   d. One copy furnished Construction Project Manager.
   e. One copy retained in OWNER's Consultant's file.
   f. Remaining copies returned to CONTRACTOR appropriately annotated.

2. Final for Construction, as Corrected: This disposition is identical to Final for Construction, except CONTRACTOR may proceed to perform submittal-related Work, in accordance with ENGINEER's notations.

3. For Correction and Resubmittal:
   a. One copy furnished ENGINEER.
   b. One copy furnished Construction Project Manager.
   c. One copy retained in OWNER's Consultant's file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall make corrections or develop replacement and resubmit (in same manner and quantity as specified for original submission).
   f. Submittal is not approved.

4. Rejected—Resubmit:
   a. One copy furnished ENGINEER.
   b. One copy furnished Construction Project Manager.
   c. One copy retained in OWNER's Consultant's file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall complete and resubmit or submit missing portions.
   f. Submittal is not approved.

1.6 CONTRACT CLOSEOUT SUBMITTALS
A. General: In accordance with SECTION 01 77 00.
B. Disposition: ENGINEER will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:

1. Final for Construction:
   a. Acceptance will indicate that Submittal conforms to intent of Contract Documents as to form and substance.
   b. CONTRACTOR may proceed to perform Submittal related Work.
   c. One copy furnished ENGINEER.
   d. One copy furnished Construction Project Manager.
   e. One copy retained in ENGINEER's file.
   f. Remaining copies returned to CONTRACTOR appropriately annotated.

2. Final for Construction, as Corrected: This disposition is identical to Final for Construction, except CONTRACTOR may proceed to perform submittal-related Work, in accordance with ENGINEER's notations.
3. For Correction and Resubmittal:
   a. One copy furnished ENGINEER.
   b. One copy furnished Construction Project Manager.
   c. One copy retained in OWNER’s Consultant’s file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall make corrections or develop replacement and resubmit (in same manner and quantity as specified for original submission).
   f. Submittal is not approved.

4. Rejected—Resubmit:
   a. One copy furnished ENGINEER.
   b. One copy furnished Construction Project Manager.
   c. One copy retained in OWNER’s Consultant’s file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall complete and resubmit or submit missing portions.
   f. Submittal is not approved.

1.7 SUPPLEMENTAL INFORMATION
   A. The Supplement listed below is a part of this Specification and can be found on the online Project Procedures Manual (PPM).

1.8 SUBMITTAL LIST
   A. The CONTRACTOR must submit a proposed project submittal list and anticipated submittal schedule, within 10 days of the Notice to Proceed date.

1.9 SUPPLEMENTAL INFORMATION
   A. The Supplement listed below is a part of this Specification and can be found on the online Project Procedures Manual (PPM). In the event the PPM is not available the forms will be provided electronically by the ENGINEER.

1. Form: Transmittal of CONTRACTOR's Submittal.

PART 2 PRODUCTS (NOT USED)
PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Definitions
B. References
C. Submittals
D. Project Conditions

1.2 DEFINITIONS
A. ANS: Aquatic Nuisance Species.
B. ANS Construction Project Inspector: Construction Project Inspector certified to perform ANS inspection by the Colorado Division of Wildlife or Colorado State Parks.
C. DW Waters: Any lake, reservoir, or body of water controlled by OWNER.

1.3 REFERENCES
A. State of Colorado, Department of Natural Resources, “Aquatic Nuisance Species (ANS) Watercraft Inspection Handbook”.
B. State of Colorado – High Risk (ANS) Inspection Form.

1.4 SUBMITTALS
A. Submit prior to beginning Work:
   1. Qualifications of Project ANS Construction Project Inspector and copy of Construction Project Inspector’s ANS card.
   2. Project vessel, watercraft and equipment entering DW Waters.
   3. ANS procedures and forms to be used on Project.
   4. ANS Construction Project Inspector completed ANS forms.

1.5 PROJECT CONDITIONS
A. OWNER requires ANS inspections and decontamination procedures for vessels, watercraft or equipment entering DW Waters.

PART 2 PRODUCTS

2.1 INSPECTIONS
A. ANS inspections:
   1. http://www.wildlife.state.co.us/WildlifeSpecies/Profiles/InvasiveSpecies/ZebraandQuaggaMussels.html
PART 3       EXECUTION

3.1       GENERAL

A. Project vessels, watercraft, and equipment shall not have been in any water body within the past 30 days prior to use on this project.

B. Provide ANS Construction Project Inspector to perform following duties:
   1. Perform a High Risk Inspection on all project vessels, watercraft and equipment required to enter DW Waters in accordance with Colorado Department of Natural Resources “Aquatic Nuisance Species (ANS) Watercraft Inspection Handbook”.
   2. Verify decontamination procedures and complete State of Colorado “(ANS) Documentation and Vessel Decontamination Form” for any project vessel, watercraft or equipment if decontamination is found necessary.

C. Provide decontamination for any project vessel, watercraft, or equipment, if required by ANS Construction Project Inspector, in accordance with Colorado Department of Natural Resources “Aquatic Nuisance Species (ANS) Watercraft Inspection Handbook”.

D. Provide required documentation to ENGINEER prior to any project vessel, watercraft or equipment entering DW Waters.

END OF SECTION
PART 1 GENERAL

1.1 DEFINITION

A. Underwater Engineer: An independent Contractor that will be hired by the OWNER to observe the underwater construction. The Underwater Engineer will serve as the Quality Assurance and Quality Control (QA/QC) representative for the OWNER for Work performed by the CONTRACTOR.

1.2 COORDINATION

A. Provide all necessary provisions for the Underwater Engineer during diving operations. Provide all necessary support, other than personnel and their personal equipment for the Underwater Engineer.

B. Develop detailed methods and procedures for the installation of all underwater construction. The ENGINEER and the Underwater Engineer shall approve these methods and procedures.

1.3 SUBMITTALS

A. Submit a QA/QC plan that will outline their QA/QC effort for the entire project.

PART 2 PRODUCTS

2.1 UNDERWATER VIDEOGRAPHY

A. Furnish each diver with a helmet mounted camera that will clearly show what the diver is working on.

B. Each video monitor shall be equipped with a DVD recorder so there is a permanent video record of the construction activities. Furnish live feed to the Underwater Engineer's working area on the barge.

C. Furnish the OWNER two copies of each DVD documenting the diving activities at the end of each shift.

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
   A. This Section outlines construction facilities and temporary controls provided by CONTRACTOR during construction.

1.2 CONTRACTOR USE OF EXISTING FACILITIES
   A. The CONTRACTOR will be permitted to use a portion of the site for CONTRACTOR personnel offices and storage as approved by the OWNER and shown on the Drawings.

1.3 REFERENCES
   A. The following is a list of standards which may be referenced in this Section:

1.4 SUBMITTALS
   A. Administrative Submittals: Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
   B. Shop Drawings:
      1. Temporary Construction Submittals:
         a. Parking area plans.
         b. Storage yard and storage building plans, including gravel surfaced area.
         c. Fencing and protective barrier locations and details.
         d. Staging area location plan.
      2. Temporary Control Submittals:

1.5 MOBILIZATION
   A. Mobilization shall include, but not be limited to, these principal items:
      1. Moving CONTRACTOR's plant and equipment required for operations onto site.
      2. Installing temporary construction power, wiring, and lighting facilities.
      3. Site Preparation: Including site grading to accommodate three office trailers and barge launching. This item also includes relocation of utilities conflicting with the graded office trailer pad.
      4. Providing onsite communication facilities, including satellite telephones.
      5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
      6. Arranging for erection of CONTRACTOR's work and storage yard.
      7. Posting OSHA and other regulatory required notices or other governing agencies and establishing safety programs and procedures.
      8. Having the CONTRACTOR's superintendent at the site full time.
      9. Providing field office trailers for CONTRACTOR and the ENGINEER.
      10. Providing security fencing and access gates as necessary to secure CONTRACTOR and OWNER-furnished equipment.
      11. Providing means and methods to launch barges, diving equipment, support vessels, and all ancillary equipment to support the work.
B. Use area designated for CONTRACTOR's temporary facilities as shown on Drawings for the staging area.

1.6 DEMOBILIZATION
A. Removal of all equipment.
B. Completion of all reports, record documents, and as-builts.
C. Cleaning of dam crest and restoration of staging areas.

1.7 PERMITS
A. Permits, Licenses, or Approvals: Obtain in accordance with the General Conditions and as otherwise may be provided in the Supplementary Conditions and retain onsite.

1.8 PROTECTION OF WORK AND PROPERTY
A. Comply with OWNER's safety rules while on OWNER's property.
B. Keep ENGINEER informed of serious accidents on the site and related claims.
C. During the performance of the Work, adapt means, methods, techniques, sequences and procedures of construction to allow OWNER to maintain operation as described in SECTION 01 11 00, at the existing level of facility production and consistent with applicable permit requirements, and Laws and Regulations. In performing such Work and in cooperating with the OWNER to maintain operations, it may be necessary for the CONTRACTOR to plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items which will be included within the Contract Price.

PART 2 PRODUCTS
2.1 ENGINEER'S FIELD OFFICES
A. Furnish equipment specified under the article for the exclusive use of ENGINEER, QA/QC CONTRACTOR, and its representatives.
B. Ownership of equipment furnished under this article will remain, unless otherwise specified, that of the CONTRACTOR.
C. Equipment furnished shall be new or in like new condition.
D. Items to Provide: As specified hereinafter.

PART 3 EXECUTION
3.1 ENGINEER'S AND OWNER'S FIELD OFFICES
A. Provide two ENGINEER's field offices, as specified below, for the exclusive use of ENGINEER and its representatives.
B. Locate new office adjacent to CONTRACTOR's office, as close to the diving operation as feasible. Construct on proper foundations, provide proper surface drainage and connections for utility services. Raise grade under field office, as necessary, to an elevation adequate to avoid flooding.
C. Provide portable toilet facilities in compliance with state and local health authorities. Provide twice per week cleaning service.
D. Telephone: Provide satellite telephone service to the ENGINEER's office trailer. Make new office ready to accept satellite telephone services, as described later.

E. Minimum Features for Each Office:

1. 110-volt, 60-Hz lighting and minimum of six duplex wall plugs. Provide a minimum of two circuits.
2. Fluorescent ceiling lights providing 50-foot candles at desk top height.
3. Exterior light at the entrance door.
4. Electric heating and self-contained air conditioning unit, properly sized for Project locale and conditions. Provide ample, electric power to operate installed systems. System shall be capable of maintaining temperature between 65°F and 75°F.
5. Railed stairways and landings at entrances.
6. Sign on entrance door reading “Engineer’s Field Office.”
7. Exterior Door(s):
   a. Number: One.
   b. Type: Solid core.
   c. Lock(s): Locks shall be cylindrical Best Locksets with construction cores ENGINEER may install own key system. Each door shall be provided with two locks using different keys.
8. Number of Windows: Four.
9. Minimum Interior Height: 8 feet.
10. Minimum Interior Width: 10 feet.

F. Floor Space: Minimum 300 square feet. Provide resilient floor covering on entire square footage of both offices.

G. Rooms: Three with two minimum private office's with floor space of 80 square feet per office, the remainder configured for open meeting or storage space. Provide a 20-square-foot storage closet.

H. Security guard screens, operable sashes, and blinds or drapes on all windows.

I. Clean interior of ENGINEER's field office on a weekly basis, including sweeping and mopping of interior, removal of debris, and emptying of waste baskets.

J. Office Equipment – General:

1. Bottled Water Service: Two, with cooler capable of producing hot water and cold water. Water shall be renewed at least once per week.
2. Paper Cup Dispenser with Cups: One each.
3. Paper Towel Dispenser with Towels: One each.
4. Desk: Two each, steel, 30 inches by 60 inches, with three drawers.
5. Swivel Chair: Two each, with arms.
6. Steel Folding Chairs: six each with meeting table.
7. Drafting Table: One, 3 feet by 6 feet.
8. Drafting Stool: One each.
9. Four-Drawer Steel File with Lock: Two each, legal width, with locks and key.
10. Bookcase: Two each, 15 lineal feet total, 48 inches high, 10 inches deep, minimum.
11. Wastepaper Basket: Six each.
12. First-Aid Kit: One each.
13. Carbon Dioxide (10-Pound) (A.B.C. Type) Fire Extinguisher: Two each.
14. Telephone: As specified later.
15. Tackboards: Two each, 36 inches by 30 inches.
16. One 36 inches x 48 inches porcelained enamel writing board with markers.
17. Copy machine capable of 11 inches x 17 inches sheets.
K. The ENGINEER's field offices are to remain onsite and connected to all required utilities, including telephone and electrical service for 30 days after the completion of all Contract Work. Remove the field offices, remove any temporary utility hook-ups, and perform all required site restoration after the 30 day period to allow OWNER to perform required project close-out and review required close-out documentation and submittals.

3.2 TEMPORARY UTILITIES

A. Power:
1. Electric power will not be available from the OWNER at the site. Temporary service shall be installed by the CONTRACTOR at his expense, as approved by the ENGINEER.
2. Cost of electric power used in construction, performance, and acceptance testing will be borne by CONTRACTOR.
3. Electric power must be supplied by the CONTRACTOR to the ENGINEER's construction trailer meeting the minimum power requirements for equipment specified.

B. Lighting: Provide temporary lighting at least to meet all applicable safety requirements to allow erection, application or installation of materials and equipment, and observation or inspection of the Work.

C. Water:
1. No potable water is available at the site. Make arrangements for and bear costs of providing water required for drinking by construction personnel during project construction.

D. Sanitary and Personnel Facilities:
1. Provide and maintain facilities for CONTRACTOR's employees, Subcontractors, and all other onsite employer's employees. Service, clean, and maintain facilities and enclosures.
2. Use of OWNER's existing sanitary facilities by construction personnel will not be allowed.

E. Telephone Service:
1. No land or cellular telephone service is available at dam site.
2. Arrange and provide onsite satellite telephone service for CONTRACTOR and ENGINEER. Pay all costs of installation and monthly bills. CONTRACTOR use of OWNER's telephone system shall be allowed only for emergencies.
3. A minimum of three satellite phone handsets will be required. Two of the phones shall operate on the same phone number which will be reserved for the use of the ENGINEER or designated representatives. The third phone will operate on a separate number reserved for the use of the CONTRACTOR.
4. Phone airtime charges will be paid by the CONTRACTOR for each phone up to 2000 minutes/month. Additional minutes will be paid by OWNER.
5. The satellite phone service must be in place and functional prior to commencement of construction due to the remote location of the site.

3.3 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within OWNER’s property in a systematic manner that minimizes inconvenience to OWNER and the public.
2. No portion of OWNER’s property shall be cut off from vehicular traffic.
3. Maintain in continuous service all existing gas pipelines, underground power, telephone or communication cable, water mains, sewers, poles and overhead power, and all other utilities encountered along the line of work, unless other arrangements satisfactory to owners of said utilities have been made.
4. Where completion of Work requires temporary or permanent removal and/or relocation of an existing facility, coordinate all activities with owner of said utility and perform all work to their satisfaction.
5. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
6. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
7. In areas where the CONTRACTOR’s operations are adjacent to or near a utility such as gas, telephone, television, electric power, water, sewer, or irrigation system and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection thereof have been made by the CONTRACTOR.
8. Notify ENGINEER and utility offices which may be affected by the construction operation at least 2 days in advance. Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to the CONTRACTOR’s operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
9. Do not impair operation of existing sewer systems. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures. Maintain original site drainage wherever possible.
10. Solvents, non-food grade greases and oils, and other deleterious materials will not be permitted in any finished water area. If the Work requires equipment that utilizes deleterious materials, the CONTRACTOR shall submit a Containment Plan to the ENGINEER for approval.

B. Dam Crest Protection:

1. The crest of the dam shall be protected from damage at all times. The use of tracked equipment, cranes or bobcats shall be minimized on the dam. Where possible load and unload the tracked equipment from rubber tired trailer as close to the work site as possible. When tracked equipment is required, the CONTRACTOR must place plywood decking on the dam crest road for protection. Rubber tired vehicles will be permitted on dam crest.

C. Sanitary and Personnel Facilities:

1. Provide and maintain facilities for ENGINEER’S personnel, CONTRACTOR’s employees, Subcontractors, and all other onsite employer’s employees. Service and clean twice per week, and maintain facilities and enclosures.

D. Telephone Service:

1. Arrange and provide onsite telephone service for CONTRACTOR’s use during construction. Pay all costs of installation and monthly bills.
2. OWNER will provide telephone service for the ENGINEER. OWNER will pay monthly bills associated with ENGINEER’s phone lines.

3. No incoming calls allowed to OWNER’s telephone system.


F. Trees and Plantings:
   1. Protect from damage and preserve trees, shrubs, and other plants outside the limits of the Work and within the limits of the Work, which are designated on the Drawings to remain undisturbed.
   2. Where practical, tunnel beneath trees when on or near the line trench.
   3. Employ hand excavation as necessary to prevent tree injury.
   4. Do not stockpile materials or permit traffic within drip lines of trees.
   5. Provide and maintain temporary barricades around trees.
   6. Water vegetation as necessary to maintain health.
   7. Cover temporarily exposed roots with wet burlap, and keep the burlap moist until soil is replaced around the roots.
   8. No trees, except those specifically shown on Drawings to be removed, shall be removed without written approval of the ENGINEER.
   9. Dispose of removed trees in a legal manner off the site.
   10. The balling and burlapping of trees indicated for replacement shall conform to the recommended Specifications set forth in the American Standards for Nursery Stock, published by American Association of Nurserymen. All balls shall be firm and intact and made-balls will not be accepted. Handle ball and burlap trees by the ball and not by the top.
   11. In the event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.
   12. Replace each plant that dies as a result of construction activities.

G. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with applied surfacing.

H. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

I. Dewatering: Construct, maintain, and operate cofferdams, channels, slurry trenches, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain the foundations and parts of the Work free from water.

J. Archaeological Finds: Should finds of an archaeological or paleontological nature be made within the limits of the site, immediately notify the ENGINEER and proceed in accordance with the General Conditions. Continue Work in other areas without interruption.

K. Signs: Comply with all applicable traffic control requirements as established by the Colorado Department of Transportation. Provide signs on York Street to warn of construction traffic entering and leaving the site.

3.4 TEMPORARY CONTROLS

A. Air Pollution Control:
   1. Minimize air pollution from construction operations.
2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to the site.

B. Water Pollution Control:

1. Provide a water pollution control plan and details a maximum of 15 days after the Notice to Proceed. The water pollution control plan shall include an emergency action plan and spill containment to respond to leaky equipment and possible contamination within Cheesman Reservoir and the South Platte River. The plan must include pollution prevention during activities which may introduce foreign materials into the reservoir or river, including the drilling, grouting, and concrete construction activities.

2. Determine method for diverting and disposing of sanitary sewer and rainstorm or snow melt runoff interfering with construction and requiring diversion. CONTRACTOR may not use OWNER’s existing sewer or overflow pond for any type of waste flow created by CONTRACTOR’s work. Do not cause or permit action to occur which would cause an overflow to an existing waterway.

3. Prior to commencing excavation and fill, obtain ENGINEER’s agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and stormwater or snow melt flow, including dewatering pump discharges.


5. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

C. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect Work and existing facilities from flooding during construction period.

3.5 STORAGE YARDS AND BUILDINGS

A. No materials will be allowed to be stored on the dam crest that may find their way into the reservoir, or down the face of the dam. If materials must be stored on crest of dam, materials must be secured inside a locking cabinet, and with the approval of the ENGINEER.

B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

C. Temporary Storage Buildings:

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.

2. Arrange or partition to provide security of contents and ready access for inspection and inventory.

3. Store combustible materials (paints, solvents, fuels, etc.) in a well-ventilated and remote building meeting safety standards.

3.6 PARKING AREAS

A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, ENGINEER’s operations, or construction operations.

B. Parking facilities for personnel working on the Project is available outside the controlled gate in the public parking area. Access to the site is controlled, access will be by designated van-pool provided by the CONTRACTOR.
3.7 CLEANING ENGINEER’S AND OWNER’S FIELD OFFICES
   A. Clean interior of ENGINEER’S and OWNER’s on-site field offices on a weekly basis, including sweeping and mopping of interior, removal of debris, and emptying of wastebaskets.

3.8 CLEANING DURING CONSTRUCTION
   A. In accordance with the General Conditions, as may be specified in Specification Sections, and as required herein.
   B. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least at weekly intervals, dispose of such waste materials, debris, and rubbish offsite.

3.9 ACCESS ROAD SNOW REMOVAL
   A. The CONTRACTOR is responsible for snow removal at the site and along the access road (Forest Service Road 211). Snow removal from the site and the access road (Forest Service Road 211) shall allow normal activities and site deliveries to commence without delay of the Project. The amount and frequency of snow removal is at the discretion of the CONTRACTOR to maintain scheduled construction activities.

   Denver Water’s operations personnel perform and will continue to perform access road (FR 211) maintenance and snow removal to maintain normal operations at the site. Maintenance and snow removal by Denver Water is not intended to provide clear access for the CONTRACTOR. The CONTRACTOR is responsible to maintain the access road (FR 211) to file extent required to support scheduled construction activities.

END OF SECTION
PART 1 GENERAL

1.1 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, whether purchased by CONTRACTOR or OWNER for the Project, or taken from previously purchased stock and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change the meaning of such other terms used in the Contract Documents as those terms are self-explanatory and have well recognized meanings in the construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in the manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.2 DESIGN REQUIREMENTS

A. Provide systems, equipment, and components, including supports and anchorages, in accordance with the provisions of the latest edition of Uniform Building Code (UBC), the Uniform Mechanical Code (UMC), and the Uniform Plumbing Code (UPC).

2. Roof Snow Load: 50 psf plus drifting.
4. Importance Factors: In accordance with Table 16K – Occupancy Category, of UBC.

1.3 SUBMITTALS

A. Administrative Submittals:

1. List of all proposed substitute items/methods.
2. Schedule of factory tests required by Contract Documents. Identify tests for which ENGINEER's presence has been specified.

B. Quality Control Submittals:

1. Factory Tests: As specified in the individual Specifications.
      1) Final Accepted Procedures: Prior to start of factory testing.
   b. Test Documentation: Results of successful testing, including certification of procedures and results.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 7,000 feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of minus 50°F to plus 110°F and

C. Atmosphere: Provide materials and equipment suitable for installation and operation under noncondensing relative humidity to 95%.
1.5 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.

C. Spare Parts, Special Tools, Test Equipment, Expendables, and Maintenance Materials:
   1. Furnish as required by the Specifications prior to (i) starting functional testing as set forth in SECTION 01 81 00, or (ii) operation of the equipment by the ENGINEER, or (iii) 75% Project completion, whichever occurs first.
   2. Properly package to avoid damage, in original cartons insofar as possible. Replace parts damaged or otherwise inoperable.
   3. Firmly fix to, and prominently display on, each package.
      a. Minimum 3-inch by 6-inch manila shipping tag with the following information printed clearly:
         1) Manufacturer's part description and number.
         2) Applicable equipment description.
         3) Quantity of parts in package.
         4) Equipment manufacturer.
         5) Applicable Specification Section.
         6) Name of CONTRACTOR.
         7) Project name.
   4. Deliver materials to site.
   5. Notify Construction Project Manager upon arrival.

D. Protect equipment from exposure to the elements and keep thoroughly dry and dust free at all times. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.

E. Factory Test Results: Reviewed and accepted by ENGINEER before product shipment as required in individual Specification Sections.

1.6 DELIVERY AND INSPECTION

A. Deliver products in accordance with the accepted current progress schedule and coordinate to avoid conflict with Work and conditions at the site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label date of manufacture and shelf life, where applicable. Include UL labels on products so specified.

C. Unload products in accordance with manufacturer's instructions for unloading, or as specified. Record the receipt of products at the site. Inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from the site and expedite delivery of identical new undamaged products and remedy incomplete or lost products to provide that specified, so as not to delay the progress of the Work.
1.7 HANDLING, STORAGE, AND PROTECTION

A. Handle products in accordance with the manufacturer's written instructions, and in a manner to prevent damage. Store products, upon delivery, in accordance with manufacturer's instructions, with labels intact and legible, in approved storage yards or sheds provided in accordance with SECTION 01 50 00. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by ENGINEER.

B. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered but not installed in the Work.

C. Store electrical, instrumentation, and control products, and equipment with bearings in weathertight structures maintained above 60°F. Protect electrical, instrumentation, and control products, and insulation against moisture, water, and dust damage. Connect and operate continuously all space heaters furnished in electrical equipment.

D. Store fabricated products aboveground, on blocking or skids, and prevent soiling or staining. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

E. Store finished products that are ready for installation in dry and well ventilated areas. Do not subject to extreme changes in temperature or humidity.

F. Hazardous Materials: Prevent contamination of personnel, the storage building, and the site. Meet the requirements of the product Specifications, codes, and manufacturer's instructions.

1.8 PROPOSED SUBSTITUTE PRODUCTS

A. Meet the requirements of the General Conditions, the Specification Sections, and as set forth herein.

B. Listing of proposed substitute items or methods.

1. With consideration of the additional evaluation time necessary for ENGINEER's review of such items, indicate for each item the review status for the proposed substitute product and estimated submission date.

2. CONTRACTOR, in indicating the review status of the proposed item, acknowledges that the time shown for ENGINEER's review on the current accepted schedule is sufficient only to allow ENGINEER to accomplish review for the status indicated and not sufficient to perform a subsequent review for substitute status on the same product.

3. ENGINEER may return unreviewed those submissions (i) not shown on the current accepted schedule, (ii) for which the review status differs from that indicated on the accepted list unless previously approved in writing by ENGINEER, (iii) not in accordance with Paragraph 6.7 of the General Conditions and as specified herein, (iv) which are incomplete, or (v) which are uncertified, in which case CONTRACTOR shall provide the specified product.

C. Submit six copies of proposed substitute item/method, to include all supporting data to allow ENGINEER's review. Complete, sign, and transmit with each proposed substitute item/method submission.

D. Disposition of Proposed Substitute Item: In accordance with SECTION 01 30 00, or in accordance with following paragraph.
E. Disposition of Proposed Substitute Item/Method:
   1. Accepted: ENGINEER will evidence such acceptance by recommendation of a Change Order for CONTRACTOR and OWNER execution. Such Change Order will accompany ENGINEER's evaluation and acceptance of CONTRACTOR's proposed substitute.
   2. Rejected:
      a. One copy retained by ENGINEER.
      b. One copy returned to CONTRACTOR with a commentary by ENGINEER.
      c. Remaining copies will be destroyed.
      d. CONTRACTOR shall provide item specified in Contract Documents.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions unless otherwise specified in the individual Specifications.

B. Where product Specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance Specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, and manufacturer's services and implement same or similar process instrumentation and control functions in same or similar manner.

D. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

F. Equipment, Components, Systems, Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

I. Provide materials and equipment listed by UL wherever standards have been established by that agency.

J. Equipment Finish:
   1. Provide manufacturer's standard finish and color, except where specific color is indicated.
   2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.
K. Special Tools and Accessories: Furnish to the ENGINEER, upon acceptance of equipment, all special tools and accessories specified in the individual Specification Sections to place each item of equipment in full operation and to maintain each item of equipment.

L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by ENGINEER.

2.2 FABRICATION AND MANUFACTURE

A. General:
   1. Manufacture parts to U.S.A. standard sizes and gauges.
   2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
   3. Design structural members for anticipated shock and vibratory loads.
   4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
   5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:
   1. Require no more than weekly attention during continuous operation.
   2. Convenient and accessible. Oil drains with bronze or stainless steel valves and fill plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
   3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
   4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.3 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by ENGINEER, notify ENGINEER not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage which necessitates procurement of new products will be considered delays within CONTRACTOR's control.

3.2 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.
B. No shimming between machined surfaces is allowed.

C. Install Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions and as may be specified. Retain a copy of manufacturers' instruction at site, available for review at all times.

F. For material and equipment specifically indicated or specified to be reused in the Work:
   1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
   2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.3 FIELD FINISHING

A. In accordance with SECTION 09 90 00.

3.4 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.5 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by OWNER.

END OF SECTION
SECTION 01 71 23
CONSTRUCTION SURVEYING

PART 1   GENERAL

1.1 SUMMARY
   A. This Section describes field engineering, material testing and surveying requirements and services provided by OWNER and responsibilities of CONTRACTOR.

1.2 SURVEY
   A. Location and elevation of bench marks are shown on Drawings.
   B. Dimensions for lines and elevations for grades of structures, appurtenances, and utilities are indicated on Drawings, together with other pertinent information required for laying out Work. If conditions vary from those indicated, notify ENGINEER immediately, who will make minor adjustments required.
   C. The OWNER shall provide vertical survey control for the project. Horizontal control shall be based on existing Johnson Valve House dimensions and orientation.
   D. Perform surveys that are necessary to layout structure lines, alignments, grades and elevations from the OWNER's provided control.
   E. ENGINEER may perform checks to verify accuracy of CONTRACTOR's layout Work and that completed Work complies with Contract Documents.
   F. Provide access to project work for ENGINEER performed checks.
   G. Reviews or surveys performed or requested by the ENGINEER shall not relieve the CONTRACTOR's responsibility for correct lines, grades, elevations and structure layout.
   H. Any existing survey points or other control markers destroyed without proper authorization will be replaced by owner of the survey points or control markers at the CONTRACTOR's expense.
   I. CONTRACTOR's Responsibilities:
      1. Provide additional survey and layout required.
      2. Locate and protect reference points prior to starting site preparation.
      3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
      4. In event of discrepancy in data or staking provided by ENGINEER, request clarification before proceeding with Work.
      5. Preserve and leave undisturbed control staking until ENGINEER has completed checks it deems necessary.
      6. Re-establish reference points resulting from destruction by CONTRACTOR's operations.
      7. Maintain complete accurate log of survey Work as it progresses as a Record Document.
      8. On request of ENGINEER, submit documentation.
      9. Provide competent employee(s), tools, stakes, and other equipment and materials as ENGINEER may require to:
         a. Establish control points and lines.
         b. Check layout, survey, and measurement Work performed by others.
         c. Measure quantities for payment purposes.
      10. Cooperate with ENGINEER so that checking and measuring may be accomplished with least interference to CONTRACTOR's operations.
1.3 CONSTRUCTION STAKEOUT

A. Perform construction stakeout using professional, qualified, licensed and competent personnel.

B. All survey data developed by the CONTRACTOR in performing surveys shall be available to the ENGINEER for review throughout the construction time period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
1.1 DEFINITIONS

A. Facility: The entire Project, or an agreed-upon acceptable portion, including all of its unit processes.

B. Field Quality Control: The term, as used in the individual Specification Sections, which refers to specified onsite functional and performance testing of equipment.

C. Functional Test: A test or tests in the presence of the ENGINEER to demonstrate that the installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements specified including, but not limited to, noise, vibration, alignment, speed, proper electrical and mechanical connections, thrust restraint, proper rotation, and initial servicing.

D. Performance Test: A test performed in the presence of the ENGINEER and after any required functional test, to demonstrate and confirm that individual equipment meets the performance requirements specified in individual Specification Sections.

E. Source Quality Control: The term, as used in the individual Specification Sections, which refers to specified testing performed on specified equipment at the manufacturer's facility prior to shipment.

F. Unit Process: As used in this Section, a unit process is a portion of the facility that performs a specific process function, such as the clarification process or the filtration process.

G. Facility Startup: Includes putting Project in operating order, cleaning, adjusting and balancing equipment, initial operation (startup) of equipment item, operating equipment, starting systems, operation of systems, testing of equipment and systems, and demonstration and verification of the completed facility as a unit.

H. Operation period: The operation period begins when the facility has been successfully started up as defined under paragraph Startup Test Period.

I. Startup Test Period:
   1. Startup of the entire facility or any portion thereof includes coordinated operation of the facilities by the CONTRACTOR, ENGINEER operating personnel, and manufacturer’s representatives for equipment items and systems after all required functional tests have been completed and those performance tests deemed necessary for the safe operation of the entire facility have been completed.
   2. Startup of the entire facility or any portion thereof shall be considered complete when, in the opinion of the ENGINEER, the facility or designated portion has operated in the manner intended.

J. System: The overall process, or portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment. Examples of systems on this project are as follows:
   1. Hydraulically operated Slide Gates
   2. Trashracks
   3. Hydraulic Power Unit
   4. Hydraulic Piping
   5. Bubbler System
1.2 SUBMITTALS

A. Administrative Submittals:
   1. Functional and performance test schedules, test plan, procedures, and log format. Submit at least 15 days prior to start of related testing.
   2. Facility Startup and Performance Evaluation Plan: Submit at least 15 days prior to commencement of startup.

B. Quality Control Submittals:
   1. Completed Manufacturer’s Certificate of Proper Installation as required by individual Specification Sections.
   2. Test Reports: Functional and performance testing, in format acceptable to ENGINEER.
   3. Written documentation, signed by ENGINEER, of functional and performance test for each piece of equipment tested.
   4. Certification of calibration for testing equipment, when so specified.
   5. Documentation of HVAC systems balancing results, when so specified.

1.3 CONTRACTOR FACILITY STARTUP RESPONSIBILITIES

A. General:
   1. Perform Work for tests specified, including items furnished by OWNER.
   2. Demonstrate proper installation, adjustment, function, performance, and operation of equipment.
   3. Divers must be available for any work on the gate needed during testing.

1.4 OWNER/ENGINEER FACILITY STARTUP RESPONSIBILITIES

A. General:
   1. Review CONTRACTOR’s test plan and schedule.
   2. Witness each functional or performance test.
   3. Coordinate other operations, if necessary, to facilitate CONTRACTOR’s tests.

B. Startup Test Period:
   1. Operate gates and appurtenances, with support of CONTRACTOR.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 CONTRACTOR’S TESTING AND STARTUP REPRESENTATIVE

A. Designate and furnish one or more CONTRACTOR’s personnel to coordinate and expedite testing and facility startup.

B. Such person or persons shall be present during the facility startup meetings specified in SECTION 01 31 00, and shall be available at all times during the testing and the facility startup and performance evaluation period to note any problems and ensure that such problems are corrected as soon as possible, including during night-shift hours.

C. After 3 days of successful operation of the facility, the OWNER’s startup and testing representative will not be required to be onsite, but shall be available by pager to respond in a timely manner to any problem that occurs.
3.2 EQUIPMENT TESTING

A. Preparation:

1. General:
   a. Complete Work associated with each unit and related processes before testing, including all related manufacturer's representative services.
   b. Furnish qualified manufacturer's representatives, when required by individual Specification Sections, to assist in testing.
   c. Obtain from equipment manufacturer's representative the Manufacturer's Certificate of Proper Installation Form.
   d. Schedule equipment testing and facility startup meetings to discuss test schedule, plan of test, materials, chemicals, and liquids required, facilities operations interface, and OWNER involvement, including type of OWNER assistance and number of OWNER's personnel required.
   e. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required to conduct testing.
   f. Provide written documentation, on CONTRACTOR's form, of functional and performance test results for each piece of equipment tested. Provide space on form for ENGINEER's signature that testing is complete.

2. Cleaning and Checking: Prior to beginning functional testing:
   a. Calibrate testing equipment in accordance with manufacturer's instructions.
   b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
   c. Lubricate equipment in accordance with manufacturer's instructions.
   d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
   e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
   f. Check power supply to electric-powered equipment for correct voltage and phase orientation – “Bump Test”.
   g. Adjust clearances and torque.
   h. Test piping for leaks.
   i. Balance HVAC systems, measuring airflow (cfm), static pressure, and component pressure losses.

3. Ready-to-test determination will be by ENGINEER based at least on the following:
   a. Notification by CONTRACTOR of equipment readiness for testing.
   b. Acceptable testing plan.
   c. Acceptable Operation and Maintenance Manuals.
   d. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
   e. Adequate completion of Work adjacent to, or interfacing with, equipment to be tested, including items to be furnished by OWNER.
   f. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
   g. Satisfactory fulfillment of other specified manufacturers' responsibilities.
   h. Equipment and electrical tagging complete.
   i. Delivery of all spare parts and special tools.

B. Functional Testing:

1. Conduct as specified in individual Specification Sections.
2. Notify ENGINEER and manufacturer's representative in writing at least 10 days prior to scheduled date of testing.
3. If, in ENGINEER's opinion, equipment meets the functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by the individual Specification Sections.

C. Performance Testing:

1. Conduct as specified in individual Specification Sections.
2. Notify ENGINEER and OWNER at least 15 days prior to scheduled date of test.
3. Performance testing shall not commence until the equipment is approved by ENGINEER as having satisfied the functional test requirements specified.
4. Follow approved testing plan and detailed procedures specified.
5. Source and type of fluid, gas, or solid for testing shall be as specified.
6. Unless otherwise indicated, furnish all labor, materials, and supplies for conducting the test and taking all samples and performance measurements.
8. If, in ENGINEER's opinion, equipment meets the performance requirements specified, such equipment will be accepted for the purposes of advancing to the facility startup and performance evaluation phase.

3.3 FACILITY STARTUP AND PERFORMANCE EVALUATION

A. General:

1. Support OWNER's operations personnel throughout the Facility Startup and Performance Evaluation Period.
2. All equipment shall be accepted by ENGINEER as having met the requirements of specified functional and performance testing prior to facility startup.
3. Sequence each unit process to the point that the complete facility is operational for evaluation of unit process and facility performance.
4. Demonstrate proper operation of required interfaces within and between individual unit processes to the ENGINEER's satisfaction.
5. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays.
6. Schedule ongoing Work so as not to interfere with or delay the completion of facility startup.
7. After the facility is operating, complete performance testing of those items of equipment not previously tested.
8. Maintain the facility, assuming a 24-hour working day, seven days a week, beginning at startup.

B. Facility Startup and Performance Evaluation Plan:

1. Develop a plan in conjunction with ENGINEER and OWNER's operations personnel detailing step-by-step instructions for startup of each unit process and the complete facility.
2. Include a method of evaluation and overall performance report for each unit process.
3. Include length of time needed for startup of each unit process and the complete facility.
4. If applicable, for Computer Subsystem applications software programming being furnished by OWNER, coordinate with OWNER's programming personnel for startup assistance.
5. Plan shall consist of bound copies of Startup and Performance Evaluation Forms. Use one form for each unit process; use example form attached, or one of CONTRACTOR's design.
6. Startup and Performance Evaluation Form will minimally include the following:
   a. Description of unit process being started.
   b. All equipment and devices included in the unit process.
c. Unit process startup procedures (i.e., valves to be open/closed, order of equipment startup, etc.).
d. Requirements for water, power, chemicals, etc. needed for startup.
e. CONTRACTOR Certification that each unit process is capable of performing its intended function(s), including fully automatic operation.
f. Space for evaluation comments.

C. OWNER Responsibilities:

1. Assist CONTRACTOR in developing a Facility Startup and Performance Evaluation Plan detailing step-by-step instructions for startup of each unit process and the complete facility.
2. Operate process units and devices, with support of CONTRACTOR.
3. The OWNER will furnish operators to coordinate with the CONTRACTOR and startup and operate the facility.

D. Startup Period:

1. Where incremental startup is required, sequencing of unit processes shall be in accordance with the construction sequencing and constraints specified in SECTION 01 31 00, and as otherwise chosen by the CONTRACTOR and approved by the ENGINEER.
2. Make adjustments, repairs, and corrections necessary to complete facility startup.
3. Incremental startup of individual unit processes shall be considered complete when, in the opinion of the ENGINEER, the unit process or designated portion has operated in the manner intended for 5 continuous days without significant interruption, unless time period is specifically changed by the ENGINEER. This period is in addition to any training, functional, or performance test periods specified elsewhere.
4. In addition to any incremental startup of individual unit processes, demonstrate to the ENGINEER that the entire facility operates in the manner intended for 5 continuous days without significant interruption. This period is in addition to any incremental individual unit process startup periods and any training, functional, or performance test periods specified elsewhere.
5. Significant Interruption: May include any of the following events:
   a. Failure of CONTRACTOR to provide and maintain qualified onsite startup personnel as scheduled.
   b. Failure to meet specified performance for more than 2 consecutive hours.
   c. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
   d. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
   e. Consistent or repeated failure of specified performance, critical equipment or unit process, and/or noncritical equipment or unit process. Consistent or repeated failure is defined as more than three occurrences.
   f. As may be determined by ENGINEER.
6. A significant interruption will require the startup then in progress to be stopped and restarted after corrections are made.

E. Facility Performance Evaluation:

1. During the Startup Period, conduct a performance evaluation for the purpose of evaluating the full capabilities of the facility and the performance of the computer system until all unit processes are operable including computer system monitoring and control functions.
2. Certify, on the Facility Performance Evaluation Form, that each unit process is capable of performing its intended function(s), including fully automatic and computerized operation.

3.4 CONTINUOUS OPERATIONS

A. ENGINEER will accept equipment and systems as ready for continuous operation only after successful facility startup is completed and documented, and reports submitted.

3.5 SUPPLEMENT

A. Supplements listed below are part of this Specification and can be found on the on-line Engineering Project Procedures Manual (PPM). In the event the PPM is not available, the forms will be provided electronically by the ENGINEER.

1. Facility Startup Evaluation Form.

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY

A. This Section covers the documentation, submittals and sign-offs required for handing over the project or portion of the project to OWNER.

B. CONTRACTOR and Subcontractors are to fill out and submit a Construction Completion Sign-Off form for each piece of equipment installed and each process area.

1.2 SUBMITTALS

A. Quality Control Submittals: Written procedures for maintaining and markup of record documents.

B. Contract Closeout Submittals: Submit prior to application for final payment.

1. Record Documents: As required in the General Conditions.
2. Approved Shop Drawings and Samples: As required in the General Conditions.
4. Special Bonds, Special Warranties, and Service Agreements.
5. Consent of Surety to Final Payment: As required in the General Conditions.
6. Releases or Waivers of Liens and Claims: As required in the General Conditions.
7. Releases from Agreements.
8. Final Application for Payment: Submit in accordance with procedures and requirements stated in SECTION 01 29 00.
9. Spare Parts and Special Tools: As required by individual Specification Sections.
10. Provide all diving records including project video recordings.

1.3 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each page of Specifications and each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of Work, both concealed and visible, to enable future modification of Work to proceed without lengthy and expensive site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in Work has occurred.
4. Prior to submitting each request for progress payment, request ENGINEER’s review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by ENGINEER to recommend the whole or any part of the CONTRACTOR’s Application for Payment, either partial or final.
5. Final Project Record Drawings shall be submitted with final pay application.

PART 2  PRODUCTS (NOT USED)
PART 3   EXECUTION

3.1 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Time, secure from ENGINEER at no cost to CONTRACTOR, one complete set of Contract Documents.
2. Label or stamp each record document with title, “RECORD DOCUMENTS,” in neat large printed letters.
3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents available at all times for observation by ENGINEER.

C. Making Entries on Drawings:

1. Date entries.
2. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
3. Call attention to entry by “cloud” drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Depths of various elements of work in relation to finished dam crest data if not shown or where depth differs from that shown.
   b. Horizontal and vertical locations of existing and new Underwater Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
   d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   e. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, Written Amendment, and ENGINEER's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as “cast iron drain,” “galv. water,” and the like.
   b. Show, by symbol or note, vertical location of item (“under slab,” “in ceiling plenum,” “exposed,” and the like).
   c. Make identification so descriptive that it may be related reliably to Specifications.
6. Specifications: Legibly mark and record for each product the description of actual product installed if differs from that specified, including:
a. Manufacturer, trade name, and catalog model number of each product and item of equipment actually installed.

3.2 FINAL CLEANING

A. At completion of Work or of a part thereof and immediately prior to CONTRACTOR's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to CONTRACTOR's notice of completion, clean entire site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to ENGINEER.
2. Remove grease, dirt, dust, paint splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Regrade barge launch area to pre-existing conditions upon completion of demobilization.

END OF SECTION
SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUMMARY
   A. This Section covers the requirements for operation and maintenance instructions and training required for installed equipment furnished by the CONTRACTOR.

1.2 QUALITY ASSURANCE
   A. Manuals for equipment and systems shall be prepared by equipment manufacturer or system Supplier.

1.3 SEQUENCING AND SCHEDULING
   A. Manual Outline: Submit detailed outline of each manual prior to preparation of Preliminary Manuals.
   B. Manuals for Equipment and Systems:
      1. Preliminary Manuals: Submit not less than 60 days prior to installation of equipment, system, subsystem, or component. Include copy of warranties, Bonds, and service agreements if specified. No partial payments will be made for equipment and systems unless preliminary manuals are acceptable to ENGINEER.
      2. Final Manuals: Submit not less than 60 days prior to equipment or system field testing or startup.
   C. Manuals for Materials and Finishes:
      1. Preliminary Manuals: Submit at least 15 days prior to request for final inspection.
      2. Final Manuals: Submit within 10 days after final inspection.

1.4 GENERAL
   A. Furnish for each item of equipment or system as specified in the individual Specification Sections, and any further requested information from individual Specification Sections. Manuals shall be provided in both hard copy and electronic formats.
   B. Prepare data for use by OWNER's personnel in the form of an instructional manual and on electronic media.
   C. Hard Copy Manual Format:
      1. Size: 8-1/2 inches by 11 inches.
      3. Text: Manufacturer's printed data, or neatly typewritten.
      4. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
      5. Provide fly-leaf for each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment and provide with heavy section dividers with numbered plastic index tabs.
      6. Provide each manual with title page, and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
7. Cover: Identify each volume with typed or printed title “OPERATION AND MAINTENANCE MANUAL, VOLUME NO. _ OF _", if applicable, and list:
   a. Project title.
   b. Designate the system or equipment for which it is intended.
   c. Identity of separate structure as applicable.
   e. Identity of equipment number and Specification Section.

8. Assemble and bind material in same order as specified, as much as possible.

9. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

10. Binders:
    b. Final Manuals: Commercial quality, substantial, permanent, three-ring or three-post binders with durable, cleanable, plastic binders.

11. Table of contents neatly typewritten, arranged in a systematic order:
    a. CONTRACTOR, name of responsible principal, address, and telephone number.
    b. List of each product required to be included, indexed to content of each volume.
    c. List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
       1) Identify area of responsibility of each.
       2) Provide local source of supply for parts and replacement.
    d. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.

12. Product Data:
    a. Include only those sheets that are pertinent to specific product.
    b. Clearly annotate each sheet to:
       1) Identify specific product or part installed.
       2) Identify data applicable to installation.
       3) Delete references to inapplicable information.

13. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
    a. Relations of component parts of equipment and systems.
    b. Control and flow diagrams.
    c. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
    d. Do not use Project record documents as maintenance manual drawings.
    e. Provide reinforced punched binder tab, bind in with text.
    f. Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
    g. Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
    h. Identify Specification Section and product on Drawings and envelopes.

14. Instructions and Procedures: Within text, as required to supplement product data.
    a. Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.
    b. Organize in a consistent format under separate heading for each different procedure.
    c. Provide a logical sequence of instructions for each procedure.
    d. Provide information sheet for ENGINEER’s personnel, including:
       1) Proper procedures in the event of failure.
       2) Instances that might affect the validity of warranties or Bonds.
15. Warranties, Bonds, and Service Agreements: In accordance with SECTION 01 77 00.

D. Electronic Manual Format:

1. Compatible with Windows XP or greater operating system in a form using Adobe Acrobat.
2. Bookmarked with index, chapter, subchapter, or index, division, subdivision layout.
3. Search capability with Optical Character Recognition (OCR).
4. Electronic format must contain the same text, diagrams, drawings and cut sheets that hard-copy versions contain all on a compact disc(s).

1.5 SUBMITTAL PROCEDURE

A. Preliminary Manuals:

1. Submit three copies for ENGINEER's review.
2. Disposition: In accordance with SECTION 01 33 00.
3. If Accepted:
   a. One copy will be returned to CONTRACTOR.
   b. One copy will be forwarded to Construction Project Manager.
   c. One copy will be retained in ENGINEER's file.
   d. Submit five copies of Final Manual.
4. If Rejected:
   a. Two copies will be returned to CONTRACTOR with ENGINEER's comments for revision.
   b. One copy will be retained in ENGINEER's file.
   c. Resubmit three copies revised Preliminary copies for ENGINEER's review.

B. Final Manuals:

1. If different than accepted Preliminary Manuals, submit:
   a. Two copies of any necessary supplemental material, including revised table of contents.
   b. Instructions for insertion of supplemental material in unreturned sets.
2. If Final Manuals are acceptable, CONTRACTOR will be so notified.
3. If rejected, and at ENGINEER's option:
   a. All copies will be returned to CONTRACTOR for revision, or;
   b. All copies will be retained by ENGINEER and the necessary revision data will be requested from CONTRACTOR.

1.6 MANUALS FOR EQUIPMENT AND SYSTEMS

A. Content for Each Unit (or Common Units) and System:

1. Description of unit and component parts, including controls, accessories, and appurtenances:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
2. Operating Procedures:
   a. Startup, break-in, routine, and normal operating instructions.
   b. Test procedures and results of factory tests where required.
   c. Regulation, control, stopping, and emergency instructions.
   d. Description of operation sequence by control manufacturer.
   e. Shutdown instructions for both short and extended durations.
   f. Summer and winter operating instructions, as applicable.
g. Safety precautions.
h. Special operating instructions.
i. Installation instructions.

3. Maintenance and Overhaul Procedures:
a. Routine operations.
c. Disassembly, removal, repair, reinstallation, and reassembly.

4. Installation Instructions: Including alignment, adjusting, calibrating, and checking.

5. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.

6. Spare parts ordering instructions.

7. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).

8. Manufacturer's printed operating and maintenance instructions.

9. As-installed, color-coded piping diagrams.

10. Charts of valve tag numbers, with the location and function of each valve.

B. Maintenance Summary:

1. Compile an individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or subunits.

2. Format:
   a. Use Maintenance Summary Form bound with this Section, or an electronic facsimile of such.
   b. Each Maintenance Summary may take as many pages as required.
   c. Use only 8-1/2-inch by 11-inch size paper.
   d. Complete using typewriter or electronic printing.

3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.

4. Recommended Spare Parts:
   a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
   b. “Unit” is the unit of measure for ordering the part.
   c. “Quantity” is the number of units recommended.
   d. “Unit Cost” is the current purchase price.

C. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Interconnection wiring diagrams, including all control and lighting systems.

2. Circuit Directories of Panelboards:
   a. Electrical service.
   b. Controls.
   c. Communications.

3. List of electrical relay settings, and control and alarm contact settings.

4. Electrical interconnection wiring diagram, including control and lighting systems.

5. As-installed control diagrams by control manufacturer.

6. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Sequences required.
   c. Safety precautions.
   d. Special operating instructions.
7. Maintenance Procedures:
   a. Routine operations.
   c. Adjustment and checking.
   d. List of relay settings, control and alarm contact settings.
8. Manufacturer's printed operating and maintenance instructions.
9. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

1.7 MANUALS FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:
   1. Manufacturer's data, giving full information on products:
      a. Catalog number, size, and composition.
      b. Color and texture designations.
      c. Information required for reordering special-manufactured products.
   2. Instructions for Care and Maintenance:
      a. Manufacturer's recommendation for types of cleaning agents and methods.
      b. Cautions against cleaning agents and methods that are detrimental to product.
      c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:
   1. Manufacturer's data, giving full information on products:
      a. Applicable standards.
      b. Chemical composition.
      c. Details of installation.
   2. Instructions for inspections, maintenance, and repair.

1.8 SUPPLEMENTAL INFORMATION

A. The Supplements listed below are a part of this Specification and can be found on the online Project Procedures Manual (PPM).
   1. Form: Facility Startup Evaluation.
   2. Form: Equipment Start-Up Requirements.
   3. Form: Maintenance Summary.
   4. Form: Manufacturer’s Certificate of Proper Installation.
   5. Form: Manufacturer’s Instruction Certification.
   6. Form: Equipment Testing Record.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A. This Section describes the work required to demolish and dispose of structures and appurtenances shown on Drawings and listed herein.

1.2  DEFINITIONS

A. Demolish, Demolition, or Remove: Remove and dispose structures, material, and all ancillary features or components shown or described to be removed.

B. Retain or Protect: Leave piping, equipment, material, and all ancillary features or components in place and protect from damage.

1.3  WORK INCLUDED

A. Provide the labor and materials necessary for the demolition work as shown on the Drawings and specified herein.

B. The information contained on Drawings showing demolition of existing facilities is based on the available record Drawings. The OWNER does not assume any responsibility for the accuracy or completeness of these Drawings or for the CONTRACTOR's interpretation of them. Inspect the facilities to be demolished prior to submitting its Bid to satisfy the CONTRACTOR as to the nature and location of the Work. Differences between these Drawings and the actual facilities shall not constitute grounds for time extension or contract modifications.

C. OWNER reserves the right to salvage any items identified for demolition.

1.4  DEMOLITION LIST

A. Complete demolition and removal of the following is required:

1. Shaft House reinforced concrete walls, wood framed roof and all attached appurtenances; steel trashracks, steel structural support members for the trashracks, structural steel embedment's, mortared rock, granite rock, concrete encased valve embedments, old hydraulic lines and remnants, and miscellaneous appurtenances within the Project boundary.

2. Protect adjacent structures, wood floor, reservoir and features from damage due to the Work.

1.5  SUBMITTALS

A. Quality Control Submittals:

1. Schedule of demolition.
2. Methods of demolition and equipment proposed for demolition work.
3. Copies of any authorizations and permits required to perform Work.

PART 2  PRODUCTS (NOT USED)

PART 3  EXECUTION

3.1  SEQUENCE AND PREPARATION

A. Notify OWNER 7 days prior to beginning demolition work.
B. Utilities:

1. Notify OWNER or appropriate utility owners to turn off affected services before starting demolition.
2. When utility lines are encountered that are not indicated on the Drawings, the ENGINEER shall be notified prior to further work in that area.

3.2 DEMOLITION

A. Provide temporary barricades and other forms of protection as required.

B. Protect the existing wood floor, stairs and steel framing covering the shaft to the Johnson Valve chamber.

1. Prevent demolition debris from falling into or entering the shaft.

C. Prevent debris and dust from falling into the reservoir.

D. Provide required shoring, bracing or support. All excavation, trenching, and sheeting shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P), and applicable State and local codes.

E. Remove all items to be demolished to limits noted on Drawings as specified herein and as required to perform the Work.

F. Dispose of debris and other nonsalvaged materials off site in accordance with applicable laws and regulations and as specified in these Contract Documents.

G. Equipment and materials, including piping within the limits of demolition, unless otherwise specified, will become the property of the CONTRACTOR.

H. Rock material produced from the demolition and blasting activities may be discarded within the reservoir. Rock material discarded within the reservoir must not be placed within 30 feet of either side of an intake location. Rock material shall not be deposited in front of an intake location.

3.3 CLEANING

A. Keep Work area, Dam crest and reservoir clean and clear of debris on a daily basis.
SECTION 03 10 00
CONCRETE FORMING

PART 1 GENERAL

1.1 SUMMARY
A. Furnish and install concrete formwork for Control Building foundation, slabs, trenches, and walls.
B. Related Sections:
   1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES
A. American Concrete Institute (ACI):
   1. 318/318R - Building Code Requirements for Structural Concrete and Commentary.
   2. 347R – Guide to Formwork for Concrete.

1.3 SUBMITTALS
A. Submittals for review:
   1. Shop Drawings: Custom, project-specific formwork, falsework, and shoring designs.
   2. Product Data:
      a. Load tables, design data, supporting calculations, and assembly/erection instructions for pre-engineered forming systems.
      b. Manufacturer's literature for taper ties, through-bolts, form ties, and forming systems.

1.4 SYSTEM DESIGN REQUIREMENTS
A. Design formwork in accordance with ACI 318/318R and ACI 347R to provide concrete finishes specified in SECTION 03 30 00.
B. Custom, project-specific formwork, falsework, and shoring designs shall be prepared and stamped by Engineer licensed in State of Colorado.
C. Pre-engineered forming systems may be used if approved by ENGINEER.
D. Make joints in forms mortar-tight.
E. Limit panel deflection to \( l/360 \) of each component span to achieve tolerances specified.

PART 2 PRODUCTS

2.1 FORM MATERIALS
A. Wall and Slab Forms:
   1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.

2.2 ACCESSORIES
A. Form Release Agent: Magic Kote by Symons Corp or approved substitute.
B. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the 2 surfaces.

C. Form Ties:
   1. Material: Steel.
   2. Spreader Inserts:
      a. Conical or spherical type.
      b. Design to maintain positive contact with forming material.
      c. Furnish units that will leave no metal closer than one inch to concrete surface when forms, inserts, and tie ends are removed.
   3. Flat bar ties for panel forms, furnish plastic or rubber inserts with minimum one inch depth and sufficient dimensions to permit patching of tie hole.
   4. Through-Bolts: Tapered minimum one inch diameter at smallest end.
   5. Elastic Vinyl Plug: Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length, and diameter upon removal forming watertight seal.

PART 3 EXECUTION

3.1 FORM SURFACE PREPARATION
   A. Thoroughly clean form surfaces in contact with concrete or previous concrete, dirt, and other surface contaminants prior to coating surface.
   B. Exposed Wood Forms in Contact with Concrete: Apply form sealer as recommended by sealer material manufacturer.
   C. Steel Forms: Apply form sealer to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

3.2 ERECTION
   A. General:
      1. Unless specified otherwise, follow recommendations of ACI 347R.
      2. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure.
      3. Construct formwork so concrete members and structures are correct size, shape, alignment, elevation and position.
      4. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
      5. Formwork shall be mortar tight.
   B. Beveled Edges (Chamfer):
      1. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
      2. Where beveled edges on existing adjacent structures are other than 3/4-inch, obtain ENGINEER's approval of size prior to placement of beveled edge.
      3. Do not chamfer at concrete surfaces below brick or concrete masonry.
   C. Wall Forms:
      1. Do not use forms with damaged surfaces.
      2. Where exposed to view, locate form ties and joints in uninterrupted pattern for smooth and uniform surface.
3. Inspect form surfaces prior to installation to assure conformance with specified tolerances.

D. Form Tolerances: Provide forms in accordance with ACI 318/318R and ACI 347R. See SECTION 03 30 00 and the following for finish tolerances specified:

1. Wall Tolerances:
   a. Exposed surface: Within 1/4-inch in 10 feet horizontal and vertical.
   b. Thicknesses: Maximum 1/4-inch minus or 1/2-inch plus from dimensions shown.

2. Slab Tolerances:
   a. Finish Slab Elevation: Slope slabs to drain.
   b. Thickness: Maximum 1/4-inch minus or one inch plus from thickness shown.

3.3 FORM REMOVAL

A. Formwork not supporting weight of concrete, (i.e., sides of beams, walls, columns, and similar parts of Work and as approved by ENGINEER) may be removed after cumulatively curing at not less than 50°F for 72 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

B. Remove forms in manner which will ensure integrity of structure and its surfaces.

C. Withdrawal of form ties through wall, column or beam is not be permitted.

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY

A. Furnish and install the following Concrete Accessories as specified and required for the work and as shown on the Drawings:

1. Hydrophilic rubber waterstop.
2. Premolded joint filler.
3. Elastomeric Sealants
4. Closed cell foam joint filler.

B. Related Sections:

1. SECTION 03 21 00 – REINFORCING STEEL
2. SECTION 03 30 00 – UNDERWATER CONCRETE SLAB

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):

7. D 994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type) (AASHTO M33).

1.3 SUBMITTALS

A. Submittals for Review:

1. Product Data:
   a. Manufacturer’s data sheets.
   b. Installation instructions.
2. Shop Drawings:
   a. Waterstops: Details of splices to be used and method of securing waterstop in forms and supporting waterstop so as to maintain proper orientation and location during concrete placement.
   b. Construction Joints: Layout and location indicating type to be used.
   c. Joint fillers for sloped and horizontal joints.
3. Samples:
   a. Splice, joint, and fabricated cross of each size, shape, and fitting of waterstops proposed for use.
   b. Tape for closed cell foam joint filler.

B. Quality Control Submittals:
   1. Waterstop manufacturer's written instructions for product shipment, storage, handling, installation, field splices, and repair.
   2. Joint Filler and Primer: Manufacturer's written instructions for product shipment, storage, handling, application, and repair.

1.4 QUALITY ASSURANCE

A. Components and Installation Procedures: In accordance with manufacturer's printed Specifications and recommendations.

B. Installer Qualifications: Skilled workers trained in procedures and methods required for proper performance of materials.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:
   1. Verify that waterstops delivered are in accordance with cross-section dimensions as shown and manufacturer's product data prior to unloading and storing onsite.
   2. Deliver materials to project site in manufacturer's unpacked containers with labels intact and legible at time of use.

B. Storage:
   1. Store materials in secure, indoor, dry area.
   2. Store waterstop under tarps to protect from oil, dirt, water, and sunlight.
   3. Maintain materials in dry condition during delivery, storage, handling, installation and concealment.

PART 2 PRODUCTS

2.1 MATERIALS

A. Hydrophilic Rubber Waterstop:
   1. Manufacturer: CJ-0725-3K by Greenstrack, St. Louis, MO, or Adeka Ultra Seal USA by Mitsubishi International Corp., Spearfish, SD.
   2. Description: Hydrotite hydrophilic waterstop dual extrusion type.
   3. Material: Combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties and shall contain no bentonite.
   4. Use only in locations indicated on Drawings or as directed by Engineer.
   5. Provide delay coating to inhibit initial expansion due to moisture present in fresh concrete.
   6. Physical and Performance Requirements:

<table>
<thead>
<tr>
<th>CHLOROPRENE RUBBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
</tr>
<tr>
<td>Tensile Strength</td>
</tr>
<tr>
<td>Ultimate Elongation</td>
</tr>
<tr>
<td>Hardness</td>
</tr>
</tbody>
</table>
### MODIFIED CHLOROPRENE (HYDROPHILIC) RUBBER

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Required Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>ASTM D 412</td>
<td>300 psi minimum</td>
</tr>
<tr>
<td>Ultimate Elongation</td>
<td>ASTM D 412</td>
<td>600% minimum</td>
</tr>
<tr>
<td>Hardness</td>
<td>ASTM D 2240</td>
<td>55 ± 5 Shore A</td>
</tr>
<tr>
<td>Expansion Ratio</td>
<td>Volumetric Change</td>
<td>3 to 1 minimum</td>
</tr>
<tr>
<td></td>
<td>Distilled Water at 70°F</td>
<td></td>
</tr>
</tbody>
</table>

#### B. Premolded Joint Filler
1. Bituminous Type: Thickness as shown, ASTM D 994 or D 1751.

#### 2.2 ACCESSORIES

A. Joint Sealants: Sikaflex 1A by Sika Corporation USA.

B. Hydrophilic Sealant:
   1. Manufacturer: Leakmaster LV-1 by Greenstreak, St. Louis, MO, Adeka P-201 by Mitsubishi International Corp., Spearfish, SD.
   2. Description: Single component hydrophilic sealant.
   3. Use: Secure hydrophilic rubber waterstop to rough, dry concrete surfaces.

C. Nails: As required for securing bituminous type premolded joint filler and hydrophilic waterstops.

### PART 3 EXECUTION

#### 3.1 GENERAL

A. Construct straight joints; make vertical or horizontal, except where walls intersect sloping floors.

B. Commence concrete placement after joint preparation is complete.

C. Time between Concrete Placements: As specified in SECTION 03 30 00.

D. Construction joints not shown on Drawings must be approved by engineer and be installed in accordance with SECTION 03 30 00.

E. Install continuous waterstop in construction joints, unless specifically shown otherwise.

#### 3.2 SURFACE PREPARATION

A. Construction Joints: Prior to placement of abutting concrete, clean contact surface:
   1. Remove laitance and spillage from reinforcing steel and dowels.
   2. Roughen surface to minimum of 1/4-inch amplitude to expose clean sound aggregate:
      a. Sandblast after concrete has fully cured.
      b. Water blast after concrete has partially cured.
      c. Green cut fresh concrete with high pressure water and hand tools.
   3. Perform cleaning without damaging waterstop, if one is present.
B. Construction Joint with Hydrophilic Waterstop:
   1. Follow manufacturer’s written instructions.
   2. Brush clean debris, dirt, dust, and foreign material.
   3. Concrete surface shall be smooth, clean and dry.

3.3 WATERSTOP INSTALLATION

A. General:
   1. Center waterstop on joint.
   2. Secure waterstop in correct position to avoid displacement during concrete placement.
   3. Repair or replace damaged waterstop.
   4. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.

B. Hydrophilic Rubber Waterstop:
   1. Install in accordance with manufacturer’s written instructions.
   2. Concrete surface must be smooth, clean, and dry.
   3. Locate waterstop strip as shown to provide minimum of 3 inches of concrete cover, or centered between curtains of reinforcing steel.
   4. Apply adhesive to concrete surface and dry for specified time before applying waterstop strip.
   5. Butt ends of waterstop strip together at splices and corners, join with sealant. Do not overlap ends.
   6. When placing concrete, do not allow vibrator to come into contact with waterstop.
   7. Where roughness, joints, or other irregularities are present in existing concrete, apply bead of water swelling elastic sealant to fill imperfections and place waterstop over fresh sealant.

3.4 EXPANSION/CONTRACTION JOINT INSTALLATION

A. Bituminous Type Premolded Joint Filler:
   1. Drive nails approximately one foot 6 inches on center through filler prior to installing to provide anchorage embedment into concrete during concrete placement.
   2. Secure premolded joint filler in forms before concrete is placed.

B. Install as shown on the Drawings and as required by ENGINEER.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY
A. Furnish and install reinforcing steel as required, as shown on the Drawings and as specified herein.
B. Related Sections:
   1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2  REFERENCES
A. American Concrete Institute (ACI):
   1. 318/318R, Building Code Requirements for Structural Concrete and Commentary.
B. American Society for Testing and Materials (ASTM):
   1. A 615/A 615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
C. Concrete Reinforcing Steel Institute (CRSI):
   1. CRSI P1, Placing Reinforcing Bars.

1.3  SUBMITTALS
A. Shop Drawings:
   2. Bending lists:
      a. Placing drawings.
      b. In addition, provide complete Shop Drawings that include plans, sections, and details showing all reinforcing bar sizes, grades, placements, spacing, splice lengths, tail and hook configurations, slab bolsters and chairs, additional reinforcing around openings, and development lengths as specified in notes, Drawings, structural details or Specifications.
B. Quality Control Submittals:
   1. Lab test reports for reinforcing steel showing stress-strain curves, ultimate strengths and chemical composition.

1.4  DELIVERY, STORAGE, AND HANDLING
A. Unload, store, and handle bars in accordance with CRSI publication “Placing Reinforcing Bars.”
PART 2  PRODUCTS

2.1  MATERIALS
   A. General: Reinforcing bars shall be new, clean stock and free from loose rust, scale, paint or other non-specified coatings of any kind.
   B. Deformed Billet-Steel Reinforcing Bars:
      1. ASTM A 615/A 615M, Grade 60.
      2. Square or twisted bars are not acceptable.

2.2  ACCESSORIES
   A. Tie Wire:
      1. Black, soft-annealed 16 gauge wire.
      2. Nylon-, epoxy-, or plastic-coated wire.
   B. Bar Supports and Spacers:
      1. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during installation and placement of concrete. Wood, brick or other unacceptable material is not permitted.

2.3  FABRICATION
   B. Reinforcing bars shall be accurately formed to the dimensions indicated on the Drawings.
   C. Bend all bars cold.

PART 3  EXECUTION

3.1  PREPARATION
   A. Notify ENGINEER a minimum of 24 hours in advance for inspection of reinforcing work and allow for inspection prior to placing concrete. No concrete shall be placed until the reinforcing steel has been approved by the ENGINEER. Notify ENGINEER when reinforcing is ready for inspection and allow sufficient time before placement of concrete for inspection and correction, as required.
   B. At the time concrete is placed, reinforcement shall be free from rust, loose mill scale, oil, earth, frost, or other contaminants that would destroy or reduce the bond.

3.2  REINFORCING BAR INSTALLATION
   A. Bundle or space bars, instead of bending where construction access through reinforcing is necessary.
   B. Spacing and Positioning: Conform to ACI 318/318R.
   C. Location Tolerances: In accordance with CRSI publication, “Placing Reinforcing Bars.”
   D. Reinforcement shall be supported in a manner to prevent any reinforcement dislocation during construction.
   E. Splicing:
      1. Follow ACI 318/318R.
      2. Use lap splices unless otherwise shown or permitted in writing by ENGINEER.
3. Stagger splices in adjacent bars.

F. Tying Deformed Reinforcing Bars:

1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
2. Bend all noncoated tie wire to prevent tie wire from being closer than one inch from the surface of concrete.

G. Reinforcement Around Openings: Place an equivalent area of steel bars or fabric around pipe or opening and extend as shown, on each side sufficiently to develop bond with each bar.

H. Protect exposed reinforcement bars intended for bonding with future extensions from corrosion by using adequate covering.

I. Straightening and Rebending: Field bending of reinforcing steel bars is not permitted.

J. Unless permitted by ENGINEER, do not cut reinforcing bars in the field.

3.3 INSPECTION

A. Inspect reinforcing bars before placement of concrete to ensure compliance with Drawing and Specification requirements.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install Cast-in-Place concrete for Control Building foundation, slabs and walls, and as required to complete the Work.

B. Related Sections:

1. SECTION 03 10 00 – CONCRETE FORMING
2. SECTION 03 15 00 – CONCRETE ACCESSORIES
3. SECTION 03 21 00 – REINFORCING STEEL
4. SECTION 03 36 00 – CONCRETE FINISHING
5. SECTION 03 39 00 – CONCRETE CURING
6. SECTION 03 68 00 – CONCRETE CRACK REPAIR

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
2. 301 - Specifications for Structural Concrete.
3. 302.1R - Guide for Concrete Floor and Slab Construction.
5. 305 - Hot Weather Concreting.
6. 306 - Cold Weather Concreting.
8. 318 - Building Code Requirements for Reinforced Concrete.

B. American Society for Testing and Materials (ASTM):

1. C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
9. C 192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
10. C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
15. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.


1.3 DEFINITIONS

A. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations, cracks 0.015-inches wide and larger, and cracks that leak in water-holding basins, spalls, chips, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form popouts, texture irregularities, and stains that cannot be removed by cleaning.

B. Field Test Data: Compressive strength data taken from concrete delivered and used for construction.

C. Lab Test Data: Compressive strength data taken from trial mixes produced in a laboratory.

D. New Concrete: Less than 60 days old.

1.4 SUBMITTALS

A. Administrative Submittals:
1. Preinstallation conference minutes.

B. Material Submittals:
1. Product Data:
   a. Portland cement.
   b. Fly ash.
   c. Cylinder test reports from field data.
   d. Admixtures.
   e. Bonding agent.
   f. Bond breaker.
   g. Patching materials.
2. Design Data:
   a. Concrete mix designs signed by qualified mix designer.
3. Aggregate:
   a. Gradation for coarse and fine aggregates in accordance with ASTM C 136.
4. Placement Drawings:
   a. Concrete, identifying location of each type of joint and placement sequence.
5. Detailed work plans:
   a. Cold weather curing and protection of concrete placed and cured in weather below 40°F.
   b. Hot weather placements including curing and protection for all concrete placed in ambient temperatures over 80°F.
   c. Pumping concrete, identifying pump location and placing sequence.
6. Repair methods:
   a. Water-holding structure.
   b. Surface finish.
   c. Honeycomb, rock pockets, and bug holes.
   d. Application schedule and instructions for patching materials and blending to match adjacent concrete.
C. Quality Control Submittals:

1. Manufacturer's application instructions for bonding agent, and bond breaker.
2. Manufacturers' Certificate of Compliance:
   a. Portland cement.
   b. Admixtures.
   c. Fly ash.
   d. Aggregates.
   e. Bonding agent.
   f. Bond breaker.
   g. Patching materials.
   h. Admixtures: Manufacturers' Certificate of Proper Installation.
3. Statements of Qualification:
   a. Mix designer.
   b. Batch plant.
   c. Epoxy injection applicator.
4. Test Reports:
   a. Admixtures: Test reports showing chemical ingredients and percentage of chloride in each admixture and fly ash.
   b. Source test analysis report for fly ash.
   c. For each trial mix design and signed by qualified mix designer.
   d. Cylinder test results from laboratory mixes.
5. Concrete Delivery Tickets: In accordance with ASTM C 94.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Mix Design: In accordance with ACI 301 and ACI 318.
2. Epoxy Injection Installers: In accordance with SECTION 03 68 00.

B. Preinstallation Meetings:

1. Minimum attendance:
   a. CONTRACTOR.
   b. ENGINEER.
   c. Ready-mix producer.
   d. Admixture representative.
   e. Testing and sampling personnel.
   f. Concrete finishing foreman.
   g. Pump truck representative.

2. Schedule and conduct prior to incorporation of respective products into Project. Notify ENGINEER of location and time.

3. Minimum agenda:
   a. Admixture types, dosage, performance, and redosing at Site.
   b. Mix designs, test of mixes, and submittals.
   c. Placement methods, sequence, techniques, equipment, consolidation, and form pressures.
   d. Slump and placement time to maintain slump.
   e. Finish, curing, and water retention.
   f. Addition of water at Site.
   g. Mixing methods.
   h. Equipment requirements.
   i. Hot and cold weather protection.
   j. Other specified requirements requiring coordination.
PART 2  PRODUCTS

2.1  CONCRETE MATERIALS

A.  Cementitious Materials:

1.  Cement:
   a.  Type II Portland cement conforming to ASTM C 150.
   b.  Maximum alkali content of 0.60%.

2.  Fly ash:
   a.  Class C or Class F fly ash conforming to ASTM C 618.
   b.  Make fly ash additions to mix on cement substitution basis in accordance with ASTM C 618.
   c.  Maximum allowable amount of fly ash: 20% by weight of total cementitious materials.

3.  Other pozzolans:

B.  Aggregates:

1.  General:
   a.  Furnish from one source.
   b.  Natural aggregates:
      1)  Free from deleterious coatings and substances in accordance with ASTM C 33, except as modified herein.
      2)  Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
   c.  Non-potentially reactive:
      1)  In accordance with ASTM C 33, Appendix, paragraph X1.1.
      2)  Tested for reactivity in accordance with ASTM C 1260.
   d.  Aggregate soundness:
      1)  Test fine and coarse aggregates per ASTM C 33.
      2)  Test fine and coarse aggregates per ASTM C 88 using sodium sulfate solution.

2.  Fine aggregates:
   a.  Natural sand or blend of natural sand and crushed sand.
   b.  Crushed sand must be less than 50% of the total sand by dry weight.
   c.  Fine aggregates shall conform to the grading and quality requirements of ASTM C 33.
   d.  Except where otherwise designated or approved fine aggregates shall be between 36% and 44% by volume of the total aggregates in the concrete.
   e.  Total materials passing No. 200 sieve: 4% maximum.
   f.  Deleterious substances:
      1)  Table 1, ASTM C 33.
      2)  3% or less total deleterious material finer than No. 200 sieve.
      3)  0.5% or less coal and lignite.

3.  Coarse aggregate:
   a.  Natural gravels or crushed stone.
   b.  Conform to grading and quality requirements of ASTM C 33 for size No. 57, No. 67, or No. 467.
   c.  Nominal maximum size of coarse aggregate: ACI 318/318R.
   d.  Limit deleterious substances in accordance with ASTM C 33, Table 3 for exposed concrete.
   e.  If aggregates used are known to be reactive with high alkali cement, as determined by ASTM C 295, or if reactivity of aggregates is not known, use low alkali cement as defined in ASTM C 150, Table 2 to ensure adequate protection from potential alkali-aggregate reaction.
C. Admixtures:

1. General:
   a. Furnish from one manufacturer.
   b. Assume responsible for damage or difficulties occurring as result of use of admixtures; additional compensation due to such difficulties not permitted.
   c. Use of admixtures does not relieve CONTRACTOR of responsibility for protection and curing of concrete.
   d. Compatible with other admixtures.
   e. Free of chlorides or other corrosive chemicals.
   f. Do not use calcium chloride.

2. Air entraining admixture:
   a. ASTM C 260, nontoxic after 30 days.
   b. Use air entraining agent in all concrete.
   c. Add to batch in accordance with ASTM C 94.
   d. Maintain air percentage as batched, within plus or minus 1.5%, for time required for placement into structure.

3. Water reducing admixtures: ASTM C 494, Type A or D.

4. Superplasticizers and high range water reducers:
   a. Use only where specified or directed by ENGINEER.
   b. ASTM C 494, Type F or G.
   c. Furnish type recommended by manufacturer for allowable temperature ranges.

5. Shrinkage reducing admixtures: Not permitted.

D. Water: ASTM C 94.

2.2 ACCESSORIES

A. Crack Repair Epoxy: Refer to SECTION 03 68 00.

B. Bonding Agent: 2-component type as recommended by manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.

C. Bond Breaker: Nonstaining type, providing positive bond prevention.

D. Patching Material:
   1. Free from chlorides and other chemicals causing steel corrosion.
   2. Low pressure silica fume mortar or polymer modified mortar: EMACO as manufactured by Master Builders Co. or approved substitute.
   3. No Liquid Storage: EMACO R-Series or approved substitute.
   4. For Liquid Storage: EMACO S-Series or approved substitute.
   5. Match color and texture of adjacent concrete.

2.3 CONCRETE MIX DESIGN

A. Design:
   1. Submit mix designs in accordance with ACI 301, Section 4.
   2. Field test data for mix design proportions are acceptable; proportions based on trial mixtures are not acceptable.
   3. Water/cement plus pozzolans ratio (w/c+p): Control allowable water addition to mix; do not exceed w/c+p ratio.
B. Mixes:

1. Structural concrete for Control Building walls and structures (Class A):
   a. Minimum 28 day compressive strength: 4,000 psi when molded and cured in compliance with ASTM C 31.
   b. Minimum cement content: 610 pounds per cubic yard.
   c. Maximum w/c+p ratio: 0.44.
   d. Slump: 3-6 inches when measured per ASTM C 143, except 4.5 to 8 inches if superplastizer is used.
   e. Air content: 4 to 7% of volume of batch, tested per ASTM C 231.
   f. Maximum air content: 3% for interior floor slabs where sealer/hardener concrete floor finish is specified.

2. Mass concrete for foundation and fill(Class M):
   a. Minimum 28 day compressive strength: 4,000 psi when molded and cured per ASTM C31.
   b. Minimum cement content: 517 pounds per cubic yard.
   c. Maximum w/c+p ratio: 0.44.
   d. Fine aggregate: Between 25 and 40% by volume of total aggregate.
   e. Coarse aggregate: ASTM C 33, size 357.
   f. Slump: 3 to 6 inches when measured per ASTM C 143, except 4.5 to 8 inches if superplastizer is used.
   g. Air content: 4 to 7% of volume of batch when tested per ASTM C 231.

C. Proportions:

1. Design mix to meet aesthetic and structural concrete requirements.
2. Proportion per ACI 211.1, unless specified otherwise.

2.4 CONCRETE MIXING

A. Ready Mixed Concrete: ASTM C 94.

B. Production inspection and field testing of approved mix will be made by ENGINEER.

C. Do not make changes in amounts or sources of approved mix ingredients without written approval of ENGINEER.

D. Concrete mix temperatures: ACI 306R (cold weather) and ACI 305 (hot weather).

E. Reverse rotation on drum of truck mixers to discharge wash water prior to charging mixer.

F. Add admixtures in accordance to ASTM C 94 and manufacturer’s instructions.

G. Furnish electronically generated batch ticket with each truck; concrete delivered without a batch ticket will be rejected.
   1. Deliver batch tickets to ENGINEER.
   2. Provide access for ENGINEER to batch tickets at all times during placements, and retain copy for record.

H. Include following minimum information on batch tickets:
   1. Supplier’s name and date.
   2. Truck number.
   3. Project name and location.
   4. Concrete class designation.
   5. Cubic yards batched.
   6. Time batched.
   7. Mix design number.
   8. Type, brand, and quantity of each admixture.
9. Type, brand, and quantity of cement and fly ash.
10. Weights of fine and coarse aggregates.
11. Moisture of fine and coarse aggregates.
12. Gallons of water batched (including ice).

I. Add following information to batch ticket at placement site:

1. Gallons of water added by truck operator.
2. Number of revolutions of drum at mixing speed.
3. Discharge time.
4. Location of batch in placement.

2.5 SOURCE QUALITY CONTROL

A. Test cement for total chloride content.
B. Test fly ash in accordance with ASTM C 311.
C. Batch Plant Inspection:
   1. Provide access for ENGINEER to inspect batch plants, cement mills, and supply facilities for products.
   2. Weighing scales: Tested and certified within tolerances per NIST Handbook No. 44.
   3. Batch plant equipment: Semiautomatic or fully automatic per ASTM C 94.

2.6 CONCRETE SUPPLIERS

A. General: Provide concrete from the following manufacturers, no exceptions:
   2. Lafarge, 1590 W. 12th Avenue, Denver, CO 80204, Telephone 303-657-4545.
   3. ACA products, P.O. Box 1887, Buena Vista, CO 81211, Telephone 719-395-3790.

PART 3 EXECUTION

3.1 PREPLACEMENT PREPARATION

A. General
   1. Place concrete in presence of ENGINEER.
   2. Meet requirements and recommendations of ACI 304R and ACI 301, except as modified herein.
   4. Clean form surfaces and embedded items of foreign material prior to placing concrete.
   5. Remove water and debris from spaces to be occupied by concrete.
   6. Inspection:
      a. Notify ENGINEER at least 24 hours in advance of concrete placement.
      b. Do not place concrete until forms, reinforcing steel, and cleanup methods have been approved by ENGINEER.
      c. Notify ENGINEER when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.
3.2 CONCRETE PLACEMENT

A. Discharge Time:
1. Do not exceed 90 minutes after adding cementitious materials to water unless approved time delay admixtures are used.
2. Coordinate information with admixture manufacturer and ENGINEER prior to placing concrete.

B. Placement into Formwork:
1. Concrete shall not be placed on frozen subgrade or into forms with temperatures less than 34°F.
2. Prior to placement of concrete:
   a. Dampen and densify subgrade under concrete to be placed on granular soils.
   b. Dampen sand where vapor retarder is specified.
   c. Dampen wood forms.
3. Place concrete as soon as possible after leaving mixer.
4. Place without segregation or loss of ingredients.
5. Place without splashing forms or steel above.
6. Place in layers not over 18 inches deep, except place slabs full depth.
7. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
8. Place concrete so that plastic concrete flows readily between reinforcing steel and other embedded items.
9. Do not place concrete that has partially hardened or is contaminated by foreign materials.
10. Use placement devices, including chutes, pouring spouts, and pumps.
11. Vertical free fall drop to final placement:
   a. 5 feet in forms, 8 inches or less wide and 8 feet in forms wider than 8 inches, except as otherwise specified.
   b. Superplasticized mixes: Up to 15 feet if slump is over 6 inches.
   c. For placements where drops are greater than specified distance, use placement device so that free fall below placement device conforms to required value.
   d. Limit free fall to prevent segregation caused by aggregates hitting reinforcing steel or other embedded items.
12. Do not use aluminum conveying devices.
13. Provide illumination of interior of forms so that interior spaces of forms are visible.
14. Waterstop:
   a. Fasten waterstop to prevent movement during concrete placement.
   b. During concrete placement, make visual inspection of entire waterstop area.
   c. Apply procedure to full length of waterstops.
15. Prevent accumulation of water on surface of concrete due to water gain or other causes during placement and consolidation by adjustments in mix design.
16. Round off top exposed edges of walls with a 1/4-inch radius steel edging tool.

C. Conveyor Belts and Chutes:
1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Angle chutes to allow concrete to readily flow without segregation with as little slope as possible.
4. Conveyor belts:
   a. Approved by ENGINEER.
   b. Wipe clean with device which does not allow mortar to adhere to belt.
   c. Cover conveyor belts and chutes.

D. Addition of Water at Site:
   1. Permitted only once and within 60 minutes of initial batching.
   2. Do not exceed w/c+p ratio of mix.
   3. If hydration stabilizing admixtures are used, submit brand, type and anticipated dosage rates to ENGINEER prior to placement.
   4. Provide accurate means to determine and measure volume of water added to mix.

E. Pumping of Concrete:
   1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to assure completion of concrete placement without cold joints in case of a primary placing equipment breakdown.
   3. Replace non-functioning and improperly functioning pumping equipment and hoses (conduits).
   4. Limit pumping distance to 300 feet maximum.

F. Consolidation and Visual Observation:
   1. Consolidate concrete in accordance with ACI 309R.
   2. Provide the proper size, type and number of vibrators to be used for each concrete placement.
   3. Consolidate concrete with internal vibrators with minimum frequency of 8,000 cycles per minute and amplitude required to consolidate concrete in section being placed.
   4. Provide minimum of one standby vibrator for every 2 vibrators in operable condition at placement site prior to placing concrete.
   5. Provide windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
   6. Do not use vibration (consolidation) to move concrete laterally within forms.
   7. Vibrate concrete in vicinity of joints to obtain impervious concrete.
   8. Thoroughly work concrete around reinforcing steel and other embedded items, and into corners of forms.
   9. Supplement vibrators by spading, rodding or forking to eliminate honeycombing at form face and voids around embedded items.
   10. Penetrate vibrator minimum 6 inches into previous lift.

G. Curing: Refer to SECTION 03 39 00.

3.3 GENERAL PLACEMENT SPECIFICATIONS

A. Maximum Size of Concrete Placements:
   1. Limit size of each placement to allow for strength gain and volume change due to shrinkage.
   2. Construction joints:
      a. Place joints at locations shown on Drawings as minimum.
      b. Where construction joints are not shown, provide where shown on ENGINEER-reviewed placement drawings and in accordance with Contract Documents.
      c. Location, size and configuration of construction joints will be subject to acceptance of ENGINEER.
d. Space joints to limit size of placements to allow for volume change from shrinkage and to minimize potential of restraint and shrinkage cracking.
e. No horizontal joints are permitted in walls of water retaining structures.
f. Keyways:
   1) When shown in Drawings, key construction joints at right angle to direction of shear.
   2) Except where otherwise shown on Drawings, keyways shall be minimum 1-1/2 inches in depth over at least 25% area of section.
3. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
4. If placement sequence results in cold joint located below finished water surface, install waterstop in joint.

B. Minimum Time between Adjacent Placements:
1. Do not place adjacent concrete until previous placement has attained 70% of specified 28-day compressive strength or 7 days, whichever is shorter.
2. Notify ENGINEER if adjacent placements are planned so that field cylinders can be taken from previous placement for verification of strength requirements.

C. Hot Weather:
1. Conform to ACI 305R.
2. Maintain concrete temperature below 90°F at time of placement.
3. Ingredients may be cooled before mixing. Method of cooling concrete to conform to ACI 305R and be approved by ENGINEER.
4. When rate of surface evaporation approaches 0.20 pounds per square foot per hour for non-flyash concrete mixes, and 0.15 pounds per square foot per hour for concrete mixes containing more than 15% fly ash as estimated by ENGINEER from ACI 305R, Figure 2.1.5, make provisions for windbreaks, shading, fog spraying, sprinkling, ice, or wet cover as required by ENGINEER before and during concrete placement.
5. If rate of evaporation approaches 0.20 pounds per square foot per hour as estimated by ACI 305R, precautions against plastic shrinkage are required.
6. Provide recording thermometer, hygrometer and wind gage in operating condition on Site 7 days prior to first concrete placement.
7. Precautions against plastic shrinkage cracks may be required in conditions other than what is normally considered hot weather conditions.
8. If reinforcement is in direct sunlight or is more than 20°F higher in temperature than concrete temperature before placement, wet reinforcement with water fog spray before placing concrete to cool reinforcement.
9. Do not cool plastic concrete mixtures without approval of ENGINEER.
10. Evaporation retardant: Refer to SECTION 03 39 00.

D. Cold Weather:
1. Do not place concrete against frozen earth or ice, or against forms and reinforcement with frost or ice present.
2. Prevent carbonation on unprotected new concrete surfaces.
3. Conform to methods in ACI 306, including maintaining temperature of concrete as specified.
4. Provide maximum and minimum thermometers placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work.
5. Maintain concrete temperature above 55°F at time of placement.
6. Maintain concrete temperature between 55 and 70°F for entire curing period.
7. External heating units:
   a. Provide heated enclosures when air temperatures are below 40°F.
b. Vent heating units to atmosphere, and do not locally heat or dry concrete. Where water cure is specified, maintain wet condition. 
   c. Do not exhaust flue gases directly into enclosed area.

8. Do not warm plastic concrete mixtures without approval of ENGINEER.

E. Maintain curing conditions as specified in SECTION 03 39 00.

3.4 CONSTRUCTION JOINTS

A. Surface Preparation:

1. Mechanically roughen concrete to produce minimum roughness profile of 1/4 inch.
2. Do not roughen areas to which hydrophilic waterstops will be bonded.
3. Clean surface of concrete construction joints and remove materials that inhibit bond.
4. Wet existing concrete surfaces with clean potable water and saturate for 24 hours prior to placing new concrete.
5. Remove standing water immediately before new concrete is placed.
6. Expose clean aggregate by abrasive blast cleaning; wire brushing and air water jets may be used while concrete is fresh provided results are equal to abrasive blast cleaning.

B. Construction Review:

1. ENGINEER shall review preparation of all construction joints prior to concrete placement.
2. Notify and provide minimum 24 hours notice to ENGINEER for review.
3. If joint placement is performed without ENGINEER’s presence, Work will be deemed unacceptable and non-conforming.
4. If ENGINEER determines that construction review of a particular activity is unnecessary, he will provide written direction to CONTRACTOR to proceed with that particular activity without construction review.

3.5 PIPE PENETRATION

A. Unless otherwise detailed in Drawings, completely remove coatings, such as tape coating or paint and other materials, that can inhibit bond from portion of pipe to be in contact with concrete.

B. Smooth, properly grade and compact ground surface.

C. Remove all debris.

D. Dampen ground surface and prepare to prevent inclusion of dirt, pieces of aggregate, or balls of soil in concrete.

3.6 PATCHING

A. General:

1. Where indicated, inject cracks with crack repair epoxy in accordance with SECTION 03 68 00.
2. Prior to starting patching work, obtain quantities of color-matched patching material and manufacturer's detailed instructions for use.
3. Provide structural patch with finish to match adjacent surface.
4. Dress surface of patches that will remain exposed to view to match color and texture of adjacent surfaces by using supplemental materials furnished by manufacturer for such purposes or by rubbing area until match is obtained.
5. Patch concrete to provide structurally sound surface finish, uniform in appearance.
6. Repair surface defects including fins, tie holes and honeycombed areas down to solid concrete in accordance with ACI 301.

B. Tie Holes:
1. Fill with grout per SECTION 03 36 00, except where sealant is shown; use only enough water to dry pack.
2. For areas exposed to view and not receiving sack rubbed finish, blend to color and texture of adjacent concrete.
3. Compact grout using steel hammer and steel tool to drive grout to high density.
4. Cure grout for 7 days minimum.

C. Alternate Form Ties-Through-Bolts:
1. Seal through-bolt hole by sandblasting or mechanically cleaning and roughening entire interior surface of hole.
2. Epoxy coat roughened surface.
3. Drive elastic vinyl plug and then dry packing entire hole on each side of plug with Category II grout per SECTION 03 36 00.
4. Use only enough water to dry pack grout.
5. Dry pack while epoxy is still tacky or remove epoxy by mechanical means and reapply new epoxy.
6. Compact grout using steel hammer and steel tool to drive grout to high density.
7. Cure grout for 7 days minimum.

D. Defective Areas:
1. Remove defective concrete to a depth of sound concrete.
2. Small infrequent shallow holes caused by air entrapment at surface of forms will not be considered defective.
3. If chipping is required, make edges perpendicular or undercut to surface with minimum of 1/2 inch in depth. Do not feather edges. Obtain ENGINEER’s approval of chipping work.
4. Patch defective area to match appearance of adjacent concrete surfaces after cracks are filled.

E. Blockouts at Penetrations:
1. Conform to details indicated on Drawings, or submit proposed blockouts for review and approval of ENGINEER.
2. Use nonshrink, nonmetallic grout as specified in SECTION 03 36 00.

3.7 CONCRETE WALL FINISHES
A. Type W-1 (Ordinary Wall Finish):
1. Patch tie holes.
2. Knock off projections.
3. Patch defective areas.

B. Type W-2 (Smooth Wall Finish):
1. Fill cracks in waterbearing surfaces by epoxy injection.
2. Patch tie holes.
4. Patch defective areas and repair rough spots resulting from form release agent failure or other reasons to provide smooth uniform appearance.
C. Type W-3 (Finish for Painting):
   1. Fill cracks in waterbearing surfaces by epoxy injection.
   2. Patch tie holes.
   4. Patch and repair defective areas as specified for Type W-3.
   5. Leave surface ready for painting as specified in SECTION 09 90 00.

3.8 CONCRETE SLAB FINISHES

A. General:
   1. Finish slab concrete in accordance with ACI 302.1R.
   2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar to accumulate.
   3. Do not dust surfaces with dry materials.
   4. Round off edges of slabs with steel edging tool, except where cove finish is shown.
   5. Provide steel edging tool radius of 1/4 inch for slabs subject to wheeled traffic.
   6. Use evaporation retardant only where specifically approved by ENGINEER. Where approved for use, follow manufacturer's instructions and precautions.
   7. Do not apply water to concrete surface during any phase of finishing operations.
   8. Do not perform concrete finishing while water is present on surface.

B. Type S-1 (Steel Troweled Finish):
   1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
   2. While concrete is still green but sufficiently hardened to bear a person's weight without deep imprint, wood float to true, even plane without visible coarse aggregate.
   3. Use sufficient pressure on wood floats to bring moisture to surface.
   4. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
   5. Burnish surface with an additional troweling.
   6. Final troweling to produce ringing sound from trowel.
   7. Do not use dry cement or additional water during troweling, nor excessively trowel.
   8. Power finishing:
      a. An approved power machine may be used in lieu of hand finishing in accordance with directions of machine manufacturer.
      b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots in slab.
      c. Do first steel troweling for slab S-1 finish by hand.

C. Type S-2 (Broomed Finish): Finish as specified for Type S-1 floor finish except omit final troweling and finish surface by drawing fine-hair broom lightly across surface to surface finish acceptable to ENGINEER.
   1. Broom in same direction and parallel to expansion joints.
   2. On inclined slabs, broom perpendicular to slope except for round slabs, broom surface in radial direction.

3.9 FIELD QUALITY CONTROL

A. General:
   1. Field quality control will be performed by OWNER.
   2. Provide access, cooperation, and incidental labor required by OWNER to obtain specimens, perform tests, and conduct inspections.
3. Provide facilities for safe storage and proper curing of concrete test cylinders onsite for first 48 hours, and for additional time as required before transporting to testing laboratory.

4. Provide concrete for testing of slump, air content, and for making cylinders from point of discharge into forms.

5. When concrete is pumped, take samples from discharge end of truck mixer chute and just prior to entering pump hopper.

6. Evaluation will be per ACI 301, Chapter 17 and Specifications. Where term “building official” is used, term shall be redefined to ENGINEER.

7. Specimens will be made, cured, and tested in accordance with ASTM C 31 and ASTM C 39.

8. Frequency of testing may be changed at discretion of ENGINEER.


10. Assist in obtaining samples and provide undisturbed testing areas with 120V AC power.

B. Compression Test Specimens:

1. Tests will be performed by ENGINEER.

2. Specimens will be fabricated, cured, and tested per ASTM C 192.

3. One specimen will be tested at 7 days and 2 at 28 days. One specimen will be retained for later break date.

C. Enforcement of Strength Requirements:

1. Should strengths shown by laboratory cured test cylinders made and tested in accordance with provisions of Standard Specifications and evaluated by methods per ACI 318/318R fall below specified values, ENGINEER may require changes in proportions of concrete mix used on remainder of Work.

2. ENGINEER may require CONTRACTOR to provide minimum of 3 cores drilled per ASTM C 42 and tested for compressive strength per ASTM C 39 for each portion of Work in which laboratory cured concrete test cylinders indicate failure to meet specified strength requirements within the specified time period.

3. ENGINEER may require CONTRACTOR to remove and replace areas determined to be defective.

D. Tolerances:

1. Walls: Measure and inspect walls for compliance with tolerances specified in SECTION 03 10 00.

2. Slabs:
   a. Floor flatness measurements will be made day after floor is finished and before shoring is removed, to eliminate effects of shrinkage, curing, and deflection.
   b. Support 10 foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
   c. Compliance with designated limits in 4 of 5 consecutive measurements is satisfactory unless defective conditions are observed.

3.10 MANUFACTURERS’SERVICES

A. Provide following representatives at Site, for installation assistance, inspection and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

1. Batch Plant Representative:
   a. Observe how concrete mixes are performing.
   b. Observe first placement of each type of concrete mix.
c. Assist with concrete mix design, performance, placement, weather problems, and problems with concrete mix throughout Project.
d. Establish control limits on concrete mix designs.

3.11 PROTECTION OF INSTALLED WORK

A. After curing as specified in SECTION 03 39 00, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage due to other construction work.

B. Patch and repair defective areas and areas damaged by construction.

3.12 SCHEDULE OF CONCRETE FINISHES

A. Provide concrete finishes as scheduled:

<table>
<thead>
<tr>
<th>AREA</th>
<th>TYPE OF FINISH</th>
<th>REQUIRED FORM TOLERANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTERIOR WALL SURFACES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above grade/covered with masonry</td>
<td>W-2</td>
<td>W-A</td>
</tr>
<tr>
<td>veneer or other finish material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERIOR WALL SURFACES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control and Generator rooms</td>
<td>W-2</td>
<td>W-A</td>
</tr>
<tr>
<td>Shaft Room and other dry areas</td>
<td>W-3</td>
<td>W-A</td>
</tr>
<tr>
<td>painted or coated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXTERIOR SLABS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walkways</td>
<td>S-2</td>
<td>S-A</td>
</tr>
<tr>
<td>Foundation Slab Sidewalls</td>
<td>W-1</td>
<td>W-A</td>
</tr>
<tr>
<td>INTERIOR SLABS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaft Room, Control Room and</td>
<td>S-1</td>
<td>S-B</td>
</tr>
<tr>
<td>Generator Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slabs to receive equipment pads</td>
<td>S-2</td>
<td>S-A</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY

A. This Section includes requirements for batching, conveying and placing concrete underwater for leveling slabs at the upstream openings of the Auxiliary Intake, Mid Level Intake, and Low Level Intake.

B. Related Sections:
1. SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION
2. SECTION 01 45 00 – QUALITY ASSURANCE AND QUALITY CONTROL
3. SECTION 03 60 10 – BACKFILL SPOOL GROUTING

1.2 REFERENCES

A. American Concrete Institute (ACI) Standards that may apply to this Section:
1. 117, Standard Specifications for Tolerances for Concrete Construction and Materials
2. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
3. 301, Specifications for Structural Concrete
4. 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete
5. 318, Building Code Requirements for Reinforced Concrete

B. American Society for Testing and Materials (ASTM) Standards that may apply to this Section:
1. C 31, Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. C 33, Standard Specification for Concrete Aggregates
3. C 39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. C 42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5. C 88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
10. C 192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
11. C 231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
13. C 295, Standard Guide for Petrographic Examination of Aggregates for Concrete
15. C 618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
1. National Institute of Standards and Technology (NIST) (formerly National Bureau of Standards):

1.1 NIST Handbook No. 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

1.3 DEFINITIONS

A. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations, cracks 0.015-inch wide and larger, spalls, chips, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, and form popouts.

B. Field Test Data: Compressive strength data taken from concrete delivered and used for construction.

C. Lab Test Data: Compressive strength data taken from trial mixes produced in a laboratory.

D. New Concrete: Less than 60 days old.

1.4 SUBMITTALS

A. Administrative Submittals:

1. Preinstallation conference minutes.

B. Material Submittals:

1. Product Data:
   a. Portland cement.
   b. Fly ash.
   c. Cylinder test reports from field data.
   d. Admixtures.

2. Design Data:
   a. Concrete mix designs signed by qualified mix designer.

3. Aggregate:
   a. Gradation for coarse and fine aggregates in accordance with ASTM C 136.

4. Detailed work plans describing how the work will be performed, including, but not limited to, the following:
   a. Provision of concrete:
      1) Sources (site-batch, ready-mix plant, etc.)
      2) Transportation and delivery
   b. Conveying and placing concrete:
      1) Pump or tremie configurations
      2) Piping (conduits, connections, end-caps, go-devils, etc.)
      3) Placement (developing and maintaining seal, reestablishing seal after loss, distribution of concrete into forms, etc.)
   c. Forming and finishing concrete:
      1) Form construction/layout
      2) Surfacing methods

C. Quality Control Submittals:

1. Manufacturers’ Certificate of Compliance:
   a. Portland cement.
   b. Admixtures.
   c. Fly ash.
   d. Aggregates.
   e. Admixtures: Manufacturers’ Certificate of Proper Installation.
2. Statements of Qualification:
   a. Mix designer.
   b. Batch plant.

3. Test Reports:
   a. Admixtures: Test reports showing chemical ingredients and percentage of chloride in each admixture and fly ash.
   b. Source test analysis report for fly ash.
   c. For each trial mix design and signed by qualified mix designer.
   d. Cylinder test results from laboratory mixes.

4. Concrete Delivery Tickets: In accordance with ASTM C 94.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Mix Design:
      a. Mix design shall be in accordance with ACI 301, ACI 318, and ACI 304R, Chapter 8.

B. Preinstallation Meetings:
   1. Required Meeting Attendees:
      a. CONTRACTOR.
      b. ENGINEER.
      c. Concrete producer.
      d. Admixture representative.
      e. Testing and sampling personnel.
      f. Concrete finishing foreman.
      g. Pumping representative.
   2. Schedule and conduct prior to incorporation of respective products into Project.
      Notify ENGINEER of location and time.
   3. Agenda shall include:
      a. Admixture types, dosage, performance, and redosing at site.
      b. Mix designs, test of mixes, and submittals.
      c. Placement methods, sequence, techniques, and equipment.
      d. Slump and placement time to maintain slump.
      e. Finishing.
      f. Addition of water at site.
      g. Mixing methods.
      h. Equipment requirements.
      i. Other specified requirements requiring coordination.
   4. Conference minutes as specified in SECTION 01 31 00.
   5. The materials and methods for underwater concrete placements shall be selected by the CONTRACTOR to result in a dense, homogeneous mass of concrete having hardened properties equivalent to those of concrete placed in the dry.

PART 2 PRODUCTS

2.1 CONCRETE

A. Cementitious Materials:
   1. Cement:
      a. Type II Portland cement conforming to ASTM C 150.
      b. Maximum alkalai content of 0.60%.
   2. Fly Ash:
      a. Class C or Class F fly ash conforming to ASTM C 618.
      b. Make fly ash additions to the mix on a cement substitution basis in accordance with ASTM C 618.
B. Aggregates:

1. General:
   a. Furnish from one source.
   b. Natural aggregates:
      1) Free from deleterious coatings and substances in accordance with ASTM C 33, except as modified herein.
      2) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
   c. Non-potentially Reactive:
      1) In accordance with ASTM C 33, Appendix, paragraph X1.1.
      2) Tested for reactivity in accordance with ASTM C 1260.
   d. Aggregate Soundness:
      1) Test fine and coarse aggregates in accordance with ASTM C 33.
      2) Test fine and coarse aggregates in accordance with ASTM C 88 using sodium sulfate solution.

2. Fine Aggregates:
   a. Natural sand or blend of natural sand and crushed sand.
   b. Crushed sand must be less than 50% of the total sand by dry weight.
   c. Fine aggregates shall conform to the grading and quality requirements of ASTM C 33.
   d. Deleterious substances:
      1) Table 1, ASTM C 33
      2) 3% or less total deleterious material finer than No. 200 sieve.
      3) 0.5% or less coal and lignite.

3. Coarse Aggregate:
   a. Natural gravels or crushed stone.
   b. Conform to the quality requirements of ASTM C 33.
   c. Limit deleterious substances in accordance with ASTM C 33, Table 3 for exposed concrete.
   d. If the aggregates used are known to be reactive with high alkali cement, as determined by ASTM C 295, or if reactivity of the aggregates is not known, the use of low alkali cement, as defined in ASTM C 150, Table 2, is required to assure adequate protection from potential alkali-aggregate reaction.

C. Admixtures:

1. General:
   a. CONTRACTOR assumes responsibility for any damage or difficulties occurring as a result of the use of all admixtures.
   b. CONTRACTOR shall not be entitled to any additional compensation above the prices bid for concrete work because of such difficulties.
   c. Use of admixtures shall not relieve CONTRACTOR of responsibility for protection and curing of the concrete.
   d. Admixtures shall be compatible with each other.
   e. Admixtures shall be free of chlorides or other corrosive chemicals.
   f. Calcium chloride shall not be used in the concrete.

2. Air Entraining Admixture:
   a. In accordance with ASTM C 260, nontoxic after 30 days.
   b. Add to the batch in accordance with ASTM C 94.

3. Shrinkage Reducing Admixtures:
   a. Shrinkage reducing admixtures are not allowed.

4. High-Range Water Reducers/Superplasticizers
   a. Because of the extreme importance of maintaining high slumps for as long as possible, high-range water reducers and/or superplasticizers shall be used with caution.
b. Submitted mix designs using high-range water reducers and/or superplasticizers shall demonstrate that high slump can be maintained long enough to properly place the concrete in the forms.

5. Antiwashout Admixture:
   a. Antiwashout admixtures shall provide equivalent resistance to washout as Sika SC-100 as determined by U.S. Army Corps of Engineers Test CRD-C 61-89A “Test Method for Determining the Resistance of Freshly Mixed Concrete to Washing Out in Water”.

D. Water:
   1. Batch water and mixer washout water shall conform to ASTM C 94.

2.2 CONCRETE MIX DESIGN
A. Design:
   1. CONTRACTOR shall design the concrete mix.
   2. Submit mix designs in accordance with ACI 301, Section 4.
   3. Water/cement plus pozzolans ratio (w/c+p) shall control allowable water addition to mix.
   4. Under no circumstances is the approved design w/c+p ratio to be exceeded.

B. Mixes
   1. Underwater Concrete:
      a. The minimum 28 day compressive strength shall be 4,000 psi when molded and cured in compliance with ASTM C 31.

C. Proportions:
   1. Mix designs shall meet pumpability, placement, and structural requirements to achieve a successful underwater placement.

2.3 FORMWORK
A. Stainless steel sheet shall be used for underwater forming.

PART 3 EXECUTION
3.1 PRE-PLACEMENT PREPARATION
A. General
   1. Concrete shall be placed only in the presence of the ENGINEER.
   2. Meet requirements and recommendations of ACI 304R and ACI 301, except as modified herein.
   3. Inspection:
      a. Notify ENGINEER at least 24 hours in advance before starting to place concrete.
      b. No concrete shall be placed until forms, reinforcing steel, and cleanup methods have been approved by the ENGINEER in writing.
      c. Notify ENGINEER when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

3.2 CONCRETE PLACEMENT
A. Discharge Time:
   1. Do not exceed 90 minutes after adding cementitious materials to water unless approved time delay admixtures are used.
2. Coordinate information with admixture manufacturer and ENGINEER prior to placing concrete.

B. Placement into Forms:
1. The CONTRACTOR shall employ placement methods that minimize the mixing of concrete and the surrounding water within the conveyance conduit and after placement.
2. Conduits used to convey and place concrete shall have sufficient diameter to ensure blockages do not occur.
3. Buoyancy of the conduits shall be considered in the design of the conveyance system.
4. Conduits and connections shall be adequately supported and designed to resist all resulting forces.
5. Connections between segments of conduit shall be watertight.
6. If the conveyance system is to be accessed from a barge, it shall be designed to accommodate vertical and horizontal movements without distress to the conduits or adverse effects on placement.
7. Place concrete as soon as possible after leaving mixer.
8. Concrete shall be placed at such a rate that it is at all times plastic and flows readily between reinforcing steel and other embedded items.
9. Concrete that has partially hardened or is contaminated by foreign materials shall not be placed into the forms.
10. Do not use aluminum conveying devices.
11. The top surface of slabs shall be flat and level.
12. The velocity of the water in the immediate vicinity of the placement shall be low enough to prevent cement fines from washing out of the concrete.

C. Addition of Water at Site:
1. Permitted only once and within 60 minutes of initial batching.
2. The w/c+p ratio of the mix is not to be exceeded.
3. If hydration stabilizing admixtures are used, the brand, type and anticipated dosage rates shall be submitted to the ENGINEER for approval prior to placement.
4. Provide accurate means to determine and measure volume of water added to mix.

D. Pumping of Concrete:
1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to assure completion of concrete placement without cold joints in case of a primary placing equipment breakdown.
2. Replace pumping equipment and hoses (conduits) that are not functioning properly.

E. Consolidation:
1. Concrete mix design shall inhibit segregation and washout underwater.
2. To avoid excessive mixing of concrete and surrounding water, mechanical vibrators shall not be used.

3.3 CONCRETE SLAB FINISHES

A. General:
1. Slabs shall have a level, flat top surface. The minimum quality of the top surface shall be comparable to that provided by a single screeding.
2. To avoid excessively mixing concrete and surrounding water, troweling, floating, brooming, or other surface finishing shall not be performed.

3.4 FIELD QUALITY CONTROL

A. General:
   1. Field quality control will be performed by OWNER.
   2. Provide access, cooperation, and incidental labor required by OWNER in obtaining specimens, performing tests, and conducting inspections.
   3. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for first 48 hours, and for additional time as may be required before transporting to test lab.
   4. Provide concrete for testing of slump, air content, and for making cylinders from the discharge end of mixer chute and just prior to entering pump hopper or tremie funnel.
   5. Evaluation will be in accordance with ACI 301, Chapter 17 and Specifications. Where the term “building official” is used, the term shall be redefined to ENGINEER.
   6. Specimens will be made, cured, and tested in accordance with ASTM C 31 and ASTM C 39.
   7. Frequency of testing may be changed at discretion of ENGINEER.
   8. Pumped Concrete: Take concrete samples for slump (ASTM C 143), air content (ASTM C 231), and test cylinders (ASTM C 31 and C 39).
   9. Assist in obtaining samples and provide undisturbed testing areas with 120V AC power.

B. Compression Test Specimens:
   1. Fabricate, cure, and test in accordance with ASTM C 192.
   2. Test one specimen at an age of 7 days and two at age of 28 days and hold one specimen for later break date.
   3. These tests shall be considered a part of normal compression tests for the Project and performed by ENGINEER.

C. Enforcement of Strength Requirements:
   1. Should the strengths shown by the laboratory cured test cylinders made and tested in accordance with provisions of the Standard Specifications and evaluated by the methods recommended in ACI 318/318R fall below the specified values, the ENGINEER shall have the right to require changes in the proportions of the concrete mix to be used on the remainder of the Work.
   2. The ENGINEER may require the CONTRACTOR to provide a minimum of three cores drilled in accordance with ASTM C 42 and tested for compressive strength in accordance with ASTM C 39 for each portion of the Work in which the laboratory cured concrete test cylinders indicate failure to meet the specified strength requirements within the specified time period.
   3. The ENGINEER may require CONTRACTOR to remove and replace areas determined to be defective.
PART 1  GENERAL

1.1 SUMMARY
A. Provide Concrete Finishing as specified and as shown on the Drawings. Repair surface defects as specified.
B. Related Sections:
   1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE
   2. SECTION 03 39 00 – CONCRETE CURING
   3. SECTION 03 68 00 – CONCRETE CRACK REPAIR

1.2 REFERENCES
A. American Society for Testing and Materials (ASTM):

1.3 SUBMITTALS
A. Submittals for Review:
   1. Product Data:
      a. Grouts.
      b. Bonding agents.
      c. Means and methods of repairing defects unless otherwise called out herein.
      d. Manufacturer’s safety data sheets.
   2. Equipment:
      a. Thermometers for measuring concrete surface temperature.

1.4 DELIVERY, STORAGE AND HANDLING
A. Deliver materials to project site in manufacturer’s containers with labels intact and legible at the time of use.
B. Store materials in secure, indoor, dry area.
C. Maintain grouts and aggregates in dry condition during delivery, storage, and handling.

PART 2  PRODUCTS

2.1 MATERIALS
A. Premixed Pre-packaged Grouts
   1. Sources: EMACO S88-CI (for placements ranging in thickness, t, 3/8-inch less than or equal to t less than or equal to 1-1/2 inches) or EMACO S-66-CI (for placements ranging in thickness, t, 1-inch less than or equal to t less than or equal to 8-inches) by Masterbuilders.
   2. No substitutes permitted.
B. Epoxy Bonding Agents
   1. Sources: Concresive Liquid (LPL) or Concresive Standard Liquid by Master Builders.
C. Cement: ASTM C 150, Type 1.
D. Aggregate: ASTM C 33, 100% passing the No. 30 mesh sieve.
E. Bond Coat Mortar: Of same materials and of approximately same proportions as used for concrete, except omit coarse aggregate and provide one part cement to not more than one part sand by damp loose volume.
F. Patching Mortar (For Patches with Thickness, t, less than or equal to 3/8-inch):
   1. Of same materials and of approximately same proportions as used for concrete, except omit coarse aggregate and provide one part cement to not more than 2-1/2 parts sand by damp loose volume.
   2. Substitute white air-entrained portland cement for part of gray portland cement on exposed concrete to produce color matching color of surrounding concrete, as determined by trial patch.
G. Water
   1. Use only clean potable water.
   2. Use calibrated measuring device to measure water added to pre-packaged grouts and mortars.
   3. Use minimum quantity of mixing water necessary for handling and placing.

PART 3 EXECUTION

3.1 REPAIR OF SURFACE DEFECTS
A. ENGINEER review
   1. Submit means and methods to ENGINEER for review prior to performing repair of improperly placed or finished concrete, including defects caused by ineffective and improper vibration such as honeycomb, excessive air voids on formed surfaces, placement "pour" lines (cold joints), sand streaking, and defects caused by excessive form deflections, form damage, or form failure, where defects do not exceed tolerances found in SECTION 03 10 00.
   2. Regardless of prior approval of means and methods of concrete finish repair, do not repair concrete finish until ENGINEER has reviewed existing finish.
B. Repair surface defects, unless otherwise specified by Contract Documents, immediately after form removal but not before review by ENGINEER.
C. Surface temperature of concrete:
   1. 50°F and rising.
   2. Measure surface temperatures when requested.
   3. If necessary, enclose and heat area to be repaired to bring surface temperature and air temperature to acceptable levels and to permit proper curing.
D. Remove defective concrete:
   1. Remove honeycombed and other defective concrete down to sound concrete.
   2. If chipping is necessary, make edges perpendicular to surface or slightly undercut.
   3. Feathered edges will not be permitted.
E. Dampen area to be patched and an area at least 6 inches wide surrounding to prevent absorption of water from patching mortar.
F. Prepare bonding grout, mix to consistency of thick cream, and after surface water has evaporated from area to be patched, brush into surface.
G. Mix patching mortar in advance and allow to stand with frequent manipulation with trowel, without addition of water, until it has reached stiffest consistency that will permit placing.

H. When bond coat begins to lose water sheen, apply premixed patching mortar.

I. Thoroughly consolidate repair mortars into place and strike off to leave patch slightly higher than surrounding surface.

J. To permit initial shrinkage, leave repair mortar undisturbed for at least one hour.

K. Keep patched area damp for 7 days.

L. Do not use metal tools when finishing patch in formed wall that will be exposed.

3.2 PROPRIETARY MATERIALS

A. Certain types of defects may require use of proprietary compounds for adhesion or patching ingredients; suggest means and methods for these repairs.

B. Epoxy bonding agents and premixed pre-packaged grouts:
   1. May be used in lieu of, or in addition to, patching procedures using bond coat and patching mortars.
   2. Use in accordance with manufacturer's written recommendations and directions.
   3. Submit for review and obtain written acceptance of procedures.

3.3 FINISHING OF FORMED AND UNFORMED SURFACES

A. Finish as called out in Drawings and Specifications.

1. Formed Surfaces:
   a. Smooth Form Finish:
      1) Form facing material shall produce smooth, hard, uniform texture on concrete.
      2) Arrange facing material orderly and symmetrically; keep number of seams to practical minimum.
      3) Grind smooth surface textures that result from forms with raised grain, torn surfaces, worn edges, patches, dents, or other defects, or otherwise repair.
   b. Air Voids on Formed Surfaces:
      1) Fill air voids on formed surfaces deeper than 1/4 inch with patching mortar.
2) Frequency and size of air voids shall be less than shown in Figure 1: Total void area is one percent of surface area, or 0.36 square inches.; this 6-inch x 6-inch figure is visual standard for acceptance of finish that does not require filling of air voids.

![Figure 1](image)

c. Tie Holes: In accordance with the requirements of this Section.
d. Form Fins: Chip or rub-off fins exceeding 1/16 inch in height.
e. Rock Pockets:
   1) Remove poorly consolidated concrete to sound concrete and repair defect.
   2) ENGINEER will outline area to be repaired.

2. As-Cast Finish:
   a. For as-cast concrete, finish form materials shall produce sound surface.
      1) Fill air voids deeper than 1/4 inch and larger than 0.50 square inches.
      2) Total area of acceptable air voids is 0.72 square inches in a 6-inch by 6-inch square.
   b. Tie Holes: In accordance with the requirements of this Section.
   c. Form Fins: Chip or rub-off form fins exceeding 1/8 inch in height.

3. Floor Slabs:
   a. Strike smooth.
   b. Bull float finish.
   c. Broom after evaporation of bleed water.
      1) Concrete shall be stiff enough such that footprint does not indent slab surface more than 1/8 inch.
      2) Brooming shall be performed after all concrete has been placed; do not broom concrete in plastic state.

3.4 PLASTIC SHRINKAGE CRACK REPAIR

A. If, during finishing, plastic shrinkage cracks appear, rework surface to close cracks by re-floating surface.

B. Do not add additional water or evaporative retardant to surface of concrete during re-floating.
3.5 CRACK REPAIR

A. Repair cracks greater than 0.010 inches wide.

B. Measure crack widths using crack comparator gauge.

C. Complete crack repairs per SECTION 03 68 00.

END OF SECTION
PART 1  GENERAL

1.1   SUMMARY
A. Provide Concrete Curing as required, specified and as shown on the Drawings for foundation, slabs and walls.

1.2   REFERENCES
A. American Concrete Institute (ACI):
   1. ACI 305, Hot Weather Concreting.
   2. ACI 306, Cold Weather Concreting.
   3. ACI 308, Standard Practice for Curing Concrete.
B. American Society for Testing and Materials (ASTM):
   1. C 171, Sheet Materials for Curing Concrete.
   5. D 883, Terminology Related to Plastics.
   6. D 2103, Polyethylene Film and Sheeting.

1.3   SUBMITTALS
A. Shop Drawings:
   1. Curing methods proposed.
   2. Manufacturers' data for the following products:
      a. Evaporation retardant.
      b. Curing compound.
B. Quality Control Submittals:
   1. Curing Compound: Manufacturer's Certificate of Compliance showing moisture retention requirements.

PART 2  PRODUCTS

2.1   MATERIALS
A. White Burlap Polyethylene Sheet (Burlene):
   1. Weighing at least 10 ounces/linear yard.
   2. At least 40 inches wide.
   3. Polyethylene securely bonded to burlap with no separation.
   4. Polyethylene shall be at least 0.004 inches thick in accordance with ASTM D 2103.
B. Curing Compound:
   1. Water-based, high solids content, non-yellowing curing compound meeting requirements of ASTM C 309 and ASTM C 1315.
      a. Moisture Loss: 0.040 grams per square centimeter per 72 hours maximum.
b. Capable of meeting moisture retention at manufacturer’s specified application rate.

2. Manufacturers and Products:
   a. BASF Building Systems (Master Builders), Shakopee, MN; Masterkure 100W or 200W.
   b. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.

C. Evaporation Retardant:
   1. Use only with written approval of ENGINEER.
   2. Fluorescent color tint that disappears completely upon drying.
   3. Manufacturers and Products:
      a. BASF Building Systems (Master Builders), Shakopee, MN; CONFILM.
      b. Euclid Chemical Co., Cleveland, OH; Eucobar.

D. Water: Clean and potable, containing less than 50 ppm of chlorides.

PART 3 EXECUTION

3.1 CURING OF CONCRETE

A. Use one of the following methods as approved by ENGINEER:

1. Walls:
   a. General: Where walls, beams or columns are to receive coatings, painting, cementitious material, or other similar finishes, or where solvent-based coatings are not permitted, use only water curing procedures.
   b. Method 1:
      1) Leave concrete forms in place.
      2) Keep entire surfaces of forms and concrete wet for 7 days.
   c. Method 2:
      1) Apply curing compound, where allowed, immediately after removal of forms.
   d. Method 3:
      1) Continuously sprinkle with water 100% of exposed surfaces for 7 days starting immediately after removal of forms.

2. Slabs/Foundations:
   a. Wet Method:
      1) Place soaker hoses in a serpentine pattern on top of finished surface.
      2) Cover soaker hoses with Burlene.
      3) Turn on soaker hoses until entire slab is saturated.
      4) Cover Burlene with concrete blankets to control temperature differential between the slab and the atmosphere.
      5) The temperature differential between the surface of the slab and the atmosphere shall not exceed 25 degrees.
      6) Place thermostatically controlled ground thaw hoses in a serpentine pattern on top of the concrete blankets.
      7) Place a second layer of concrete blankets on top of the ground thaw hoses.
      8) Provide means to measure the temperature of the surface of the slab.
      9) Monitor temperature closely until patterns are developed. The first 24 hours is the most critical as far as temperature control.
      10) The slab is to be kept completely saturated for the 7 day curing cycle.
      11) Pull blankets and burlene back at least 4 times per 24 hours to check that surface is completely saturated.
      12) Leave edge forms in place where practical.
13) If edge forms are removed, the edge must moist cured for 7 days as well.
14) Provide sufficient means to hold all blankets in place.

B. Use only water curing where additional finishes such as sealer/hardener, painting, and other special coatings are required.

C. Curing system must remain in place and be maintained for a duration of 7 days following placement.

D. No construction, dead, or live loads are to be applied to the new concrete until field cylinders indicate a minimum compressive strength of 80% of the design strength or 7 days as a minimum.

3.2 EVAPORATION RETARDANT APPLICATION

A. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture as directed by manufacturer.

B. Reapply per manufacturer’s requirement.

END OF SECTION
PART 1  GENERAL

1.1  GENERAL
   A. This Section includes backfill grouting of spools under water.

1.2  REFERENCES
   A. ASTM International (ASTM):
      1. C 150-07 Portland Cement
      2. C 494/C 494M-05a Chemical Admixtures for Concrete
      3. C 1602/C 1602M-06 Mixing Water Used for Production of Hydraulic Cement
         Concrete
      4. C 937-02 Grout Fluidifier for Preplaced-Aggregate Concrete

1.3  SUBMITTALS
   A. Submit in accordance with SECTION 01 33 00.
   B. Resume:
      1. Qualifying experience of individual responsible for supervising and directing
         backfill grouting for spool encasement.
   C. Certification and Test Reports:
      1. Cement: Manufacturer’s certification and test reports for each lot of cement from
         which shipments are drawn.
      2. Certify materials were tested during production or transfer in accordance with
         specified reference Specifications.
      3. Submittal of certifications and test reports shall not relieve CONTRACTOR of
         responsibility for furnishing materials meeting specified requirements.
   D. Admixtures:
      1. Manufacturer’s name and specific brand names, product description, instructions,
         recommended dosage, chloride content, and precautions for its use.
      2. Independent laboratory test data confirming Specifications requirements are met.
      3. Final approval of admixture will not be given until it has performed satisfactorily at
         the jobsite
   E. Grout Plant and Equipment Information:
      1. Grout Pump Rate Curves.
      2. Mixer and Agitator details
      3. Photographs of mixing equipment.
      4. Power system for grout pump, grout mixing pump, and agitator.
   F. Bulkheads:
      1. Details of bulkhead construction on each end of the Spools, including type of
         materials utilized. (Note: Construction materials utilized in constructing the
         bulkheads and in contact with the Spools, must be compatible with stainless steel
         construction methods.)
      2. Methods to be used in sealing the rock/concrete contact of the bulkheads.
      3. Details of bulkhead support system.
1.4 QUALITY ASSURANCE

A. OWNER will perform tests of grout mix, including admixtures, to check strength and flow properties of the grout.

B. OWNER, CONTRACTOR, and Grouting Engineer shall participate in a pre-grouting meeting for each spool location. The meeting shall outline sequencing, quality assurance, means and methods, and schedule.

PART 2 PRODUCTS

2.1 CEMENT

A. Portland Cement:
   1. ASTM C 150, Type II

2.2 WATER

A. ASTM C 1602, including optional requirements of Table 2.

2.3 ADMIXTURES

A. ASTM C 937 Grout Fluidifier with added water retention capability.

2.4 GROUT MIX

A. The OWNER will design the grout mix for backfill grouting of the Spools. The grout mix design shall include proportions of cement and water used, and type and quantity of admixture used.
   1. The grout mix shall be as thick as possible based on successful performance in the field.
   2. Anticipated water-cement ratio of the grout mixture: 0.7:1, by volume.
   3. Use of admixture in mix as directed by the manufacturer and approved by the OWNER.
   4. A grout mix utilizing sand will not be allowed.

B. Viscosity Modifying Admixture:
   1. The admixture to be used will be Micro-Aid, UWG as manufactured by Specrete-IP Incorporated, 10703 Quebec Ave., Cleveland, OH 44106, and Telephone: 1-800-245-3407.

PART 3 EXECUTION

3.1 GENERAL

A. Perform all backfill grouting operations in presence of the OWNER.

B. Location and spacing of grout hook-ups will be as shown on the Drawings.

C. The OWNER will direct sequence of backfill grouting, starting mix design, changes in mix design, and grouting pressures used.

D. Notify the OWNER of proposed grouting schedule and give 48-hour notice prior to change in a shift schedule.

E. CONTRACTOR shall be responsible for operating the mixing plant, grout plant, and manifold.
F. The OWNER shall provide an onsite grouting engineer who will provide guidance and assistance with respect to the grouting operation.

3.2 GROUT PLANT AND EQUIPMENT

A. Use plant and equipment of a type and size approved by the OWNER to mix and place grout.

B. Use plant and equipment capable of effective mixing and stirring of grout and forcing grout into grout injection points in a continuous flow at any pressure as directed by the OWNER.

C. Furnish adequate water supply to the mixer to provide required pumping rate.

D. Mixing Plant:

1. Cylindrical mixing tank:
   a. Mounted vertically.
   b. Volume: 17 cubic feet minimum
   c. High-speed colloidal type
   d. Equipped with high-speed, diffuser-type centrifugal mixing pump operating at 1,500 to 2,000 revolutions per minute during mixing.
   e. The mixing pump shall have variable speed capabilities.
   f. Delivers 300 gallons per minute at 30 pounds per square inch pressure.
   g. Furnish with watermeter to measure amount of mixing water used in grout.
      1) Meter shall be capable of reading cubic feet to tenths of a cubic foot for controlling amount of mixing water used in grout.
      2) Meter shall be capable of being reset to zero.
      3) Calibrate meter in presence of the OWNER at times as directed by the OWNER.
         a) Calibrate at least once a week during grouting operations.
         b) When calibration is off, recalibrate before continuing to rout.
         c) Calibration equipment and supplies: Furnish adequate water supply, calibrate container capable of holding 55 gallons of water, and scales to weigh water container.
         d) Keep calibration equipment and supplies on Site for duration of grouting operation.
         e) Immediately replace defective water meter.
         f) Demonstrate testing and calibration procedures to the OWNER, for approval, prior to grouting startup.
         g) Keep at jobsite one extra calibrated and working water meter for immediate replacement of defective unit.
         h) Calibration range of the meter shall be ±1-1/2%.
   2. Direct return flow from centrifugal mixing pump tangentially into cylindrical tank near the top to create a vortex.
   3. Provide a holdover mechanical agitator tank similar in volume to mixer.
   4. Pass grout through a U.S. Standard No. 16 screen as it is discharged from the mixer to the agitator.
   5. Locate screen so that flows from return line of the circulation grout system shall be passed over the screen.
   6. Keep screen clean and free of grout scale and buildup.
   7. Make screen readily accessible for cleaning and replacement.
   8. The OWNER has the right to require the CONTRACTOR to make changes in equipment which the OWNER determines necessary to make equipment perform satisfactorily during grouting operations without additional cost to the OWNER.
E. Grout Plant:

1. Grout pump: Helical-screw, progressive cavity rotor-type pumps that produce a uniform flow without pulsation.
   a. Power units for grout pump(s) shall have variable speed capabilities.
   b. Pump minimum capacity of 25 gallons per minute at pressures of 50 pounds per square inch.
   c. Grout pumps with open-throat design including holding hoppers will not be allowed.
   d. Grout pump able to circulate grout through grout hoses which may be submerged to a depth of 220 feet in the reservoir.
   e. Test grout pumps as directed by the OWNER.

2. Include one standby grout pump, capable of being placed in operation with no more than 15-minute notice.

3. Maintain grouting equipment in a manner satisfactory to the OWNER so it is capable of continuous and efficient performance during any grouting operation.

4. Arrange grouting equipment to provide a supply line and a return line from the grout pump to the grout injection point.

5. Manifold:
   a. Locate manifold in the grout line at the collar of the injection point to permit continuous circulation, accurate control and monitoring of grouting pressure, bleeding, and regulation of flow into grout injection points.
   b. Manifold shall consist of a system of valves and pressure gauges as shown on the Drawings.
   c. Quick shutoff type steel-bodied valves with 6-inch lever handles shall be furnished for the manifold.
   d. Minimum size of supply lines and manifold including valves and fittings: 1-inch inside diameter.

F. Pressure Gauges:

1. Pressure gauges as manufactured by Marsh Bellofram, 8019 Ohio River Road, State Rt. 2, Box 305, Newell, WV 28050, Telephone: 1-800-727-5646, with the following essential characteristics:
   a. Glycerin filled.
   b. Plain case.
   c. Pressure indicated in pounds per square inch.
   d. 2.5-inch diameter minimum dial-face size.
   e. Rating of each pressure gauge not more than 1-1/2 times the pressure rating at which the grout is anticipated to be pumped for the stage being grouted.
   f. Gauges accurate to no more than 2% error over the full range of gauge.
   g. Gauges must be capable of withstanding 220 feet of reservoir head, externally.

2. Equip pressure gauges with approved pressure sensors/gauge savers:
   a. Furnish Series 42 Pressure Sensor, manufactured by Red Valve Co., Inc., Carnegie PA 15106 with the following essential characteristics:
      1) Flow-through type suitable for installation in the manifold in the flow pattern behind pressure control valve and also after the flow control valve to measure pressures on each side of the flow control valve.
      2) Threaded –ends with standard NTP threads.
      3) Capable of measuring pressure for full circumference around sensor sleeve.

3. Check pressure gauges with attached pressure sensors at least once a day to ensure accuracy.
   a. Immediately replace defective gauges.
b. Provide an accurately calibrated, high precision master gauge for periodic checking of the accuracy of gauges used in the grouting operations.
   1) Master gauge: Calibrated and certified by gauge manufacturer to be accurate to not more than one percent error over the full range of gauge.
   2) Provide 4 standby pressure gauges for each pressure range at all times for replacement of malfunctioning or broken gauges.

3.3 FORMWORK FOR GROUTING

A. Design and build adequate forms and leave them in-place until the forms can be safely removed.
B. Design formwork for anticipated live and dead loads.
C. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
D. Monitor forms during grout placement and correct deficiencies.
E. Align joints and make watertight to prevent leakage of mortar. Keep form joints to a minimum.
F. Remove forms in a manner, which will not damage concrete/grout.

3.4 PREPARATION FOR GROUTING

A. Drill each grout/vent hole along the crown (top) of the spool to the depth as shown on the Drawings.
B. Clean concrete and/or rock surfaces of all laitance, loose or defective concrete, loose rock, other coatings, and foreign material in accordance with approved installation plan of the spools.
C. Furnish, operate, and maintain adequate lighting to illuminate Work area during night time operations on the barge.
D. Place grouting equipment no more than 300 feet away from the spool installation area. Grouting equipment shall be located as close to the grouting operations as possible.
E. Caulk and seal all gaps between spool and the surrounding rock/concrete area.
F. Correct any and every possible sources of grout leakage.

3.5 GROUTING

A. Inject grout at a rate not to exceed 0.5 to 0.75 cubic feet per minute as monitored at the grout plant and at a maximum of 10 pounds per square inch differential (greater than hydrostatic head) as indicated on the pressure gauge nearest to the point of injection, initially. (Note: Pressures will need to be increased as grouting progresses as indicated by grout take measured at the pump).
B. Initially hook grout to the upstream injection point in the floor of the liner.
C. Inject grout into this hook-up until dense grout returns are received from floor vents and all lower side vents. Monitor side vents to assure that grout levels are near equal on each side of the liner as grout is being injected.
D. Check and correct any occurrence of a grout leakage during injection which is in a quantity sufficient to cause an unbalance of flow or grout levels behind the liner.
E. Continue grout injection on the upstream lower side vents, alternating from side to side with approximate 10 cubic foot batches.

F. Continue grout injection until dense grout is received from each of the upper side vent valves.

G. Continue grout injection on the upstream higher side vents, alternating from side to side with approximate 10 cubic foot batches.

H. Continue grout injection on the upstream higher side vents until dense grout returns are received from all of the top vent valves. Close top vent valves.

I. After a period of 120 minutes, open arch vent valves and reinject grout in the upper upstream side vents until dense grout reappears from the all of the arch vent valves.

J. As a safeguard against displacement or while leaks are being calked, the OWNER may require reducing pumping pressure, intermittent pumping, or discontinuing of pumping.

K. Dispose of grout not injected within 2 hours after mixing.

L. Comply with SECTION 01 50 00, Construction Facilities and Temporary Controls for treatment and disposal of wash water and waste grout.

3.6 COMMUNICATION FACILITIES

A. Furnish and maintain communication between the manifold operator, the grout plant operator, and the onsite grouting engineer during grouting operations.

3.7 TRAINING

A. A Grouting Training Session will be conducted by the OWNER after erection of the grouting plant and prior to conducting grouting operations for ALL of the CONTRACTOR’s grouting personnel who will be involved in the grouting operation.

B. Allow a minimum of 2 hours in his schedule for this training program. Give 7 days of prior notice for conducting the training program.

END OF SECTION
SECTION 03 68 00
CONCRETE CRACK REPAIR

PART 1  GENERAL

1.1  SUMMARY

A. Provide and perform the following Work as required:
   1. Concrete crack and spall repair.
   2. Concrete surface preparation.
   3. Polyurethane chemical grouts.
   5. Polymer-modified portland cement mortar.
   6. Contraction joints.

B. Related Sections:
   1. SECTION 03 10 00 – CONCRETE FORMING
   2. SECTION 03 36 00 – CONCRETE FINISHING

1.2  REFERENCES

A. American Society for Testing and Materials (ASTM):
      or 50-mm Cube Specimens).
   4. C 293 - Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading).
   5. C 309 - Liquid Membrane-Forming Compounds for Curing Concrete.
   6. C 496/C 496M - Splitting Tensile Strength of Cylindrical Concrete Specimens.
   7. C 580 - Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars,
      Grouts, and Monolithic Surfacing, and Polymer Concretes.
   8. C 666/C 666M - Resistance of Concrete to Rapid Freezing and Thawing.
   9. C 827 - Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
  10. C 882/C 882M - Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
  11. C 884/C 884M - Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay.
  15. D 624 - Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.
  18. D 2126 - Response of Rigid Cellular Plastics to Thermal and Humid Aging.
  19. D 2240 - Rubber Property - Durometer Hardness.
  22. G 3 - Conventions Applicable to Electrochemical Measurements in Corrosion Testing.

C. U.S. Army Corps of Engineers (CRD): CRD C 621 - Grout.

D. Federal Specifications (TT-S):
   1. TT-S-001543A - Physical Test Requirements.
   2. TT-S-00230C - Sealants.

1.3 SYSTEM DESCRIPTION
A. Design Requirements:
   1. Repair any crack whose width greater than or equal to 0.010 inches at any point along crack length.
   2. Repair of cracks using pressure or gravity grouting may be terminated when crack width is less than or equal to 0.050 inches or where applicable, visible leakage ceases.

1.4 SUBMITTALS
A. Submittals for Review:
   1. Product Data:
      a. Manufacturer's Specifications, data sheets, recommendations, installation instructions, guarantees, test reports, and other pertinent data on all materials showing compliance with contract requirements.
      b. List of items which have limited shelf life or require special handling, with description of limitations and requirements.
   2. Samples:
      a. Upon request, submit representative samples of proposed products of sufficient quantity for independent examination and testing.
      b. When requested, proposed samples shall be tested and certified by independent testing laboratory at no expense to OWNER.

1.5 QUALITY ASSURANCE
A. Manufacturing qualifications: Have in existence, for minimum of 10 years, program of training, certifying, and technically supporting nationally organized Approved Contractor Program.

B. CONTRACTOR qualifications:
   1. Approved Contractor of manufacturer of specified product.
   2. Completed program of instruction in use of specified repair material.
   3. Provide notarized certification from manufacturer attesting to Approved Contractor status or, if approved by ENGINEER, provide 5 job references of successfully repaired concrete cracks with specified product.

C. Provide notarized certificate stating that repair material meets specified requirements and have manufacturer’s current printed literature on specified product.

1.6 DELIVERY, HANDLING AND STORAGE
A. All equipment used for handling and transporting materials must be clean and in proper operating condition before any material is placed therein.

B. Materials shall be stored and handled to insure the preservation of their quality and fitness for use and shall be located to facilitate prompt inspection.
PART 2 PRODUCTS

2.1 MATERIALS

A. General:

1. Use only approved materials, conforming to requirements of these Specifications.
2. Materials are subject to inspection and tests at any time during progress of preparation or use.
3. Obtain approval for source of supply of each material before delivery or use is started.

B. Polyurethane Chemical Grout for Pressure Grouting:

1. Source: SikaFix HH by Sika Corporation, Lyndhurst, New Jersey, or approved substitute.
2. Description:
   a. Non-flammable, high flash point (212°F) hydrophobic polymer of type which is applied in crack or open joint by use of packer. It shall be non-toxic.
   b. When the grout is mixed with about 5% water, material will expand 20 times its original volume and cure to golden-yellow closed-cell polyurethane foam.
3. Properties of mixed polyurethane chemical grout:
   a. Pot life: approximately 5 hours providing no moisture enters the system.
   b. Mixed viscosity: 300 cps.
   c. Color: light amber.
4. Properties of cured polyurethane chemical grout:
   a. Tensile Properties (ASTM D 1623):
      1) Tensile strength: 15.5 psi at one day.
      2) Elongation: plus 25%.
   b. Shear Strength (ASTM C 273): 11.7 psi at one day.
   c. Shrinkage (ASTM D 2126): 0%.
   d. Water absorption (ASTM C 2842): 0.09 psf at one day.
   e. Density (ASTM D 1622)
      1) Free rise (number 10 cup): 1.64 pcf.
      2) Molded overall: 4.2 pcf.
5. Accelerator:
   a. Based on Stannous Octate.
   b. Able to control reaction time from 3 to 30 seconds.
   c. Catalyzed polyurethane chemical grout should not react until it contacts water.

C. Epoxy Grout for Gravity Feeding for Concrete Slabs:

1. Source: DENEPOX I-40 by de neef Construction Chemicals, Inc.
2. Description: Ultra low viscosity, 2-component epoxy resin for gravity feeding or pressure injection of cracks in slabs.
3. Properties:

<table>
<thead>
<tr>
<th>Part A – Resin</th>
<th>Part B - Hardener</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids (%)</td>
<td>100</td>
</tr>
<tr>
<td>Color</td>
<td>Clear</td>
</tr>
<tr>
<td>Viscosity (CPS)</td>
<td>125</td>
</tr>
<tr>
<td>Shelf Life (year)</td>
<td>1</td>
</tr>
</tbody>
</table>
### Properties at 77°F

<table>
<thead>
<tr>
<th>Property</th>
<th>Typical Mixed Values</th>
<th>ASTM Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix ratio (A:B by volume)</td>
<td>2.85:1</td>
<td>N/A</td>
</tr>
<tr>
<td>Viscosity (cps)</td>
<td>40</td>
<td>N/A</td>
</tr>
<tr>
<td>Potlife (3.5 oz.) (minutes)</td>
<td>80</td>
<td>N/A</td>
</tr>
<tr>
<td>Tensile Strength (psi)</td>
<td>9,000</td>
<td>D 638</td>
</tr>
<tr>
<td>Flexural strength (psi)</td>
<td>14,400</td>
<td>D 790</td>
</tr>
<tr>
<td>Compressive strength (psi)</td>
<td>15,250</td>
<td>D 695</td>
</tr>
<tr>
<td>Bond strength to dry concrete (psi)</td>
<td>870</td>
<td>C 321</td>
</tr>
<tr>
<td>Bond strength to wet concrete (psi)</td>
<td>520</td>
<td>C 321</td>
</tr>
<tr>
<td>Elongation (%)</td>
<td>9</td>
<td>D 638</td>
</tr>
</tbody>
</table>

### D. Portland Cement Grout:

1. **Source:** SikaGrout 212 by Sika Corporation, Lyndhurst, New Jersey, or approved substitute.

2. **Description:**
   b. Shrinkage agents shall compensate for shrinkage in both plastic and hardened state.

3. **Properties of the mixed Portland cement grout:**
   a. **Time of set (ASTM C 191)**
      1) Initial set: 3.0 hours min.
      2) Final set: 6.5 hours max.
   b. **Color:** concrete gray.
   c. The grout shall not exhibit bleeding.
   d. The grout shall not segregate.
   e. The grout shall be pumpable through standard grout pumping equipment.

4. **Properties of the cured Portland cement grout (flowable consistency):**
   a. **Compressive Strength (CRD C 621):**
      1) 3500 psi at one day.
      2) 6200 psi at 28 days.
   b. **Splitting Tensile Strength (ASTM C 496):** 575 psi at 28 days.
   c. **Flexural Strength (ASTM C 580):** 1200 psi.
   d. **Bond Strength (ASTM C 882 Modified):** 1900 psi at 28 days under moist cure.
   e. **Expansion (CRD C 621):** plus 0.056% min. at 28 days
   f. Not produce vapor barrier.
   g. Exhibit positive expansion when tested in accordance with ASTM C 827.
   h. Conform to United States Army Corps of Engineers Specification CRD C 621.
   i. Conform to ASTM C 1107
   j. Approved by United States Department of Agriculture.
E. Water:
   1. Potable water.
   2. Meet requirements of ASTM C 94.
   3. Free from sewage, oil, acids, strong alkalis, vegetable matter, clay, loam, or other deleterious substance which might affect performance of grout.
   4. If water is of questionable quality, test in accordance with AASHTO T-26 and submit results to ENGINEER.

F. Polymer-modified Portland Cement Mortar:
   1. Source: SikaTop 123 by Sika Corporation, Lyndhurst, New Jersey, or approved substitute.
   2. Description:
      a. Liquid polymer emulsion of acrylic copolymer base and additives.
      b. Particle size less than 0.1 micron.
   3. Component A:
      a. Contain organic, migrating corrosion inhibitor:
         1) Independently proven to reduce corrosion in concrete via ASTM G 3.
         2) Not calcium nitrite.
         3) Minimum of 7 years independent field testing to document performance on actual construction projects.
   4. Component B: Blend of selected Portland cements, specially graded aggregates, admixtures for controlling setting time, water reducers for workability, and accelerator.
   5. Ratio of Component A to Component B: 1:5.2 by weight.
   6. Non-combustible, either before or after cure.
   7. Supplied in factory-proportioned unit.
   8. Placeable from 1/8 to 1 1/2 inches in depth per lift.
   9. Properties of the mixed polymer-modified Portland cement mortar:
      a. Working time: 10 to 15 minutes.
      b. Finishing time: 20 to 60 minutes.
   10. Properties of cured polymer-modified Portland cement mortar:
      a. Compressive Strength (ASTM C 109 Modified):
         1) 3500 psi at one day.
         2) 6500 psi at 7 days.
         3) 8000 psi at 28 days.
      b. Splitting Tensile Strength (ASTM C 496): 900 psi at 28 days.
      c. Flexural Strength (Modulus of Rupture) (ASTM C 293): 2000 psi at 28 days.
      e. Bond Strength (ASTM C 882 Modified): 2200 psi at 28 days.
      g. Abrasion (Taber Abrader with H-22 wheel, 1000 gm load, 1000 cycles): 8.0 gm weight loss in 7 days.
      h. Rapid Chloride Ion Permeability (AASHTO T-277): 1000 Coulombs max.
      i. Not produce vapor barrier.

2.2 ACCESSORIES

A. Curing Compounds:
   1. Satisfy requirements of ASTM C 309, Type ID.
   2. White pigmented or tinted.

B. Closed Cell Backer Rod:
   1. Meet requirements of ASTM D 5249.
C. Polyurethane Sealant:

1. **Source:** SikaFlex-15LM by Sika Corporation, Lyndhurst, New Jersey, or approved substitute.
2. **Description:**
   a. One-component, gun-grade, low-modulus, polyurethane-base material.
   b. It shall be applicable in vertical and overhead joints.
   c. Shall cure under influence of atmospheric moisture to form elastomeric substance.
3. **Properties of uncured polyurethane sealant shall be as follows:**
   a. Initial cure (tack-free time): 6 to 8 hours.
   c. Color: limestone gray.
4. **Properties of the cured polyurethane sealant shall be as follows:**
      1) Tensile strength: 100 psi min. at 21 days.
      2) Elongation at break: 600% min.
      3) Tensile stress at 100% elongation: 45 psi min.
      4) Tensile set after break: 20% max.
   b. Hardness (ASTM D 2240): 25 max. at 21 days (Shore A).
   c. Tear Strength (ASTM D 624): 25 pounds per inch min. at 21 days.
   d. Adhesion in Peel from Concrete (TT-S-00230C): 20 pounds min. at 28 days.
   e. Service Range: minus 40°F to plus 170°F.
   f. The sealant shall conform to Federal Specification TT-S-00230C, Type II, Class A.
   g. The sealant shall conform to ASTM C 920, Type S, Grade NS, Class 25.
   h. The sealant shall be capable of plus 100% to minus 50% of the average joint width when tested in accordance to the durability bond test in Federal Specification TT-S-00230C.
   i. The sealant shall conform to the physical test requirements of Federal Specification TT-S-001543A.
   j. The sealant shall be non-staining.
   k. Final Cure: 7 to 10 days.

## PART 3 EXECUTION

### 3.1 GENERAL

A. Furnish labor, materials, and services necessary for, and incidental to, completion of Work as shown on Contract Drawings and specified herein.

B. Use equipment of sufficient size to meet requirements of Work and to produce satisfactory Work.

C. All Work is subject to inspection and approval of ENGINEER.

D. Employ, at all times, a sufficient force of workmen of such experience and ability that Work can be completed in satisfactory and workmanlike manner.

E. Provide 24 hours notice to ENGINEER prior to performing repair work to permit the ENGINEER review of surface preparation and work in progress.

### 3.2 REPAIR METHODS

A. Cracks:

1. **Floor slabs:**
   a. Treat cracks in floor slab greater than 0.010 inches in average width by direct injection with polyurethane grout.
2. Walls:
   a. Form cracks 1/2 inch and greater in average width and either pour or pump using Portland cement grout.
   b. Treat cracks greater than or equal to 0.010 inches in average width with polyurethane chemical grout.
   c. Seal the surface of cracks greater than or equal to 1/4 inch and less than 1/2 inch in average width shall in accordance with instructions for spalls below.

B. Spalls:
   1. Repair spalls greater than 1/8 inch in depth which are designated for repair using polymer-modified portland cement mortar.

3.3 POLYURETHANE CHEMICAL GROUT REPAIRS

A. Mix and apply in accordance with manufacturer’s recommendations.

B. Crack Preparation:
   1. Cracks and adjacent substrate shall be clean, sound and free of frost.
   2. Remove bond inhibiting materials from surface by mechanical means, i.e., sandblasting, high pressure water blasting, etc., as approved.
   3. Prior to application of chemical grout, moisture must be present in cracks.
   4. If concrete being injected contains insufficient moisture to activate grout, inject crack with small amount of water prior to application of chemical grout.

C. Surface Sealing:
   1. For cracks in roof and walls greater than or equal to 1/4 inch in average width, seal surface of crack prior to grouting.
   2. Sealing may be accomplished by one of three methods:
      a. Apply portland cement grout to surface of crack.
      b. Use polyurethane chemical grout with additional accelerator (Component B) to form seal on surface of crack.
      c. Install open-cell backer rod soaked with polyurethane chemical grout.
   3. Leave short segments of crack (one to two inches) open at regular intervals to facilitate venting of air and to allow visual verification of complete crack filling.
   4. Cracks in floor and walls less than 1/4 inch in average width may be injected directly with polyurethane chemical grout without surface sealing.

D. Mixing:
   1. Slowly combine accelerator Component B with 5 gallons of Component A and mix thoroughly for about 2 minutes with low-speed (400-600 rpm) drill and paddle until uniform in color.
   2. Do not allow water to enter mix.
   3. Avoid “whipping” air into mix.

E. Application:
   1. Drill 5/8-inch diameter holes along side of crack at 45 degree angles.
   2. Drill hole to intersect crack midway through substrate.
   3. Space devices to achieve travel of grout for pressure injection grouting between packers and to fill crack to maximum.
   4. Install injection packers in holes.
   5. Pumping grout:
      a. Pump at minimum of 250 psi for 45 seconds and then pause to allow material to flow into cracks.
      b. Watch for material flow and water movement to appear on surface.
c. When movement stops, begin injection into next packer.
d. When sealing vertical cracks, begin injecting at bottom of crack and work vertically.

6. If faster reaction time is needed, or if grout is being pumped at cold temperature, add additional accelerator to base resin, Component A if approved.

7. Re-inject to assure voids are properly sealed off.

F. Finished Surfaces:

1. After grout has cured, use sharp-sided tools such as putty knife or trowel to remove excess material from injected surfaces.

3.4 EPOXY GROUT REPAIRS

A. Mix and apply in accordance with manufacturer’s recommendations.

B. Surface Preparation:

1. Surfaces to be repaired or sealed shall be clean and sound.
2. Remove bond inhibiting contaminants from concrete.
3. Apply material when ambient and surface temperature is greater than or equal to 50°F and rising.
4. Use low-height sand or wood dams to confine grout, establish neat width of repair and make positive head to assist grout in penetrating crack.

C. Mixing:

1. Mix material on low speed with drill and paddle for approximately 4 minutes to ensure thorough mix.
2. Use mixed material in 60 minutes or less.

D. Placing:

1. Place material incrementally using gravity to fill crack.
2. As material penetrates crack, add additional material until “refusal”; several iterations may be required to fill crack to refusal.

3.5 PORTLAND CEMENT GROUT REPAIRS

A. Mix and apply in accordance with manufacturer’s recommendations.

B. Surface Preparation:

1. Concrete areas to be grouted shall be clean, sound and free of contaminants.
2. Remove loose and deteriorated concrete by approved mechanical means.
3. Saw cut perimeter of spalled areas 1/2 inch maximum.
4. Chip concrete substrate to obtain surface profile of plus or minus 1/8 inch in depth.
5. Remove minimum of 1/2 inch concrete behind exposed reinforcing steel without damaging steel.
6. Sandblast reinforcing steel to remove corrosion.
7. Prior to grouting, saturate concrete surface to receive grout and surface dry.

C. Forms:

1. Forms for placement of grout shall conform to SECTION 03 10 00.
2. Construct forms so that they do not deflect during pumping of grout.
3. Provide vents with caps in forms as recommended by grout manufacturer to release air during grouting.
4. Run a bead of polyurethane sealant around edge of form to prevent leakage of grout.
5. Check forms for water tightness by filling with water.

D. Mixing:
1. Either manually or mechanically mix.
2. Manually mix in wheelbarrow or mortar box.
3. Mechanically mix with low-speed (400-600 rpm) drill and jiffy paddle or in appropriate sized mortar mixer.
4. Add appropriate quantity of water to mixing container to achieve desired consistency.
5. While mixing, slowly add bag of powder to water.
6. Mix to uniform consistency for minimum of 2 minutes.
7. Mix temperature should be maintained at 70°F to 75°F using cold or warm water accordingly.

E. Application:
1. Either pour or pump grout into place.
2. Begin application within 15 minutes of mixing.
3. Vibrate form during placement of grout.
4. Pour grout from top of form.
5. Construct chip spot and pour box at top of form to direct grout behind wall.
6. Begin pumping through lowest point in form with variable pressure pump.
7. Pour or pump until there is steady flow of grout from bottom vent.
8. Cap off bottom vent and continue pouring or pumping grout until there is steady flow of grout from adjacent vent.
9. Continue capping vents as soon as steady flow of grout appears.
10. Continue pumping until there is 3 to 5 psi increase in normal line pressure.

F. Form Removal:
1. After grout has achieved final set, remove any forms.

G. Curing and Protection:
1. Curing and protection of grout shall conform to SECTION 03 39 00.

H. Finished Surfaces:
1. Finishing of formed surfaces shall conform to SECTION 03 36 00.
2. Remove defective work disclosed after forms have been removed immediately and replace at no cost to OWNER.
3. Drypack anchor holes with portland cement grout in accordance with manufacturer’s recommendations.

I. Contraction Joints:
1. Create sawed contraction joints in each area designated for portland cement grout repairs. Form joints in accordance with Forms paragraph, above.

3.6 POLYMER-MODIFIED PORTLAND CEMENT MORTAR REPAIRS

A. Mixed and apply in accordance with manufacturer's recommendations.

B. Surface Preparation:
1. Spalled concrete areas to be repaired shall be clean, sound and free of contaminants.
2. Remove loose and deteriorated concrete by approved mechanical means.
3. Saw cut perimeter of spalled areas 1/2 inch maximum.
4. Chip concrete substrate to obtain a surface profile of plus or minus 1/8 inch in depth.
5. Remove minimum of 1/2 inch concrete behind exposed reinforcing steel without damaging steel.
6. Sandblast reinforcing steel to remove corrosion.
7. Prior to repair, saturate concrete surface to receive mortar and surface dry.

C. Mixing:
1. Either manually or mechanically mix.
2. Manually mix in wheelbarrow or mortar box.
3. Mechanically mix with low-speed (400-600 rpm) drill
4. Pour approximately 4 to 5 gallons of Component A into mixing container.
5. Add Component B while continuing to mix.
6. Mix to uniform consistency for maximum of 3 minutes.
7. Add remaining Component A to mix if more loose consistency is desired.
8. If manual mixing takes more than 3 minutes, mix small quantities.
9. Should smaller quantities be needed, ensure components are dosed in correct ratio and Component B is uniformly pre-mixed before batching.

D. Application:
1. Apply scrub coat to substrate, filling all pores and voids.
2. While scrub coat is still plastic, force material against edge of repair, working toward center.
3. After filling, consolidate, then screed.
4. Allow mortar to set to desired stiffness.
5. Finish with trowel to obtain smooth surface.
6. Where depth of repair to sound concrete is greater than 1-1/2 inches:
   a. Make areas in lifts of 1-1/2 inch maximum thickness.
   b. Score top surface of each lift to produce roughened surface for next lift.
   c. Allow preceding lift to reach final set before applying fresh material.
   d. Scrub fresh mortar into preceding lift.

E. Curing and Protection: Curing and protection of portland cement grout shall conform to SECTION 03 39 00.

F. Contraction Joints:
1. Create sawed contraction joints in each areas designated for polymer-modified portland cement mortar repairs when transverse cracking of concrete is present.
2. Form joints shall be formed in accordance with portland Cement Grout Repair, Forms, paragraph, above.

3.7 CONSTRUCTION OF CONTRACTION JOINTS

A. Create contraction joint on surface of concrete in plane of crack in each area designated for portland cement grout and areas of spall repair when transverse cracking is present.

B. Form joints by sawing 1/4 inch grooves 1/2 inch deep in surface of repair with approved concrete saw.

C. Commence sawing of joint as soon as portland cement grout or polymer-modified portland cement mortar has hardened sufficiently to permit sawing without excessive raveling, usually 6 to 24 hours.

D. Saw joints to full depth before uncontrolled shrinkage cracking takes place.

E. After contraction joint is sawed, thoroughly clean joint and adjacent concrete surface.

F. Insert 1/4-inch diameter closed-cell backer rod to full depth of joint.
G. Apply polyurethane sealant:
   1. Before sealant is applied, clean joint and adjacent substrate.
   2. Install between backer rod and concrete surface in accordance with manufacturer’s recommendations.
   3. Place gun nozzle, either hand-, air-, or electric-powered, into bottom of joint and fill entire joint.
   4. Keep tip of nozzle in sealant, and continue with steady flow of sealant proceeding from nozzle to avoid air entrapment.
   5. Avoid overlapping sealant to eliminate entrapment or air.
   6. Tool as required to properly fill joint.

3.8 FIELD QUALITY CONTROL

A. General:
   1. Samples of material submitted for inspection and possible testing shall be obtained from stock on hand provided or proposed for use on this Project.

B. Sampling and Testing of Grouts:
   1. Grouts shall be sampled and tested by CONTRACTOR’s testing laboratory to assure that materials are properly mixed and proper ingredients are incorporated.
   2. Frequency of tests will be as required in ACI 301, Chapter 16, but may be increased by ENGINEER.

3.9 CLEANUP

A. Leave finished Work and Work area in neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install Concrete Unit Masonry including:

1. Concrete Block for partition walls.
2. Mortar and Grout.
3. Reinforcement and Anchorage.
4. Lintels.
5. Accessories.

B. RELATED SECTIONS:

1. SECTION 06 10 00 – ROUGH CARPENTRY
2. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 530/ASCE 5/TMS 402 - Building Code Requirements for Masonry Structures; American Concrete Institute International; 1999.
2. ACI 530.1/ASCE 6/TMS 602 - Specification For Masonry Structures; American Concrete Institute International; 1999.

B. American Society for Testing and Materials (ASTM):

1. A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
3. A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
5. C 90 - Standard Specification for Loadbearing Concrete Masonry Units.
7. C 129 - Standard Specification for Nonloadbearing Concrete Masonry Units.
8. C 140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units.

C. Underwriters Laboratory (UL):

1.3 SUBMITTALS
A. Product Data: Provide data for masonry units, fabricated wire reinforcement, and mortar.
B. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.4 QUALITY ASSURANCE
A. Comply with provisions of ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by requirements of the contract documents.
B. Fire Rated Assemblies: Conform to applicable code for indicated requirements for fire rated masonry construction.

1.5 PRE-INSTALLATION MEETING
A. Convene one week before starting work of this Section.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.7 ENVIRONMENTAL REQUIREMENTS
A. Maintain materials and surrounding air temperature to minimum 40°F prior to, during, and 48 hours after completion of masonry work.
B. Maintain materials and surrounding air temperature to maximum 90°F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS
A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 inches x 8 inches unless otherwise indicated and nominal depth of 8 inches.
   2. Special Shapes: Provide non-standard blocks configured for corners, lintels, headers, control joint edges, sill and other conditions.
   3. Load-Bearing Units: ASTM C 90, lightweight.
      a. Hollow block.
      b. Exposed faces: As selected by ENGINEER from manufacturer's standard color and texture.
      c. Bullnose exposed corners at interior face of units at following locations:
         1) Doorjams.

2.2 MORTAR AND GROUT MATERIALS
A. Masonry Cement: ASTM C 91, Type N.
B. Portland Cement: ASTM C 150, Type I.
   1. Hydrated Lime: ASTM C 207, Type S.
C. Water: Clean and potable.
2.3 REINFORCEMENT AND ANCHORAGE

A. Reinforcing Steel: In accordance with SECTION 03 21 00 and the Drawings.

B. Single Wythe Joint Reinforcement: Ladder type; ASTM A 82 steel wire, mill galvanized to ASTM A 641/A 641M, Class 3; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than one inch and not less than 1/2 inch of mortar coverage on each exposure.

1. Manufacturers:

2.4 LINTELS

A. Steel Lintels and Reinforced Masonry (CMU) Lintels as indicated on the Drawings.

2.5 MORTAR AND GROUT MIXES

A. Mortar for Unit Masonry: ASTM C 270, using the Property Specification.

1. Interior: Type N.

B. Grout: ASTM C 476. Consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

C. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.

B. Verify that related items provided under other Sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.2 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other Sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.3 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Masonry Units:

1. Bond: As indicated for different locations.
2. Coursing: One unit and one mortar joint to equal 8 inches.
3. Fill voids with concrete.
3.4 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

B. Lay hollow masonry units with face shell bedding on head and bed joints.

C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.

D. Remove excess mortar as work progresses.

E. Interlock intersections and external corners, except for units laid in stack bond.

F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

H. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.

I. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.5 REINFORCEMENT AND ANCHORAGE - SINGLE WYTHE MASONRY

A. Install horizontal joint reinforcement 16 inches on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Lap joint reinforcement ends minimum 6 inches.

E. In addition to joint reinforcement, provide reinforcement as indicated on the Drawings.

3.6 LINTELS

A. Install loose steel lintels over openings, as indicated.

B. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled or shown.

3.7 GROUTED COMPONENTS

A. Reinforce bond beams with 2, No. 5 bars, one inch from bottom web, unless otherwise indicated.

B. Lap splices minimum 30 bar diameters.

C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.

D. Place and consolidate grout fill without displacing reinforcing.

E. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.
3.8 BUILT-IN WORK

A. As work progresses, install built-in metal door frames and anchor bolts and other items to be built into the work and furnished under other Sections.

B. Install built-in items plumb, level, and true to line.

C. Bed anchors of metal door frames in adjacent mortar joints. Fill frame voids solid with grout.
   1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.

D. Do not build into masonry construction organic materials that are subject to deterioration.

3.9 TOLERANCES

A. Maximum Variation from Unit to Adjacent Unit: 1/16 inch.

B. Maximum Variation from Plane of Wall: 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.

C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

D. Maximum Variation from Level Coursing: 1/8 inch in 3 feet and 1/4 inch in 10 feet; 1/2 inch in 30 feet.

E. Maximum Variation of Joint Thickness: 1/8 inch in 3 feet.

F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.10 CUTTING AND FITTING

A. Cut and fit for pipes, conduit, and sleeves. Coordinate with other sections of work to provide correct size, shape and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.11 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in General Conditions.

B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C 140 for conformance to requirements of this Specification.

C. Mortar Tests: Test each type of mortar in accordance with ASTM C 780, testing with same frequency as masonry samples.

3.12 CLEANING

A. Remove excess mortar and mortar smears as work progresses.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

D. Use non-metallic tools in cleaning operations.
3.13 PROTECTION OF FINISHED WORK

A. Without damaging completed work, provide protective boards at exposed external corners which are subject to damage by construction activities.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY
A. Furnish and install all granite veneer masonry including but not limited to cut rock, mortar and all accessories necessary for a complete installation.
   1. Control Building exterior walls.
   2. Concrete Foundation: from brick ledge to top of foundation.
B. Related Sections:
   1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE
   2. SECTION 08 11 00 – STEEL DOORS AND FRAMES
   3. SECTION 08 51 00 – ALUMINUM WINDOWS

1.2  SUBMITTALS
A. Shop Drawings:
   1. Granite Veneer Masonry: 12-inch x 12-inch x 2-inch sample of local granite matching the Dam and Manway Entrance Building.
   2. Mix designs for mortar and grout. Color to match mortar in Manway Entrance Building.
   3. Accessories embedded in the masonry.
B. Quality Control Submittals:
   1. Installer Experience: Provide certification for installers including a minimum of 5 years experience on commercial facilities installing masonry.
   2. Manufacturer's certificate of compliance for the masonry units specified herein.
   3. Procedures for protecting finished work against freezing for the first 48 hours after installation.
   4. Method and materials for cleaning exposed surfaces.

1.3  QUALITY ASSURANCE
A. Regulatory Requirements: For masonry construction shall meet the requirements of the International Building Code, 2002 edition, and as supplemented by these Specifications.

1.4  DELIVERY, STORAGE, AND HANDLING
A. Storage and Protection:
   1. Protect veneer materials from mortar splatters and staining.

1.5  REFERENCES
A. American Society for Testing and Materials (ASTM):
   1. C 144, Standard Specification for Aggregate for Masonry Mortar
   2. C 150, Standard Specification for Portland Cement
   5. C 404, Standard Specification for Aggregates for Masonry Grout
   7. C 91, Standard Specification for Masonry Cement
8. D 994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)


1.6 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when the ambient temperature is below 32°F on a rising temperature or below 40°F on a falling temperature, or when there is a probability of such conditions occurring within 48 hours, unless approval of the ENGINEER is obtained. In such case, make special provisions for heating materials and protecting the finished Work. Protect masonry against freezing for a minimum of 48 hours after being laid. Protect the tops of walls at all times. Cover with waterproof paper when rain or snow is imminent and Work is discontinued.

B. Humidity: Protect masonry construction from direct exposure to wind and sun when erected in an ambient air temperature of 99°F (37°C) in the shade with relative humidity less than 50%.

PART 2 PRODUCTS

2.1 MASONRY UNITS

A. Color, Texture, and Pattern: Match the existing Manway Entrance Building onsite, and the submitted samples approved by the ENGINEER.

B. Granite Veneer Masonry: pink and gray granite rock with black specs matching rock quarried locally and matching the Dam and Manway Entrance Building granite color, texture and shape. Size, type, color, and random shapes shall match veneer used in the Manway Entrance Building.

2.2 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C 91, low alkali content (0.03% maximum).

B. Portland Cement: ASTM C 150, Type I, low alkali content (0.60% maximum).

C. Lime: ASTM C 207, Type S.

D. Mortar: ASTM C 270, Type S. Consisting of one part portland cement, from 1/4 to 1/2 part lime putty or hydrated lime, and clean well-graded sand in the proportion of 3 times the sum of the cementitious material; or 1/2 part portland cement, one part masonry cement, and clean well-graded sand in the proportion of 3 times the sum of the cementitious material.

1. Integral Color: Gray, matching the color of the color of the mortar used in the Manway Building veneer.
2. No antifreeze liquid, salts, or other substances are allowed to lower the freezing point. No calcium chloride is allowed in the mortar.
3. Tuck-Pointing Mortar: Prehydrated Type N, one part portland cement, one part Type S hydrated lime, and 6 parts sand, by volume.
4. Grout: Conform to ASTM C 476 and the following:
5. Proportions:
   a. Grout for pouring of fluid consistency conforming to the requirements of ASTM C 476. Coarse grout may be used in grout spaces measuring 4 inches or more in both horizontal dimensions.
   b. Grout for pumping of fluid consistency and having not less than 7 sacks of cement in each cubic yard of grout. The mix design will be reviewed by the ENGINEER.
6. Grout Admixture:
   a. Manufacturers and Products:
      1) Sika Chemical Corp; Sika Grout Aid, Type II.
      2) Concrete Emulsions; Grout Aid GA-II.
      3) Master Builders Co; Grout Fluidifier MB-612
   b. Amount of admixture and method of introducing admixture in accordance with manufacturer's recommendations.
   c. Fluid consistency means a fluid suitable for pouring without segregation.
7. Compressive Strength:
   a. The average 28-day compressive strength of the grout samples for each grout pour tested shall not be less than 2,000 psi.
   b. Aggregate for grout shall conform to ASTM C 404.

E. Sand: ASTM C 144, in addition not less than 5% passes the No. 100 sieve.
F. Water: Fresh, clean, and free of deleterious acids, alkalies, chlorides, and organic materials.

2.3 MASONRY ACCESSORIES AND ANCILLARY MATERIALS
A. Manufacturers, unless noted otherwise:
   1. Hohmann and Barnard, Inc.
   2. Heckmann Building Products.
B. Dovetail Slots and Anchor Ties: 20-gauge galvanized steel anchor slots and mating anchors. Minimum 16-gauge, corrugated type of suitable length for proper embedment in the masonry joints.
   1. Manufacturers:
      a. Gateway Building Products, Los Angeles, CA.
      b. Burke Concrete Accessories, Inc., San Mateo, CA.
C. Corrugated Wall Ties: Form of 20-gauge minimum galvanized sheet steel. Length as required by 7/8-inch wide.
E. Flashing: DCF 1500S by Dur-O-Wal.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine conditions, with installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of veneer.
B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.
C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Provide or cut special shapes for corners, jambs, lintels, and other areas as shown or as required. Match color and texture of standard units.
B. Matching Existing Masonry: Match coursing, bonding, tooling, color, sizes, and texture of existing Manway Entrance Building.
3.3 MORTAR PREPARATION

A. Place 1/2 the water and aggregate in the operating mixer; add cement; add the remaining aggregate and water and mix for at least 2 minutes. Add lime and continue mixing as long as needed to secure a uniform mass, but no less than 3 minutes after the addition of lime. Time the addition of admixture in strict accordance with the manufacturer's instructions and the procedure used for adding it to the mix shall provide good dispersion.

B. Mix mortar in machine with mixing drums clean and free of debris and dried mortar. Use mortar before the initial setting of the cement has taken place. Do not retemper mortar in which the cement has started to set.

C. Retemper mortarboards by adding water within a basin formed with the mortar and the mortar reworked into the water. Dashing or pouring water over mortar and retempering of harsh, nonplastic mortar is not permitted.

3.4 GROUT PREPARATION

A. Mix grout as specified for mortar preparation if onsite mixing is performed or use transit-mixed grout, meeting the requirements of ASTM C 476.

B. Add grout admixtures at the Site, following manufacturer's recommendation. Premix the admixture with water and add resulting solution to the grout and thoroughly mix. Do not exceed quantity of admixture recommended by the manufacturer.

3.5 GRANITE VENEER INSTALLATION

A. General: Do not install cracked, broken, or chipped granite veneer masonry units exceeding ASTM C 216 allowances.

1. Thoroughly wet all masonry just before laying except in freezing weather where masonry is laid dry.

2. Prewetting may also be omitted if the masonry at the time of laying has a rate of absorption not exceeding 0.025 ounce of water per square inch of surface after being placed in 1/8-inch of water for one minute.

3. Coordinate installation with walls and other construction. Use masonry saws to cut and fit exposed units. Lay masonry plumb, true to line, with level courses accurately spaced, and do not furrow bed joints.

4. Finish horizontal run by racking back in each course; toothing not permitted. Adjust all units to final position while mortar is soft and plastic. If units are displaced after mortar has stiffened, remove, clean joints and units of mortar, and relay with fresh mortar.

5. Bond unexposed units in a wythe by lapping a minimum of 2 inches. Adjust shelf angles to keep Work level at proper elevation. Provide pressure relieving joints by placing a continuous 1/8-inch foam neoprene pad under the shelf angle.

6. When joining fresh masonry to set or partially set masonry:
   a. Remove loose masonry and mortar.
   b. Clean and lightly wet exposed surface of set masonry prior to laying fresh masonry.

B. Mortar Beds: Lay masonry with full mortar coverage on horizontal and vertical joints. Rock closures into place with head joints thrown against 2 adjacent masonry in-place. Do not pound corners or jambs to fit stretcher units after setting in-place. Where adjustment to corners or jambs must be made after mortar has started to set, remove mortar and replace with fresh mortar.

C. Horizontal and Vertical Face Joints:

1. Nominal Thickness: 3/8-inch.
2. Construct uniform joints.
3. Convex tool all exterior joints.

D. Tooled Joints:
1. Saturate exposed joints with clean water.
2. Fill joints solidly with mortar.
3. Tool joints concave to match existing Manway Entrance Building.

E. Movement Joints: Keep clean of all mortar and debris.

F. Masonry Control Joints:
1. Omit mortar from the vertical joints. Place the control joint material as the wall is built.

G. Sealant Joints: Retain sealant joints around outside perimeters of exterior doors, and other wall openings.
1. Uniform Depth: 3/4-inch.
2. Uniform Width: 1/4-inch.

H. Anchoring: Anchor masonry to concrete backing with dovetail anchor ties.
1. Maintain a space not less than one inch wide between masonry wall and concrete members.
2. Keep space free of mortar or other rigid material to permit differential movement between concrete and masonry.
3. Attach masonry to backing with anchor ties.
   a. Use one dovetail anchor tie for each 2 square feet of wall area and one corrugated or adjustable anchor tie for each 1.77 square feet of wall area.
   b. Maximum Space Between Adjacent Ties:
      1) Vertically: 24 inches.
      2) Horizontally: 24 inches.
   c. Embed ties at least 2 inches in horizontal joint of masonry.
   d. Provide additional ties at openings:
      1) Maximum Spacing Around Perimeter: 24 inches.
      2) Install within 12 inches of opening.
      3) Pointing: Cut out defective joints and holes in exposed masonry and repoint with mortar. Dry brush masonry surface after mortar has set at end of each day's Work and after final pointing.

3.6 CLEANING

A. Remove mortar stains with clear water as Work progresses. Upon completion, clean all exposed surfaces with an approved method, removing all stains.

B. Cleaning Agents:
1. Proprietary Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

C. Clean exposed masonry with stiff brush and clear water. If cleaning by water does not produce satisfactory results, apply cleaning agent to sample wall area of 20 square feet in location acceptable to the ENGINEER. Do not proceed with cleaning until sample area is acceptable to the ENGINEER.
D. Follow manufacturer's recommendations for use of cleaning agents.

E. Application:
   1. Thoroughly wet surface of masonry on which no efflorescence appears before using cleaning agent.
   2. Scrub with acceptable cleaning agent.
   3. Immediately rinse with clear water.
   4. Work small sections at a time.
   5. Work from top to bottom.
   6. Protect sash, metal lintels, and other materials which may corrode when masonry is cleaned with acid solution.
   7. Remove efflorescence in ENGINEER approved method.

F. Leave Work area and surrounding surfaces clean and free of mortar spots, droppings, and broken masonry.

3.7 FIELD QUALITY CONTROL

A. At least once a week while installation of masonry is in progress, provide mortar samples for testing. Continue on that basis for duration of installation of masonry at the discretion of the ENGINEER.

B. Take samples in accordance with ASTM C 270.

3.8 PROTECTION

A. Wall Covering: During erection, cover top of wall with strong waterproof membrane at end of each day or shutdown and as follows:
   1. Cover partially completed walls when Work is not in progress. Extend cover minimum of 24 inches down both sides. Hold cover securely in place.
   2. Protect sills, ledges, and offsets from mortar drippings or other damage during construction. Remove misplaced mortar or grout immediately. Protect face materials against staining. Protect the doorjambs and corners from damage during construction.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. The Section includes field welding of trashrack components.
B. Reference SECTION 33 11 00 for pipe requirements.

1.2 REFERENCES
A. The following is a list of standards which may be referenced in this Section:
   2. American Welding Society (AWS):
      b. D1.1, Structural Welding Code–Steel.
      c. QC-1, Standard for AWS Certification of Welding Construction Project Inspectors.
      d. D3.6, Specification for Underwater Welding.
   3. American Society of Mechanical Engineers (ASME):
      a. Boiler and pressure vessel core SEC V, Nondestructive Examination.
      b. Boiler and pressure vessel core SEC IX.

1.3 SUBMITTALS
A. Submit in accordance with SECTION 01 33 00.
B. Shop Drawings:
   1. Field welding procedures.
   2. Nondestructive testing procedure Specifications prepared in accordance with ASME boiler and pressure vessel core SEC V.
C. Quality Control Submittals:
   1. Qualifications:
      a. Welders:
         1) List of qualified welders and welding operators.
         2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
   2. Weld Procedures: All welding procedures used shall be prequalified under provisions of AWS D1.1 and D3.6 and as required by individual Specification Section. Welding procedures shall be required for, but not necessarily limited to, fillet and groove welds.
   3. Nondestructive inspection and testing procedures.
   4. Manufacturer’s Certification of Compliance:
      a. Welding electrodes and filler materials.
      b. Factory applied linings and coatings.
1.4 QUALIFICATIONS

A. Qualifications of Procedures and Welders:

1. All welding shall be performed by skilled welders, welding operators and tackers who have had adequate experience in the methods and materials to be used. All welders, welding operators and tackers shall be qualified under the provisions of AWS D1.1. Welders performing field welds for welded joints shall be prequalified using test position 6G. All welding completed by welders not qualified shall be rejected.

2. Welders, welding operators and tackers shall be qualified by an independent, testing agency. Submit evidence of qualification, including proof that each welder, welding operator and tacker has been continuously engaged in the given process of welding for which the welder, welding operator or tacker is qualified with no gaps in experience of more than six months, and those whose ability is questioned by ENGINEER for a specific reason, shall be requalified under the provisions of AWS D1.1 as specified above.

3. Machines and electrodes similar to those used in the work shall be used in qualification tests. All tests for qualification shall be done in the presence of the testing agency or in the presence of a certified welding inspector appointed by the testing agency. Furnish all material and bear the expense of qualifying welders.

1.5 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, all Submittals required in this Section shall be submitted and approved prior to commencement of welding operations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 WELDED CONNECTIONS

A. General

1. Prior to the beginning of the welding procedure, any tack welds shall be removed. Any annular space shall be evenly distributed around the circumference of the joint by shimming, jacking, or other suitable means.

2. Shop-applied coatings shall be removed locally to permit field-welding.

3.2 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. All Welds:

1. Selection of Welds to be Tested: As agreed upon between ENGINEER and CONTRACTOR.

2. Unless otherwise specified, perform nondestructive testing (NDT) of welds at a spot testing frequency as shown below in accordance with the AWS Level II inspection. In case there is a conflict the higher frequency level of NDT shall apply:
   a. All Welds: 100% visually inspected, and ultrasonically inspected where requested by the ENGINEER.

3. Unless otherwise specified, perform all nondestructive testing in accordance with Chapter 6 of AWS D1.1 for statically loaded nontubular connections.

4. Provide testing by an independent weld inspection testing company.
3.3 WELD DEFECTS REPAIR
A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

3.4 REPAIR OF SHOP-APPLIED COATINGS
A. Where field-welds result in damage to the existing shop-applied coatings, the affected area(s) shall receive touch-up painting similar to that specified for shop application. All surfaces shall be cleaned and prepared as directed by the ENGINEER.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Provide all labor, material and equipment required to complete all items of carpentry work shown on Drawings and as specified herein.
B. Perform carpentry work in cooperation with the work of all other trades and subsystems to produce well staged and scheduled building construction.

1.2 MISCELLANEOUS CARPENTRY WORK
A. Work includes construction of all concrete forms, wood framing, roof decking, sheathing behind hardboard paneling, miscellaneous backing and temporary construction involving wood.
B. Work necessary to expedite and protect the Work. Brace metal door frames and bucks, metal sash frames, etc., to hold them securely in place until permanently built into adjacent construction.
C. Blocking for support of casework and wall cabinets, wall mounted hardware, wall mounted fire extinguishers, signs with greater than normal weight, visual display boards, and similar items that are wall mounted and require bolt, screw or nail fastening to the wall.
D. Blocking to prepare substrates at perimeters of openings; doors, louvers, to provide adequate substrate condition and nailer for fastening items that require bolt, screw or nail fastening.

1.3 REFERENCES
A. American Institute of Timber Construction (AITC).
B. American Lumber Standards Committee (ALSC): Softwood Lumber Standards.
D. American Plywood Association (APA).
E. American Wood Preservers' Association (AWPA).
F. National Forest Products Association (NFPA).
G. Underwriters' Laboratories, Inc (UL).
H. West Coast Lumber Inspection Bureau (WCLIB): Standard Grading Rules for West Coast Lumber.
I. Western Wood Products Association (WWPA).
J. Forest Stewardship Council (FSC).
K. Structural Board Association (SBA).
1.4 SUBMITTALS
A. Submit product data for all manufactured products including but not limited to fasteners, adhesives, anchors, underlayment, engineered wood products, sheathing, siding, wood treatment.

B. Submit material certificates for dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee's (ALSC) Board of Review. Submit FSC certification.

1.5 STORAGE
A. Stack lumber and plywood in a manner to insure ventilation, and in a place to insure protection from weather damage. Cover with water proof covering.

1.6 QUALITY ASSURANCE
A. Lumber Grading Agency: Certified by ALSC.
B. Plywood Grading Agency: Certified by APA.
C. Oriented Strand Board: Certified by APA.
D. Single source responsibility for Engineered Wood Products: Obtain each type of engineered wood product from one source and by a single manufacturer.
E. Lumber certification: FSC certified.

PART 2 PRODUCTS

2.1 MATERIALS
A. Lumber: Grade stamp containing symbol of grading agency, rules under which graded, mill number or name, grade of lumber, species or species grouping and condition of seasoning. FSC certified.

B. Framing materials: Hem-Fir-larch, No. 2 or better grade, 19% maximum, moisture content. Kiln dried to 15% average. FSC certified.

C. Non-structural light framing and blocking: Douglas Fir-larch, 19% maximum moisture content. Construction grade, kiln dried to 15% average. FSC certified.

D. Plywood: Provide as required to perform the Work.

E. Oriented Strand Board (OSB): Provide thicknesses shown on the Drawings of structural grade PS 2, exposure 1 and 4 foot x 8 foot minimum board sizes.

2.2 ACCESSORIES
A. General anchors and fasteners: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. Fasteners (nails, screws, bolts): Hot dipped galvanized steel for exterior and treated wood locations, plain finish elsewhere. Select size and type of fastener as required for proper installation and to rigidly secure members in place.
C. Structural adhesive appropriate for condition to fasten carpentry to support or to fasten items to carpentry when mechanical fastening cannot be accomplished.

2.3 WOOD TREATMENT

A. Wood Preservative Treatment: Pressure impregnate with a waterborne preservative in accordance with the American Wood Preservative Association (AWPA) Standard C22-92 for wood in contact with ground, 0.40 pound per cubic foot retention, or C2-92 for wood in exterior assemblies and not in contact with ground, 0.25 pound per cubic foot retention. Fabricate lumber insofar as possible before treatment. Dry lumber to 19% after treatment. Field treat all cut ends per execution requirements of this Specification. Treat the following:

1. Framing, blocking, furring, nailing strips built into exterior masonry walls, wood in contact with masonry walls, wood in contact with concrete and foundations, and wood in contact with earth, wood board siding and trim, and wood exposed to the exterior.
2. Wood cants, nailers, curbs, equipment support bases, blocking, stripping and similar members in connection with roofing, flashing, vapor barriers and waterproofing.

B. Wood Fire-Retardant Treatment: Pressure impregnate with fire-retardant chemical to comply with AWPA C20 for lumber and C27 for plywood. Provide UL label on each piece of fire-retardant lumber or plywood. Treat the following:

1. All interior lumber or plywood used for blocking behind finish wall construction used for support of casework and specialty equipment and furnishings requiring blocking or as shown on the Drawings.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine substrates to which construction attaches or abuts, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of construction of the Work of this Section.

B. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.

C. Failure to call attention to defects or imperfections will be construed as acceptance and approval of substrate conditions. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation and full responsibility for completed Work.

3.2 GENERAL

A. Use only sound, thoroughly seasoned, well-manufactured materials of the longest practical lengths and sizes to minimize jointing. Use materials free from warp which cannot be easily corrected by anchoring and attachment. Sort out and discard warped material and material with other defects which would impair the quality of the Work.

B. Securely attach carpentry work to substrates by anchoring and fastening as required by recognized standards. Provide washers under bolt heads and nuts in contact with wood. Nail plywood to comply with the recommendations of the American Plywood Association. Countersink nail heads on exposed carpentry work and fill holes.
C. When using structural adhesive, follow installation instructions, using product within working time and allowing for setup time.

D. Set carpentry work accurately to required levels and lines with members plumb and true and accurately cut and fitted. Shim with metal or slate for full-bearing on concrete substances.

E. Install rough carpentry in accordance with governing building codes with local amendments, unless otherwise shown or specified.

3.3 COORDINATION

A. Obtain measurements and verify dimensions shown and shop drawing details before proceeding with carpentry work, wherever possible. Correlate location of furring, nailers, blocking and similar supports so that attached work will comply with design requirements. Fit carpentry work to other Work. Scribe and cope as required for accurate fit. Coordinate installation of all wood members and wood materials.

B. Wall sheathing: Coordinate installation of OSB sheathing with hardboard paneling so joints are offset and do not occur in same place.

3.4 ATTACHMENT AND ANCHORAGE

A. Use common wire nails for wood to wood connections, except as otherwise shown or specified herein. Use finishing nails for finish work. Do not wax or lubricate fasteners that depend on friction for holding power.

B. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; pre-drill as required. Do not drive threaded friction type fasteners; turn into place. Tighten bolts and lag screws at installation and retighten as required for tight connections prior to closing in or at completion of Work.

3.5 WOOD NAILERS, BLOCKING AND SLEEPERS

A. Provide wherever shown and where required for attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached.

B. Coordinate location with other work involved; refer to Shop Drawings of such work.

C. Attach to substrate securely with anchor bolts and other attachments devices and materials indicated in Part 2 as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown.

D. Provide 2-inch x 6-inch nominal wood blocking in stud framing. Provide adequate support for mounting load carrying elements including railings, grab bars, and to support weight of all items requiring support.

3.6 SITE APPLIED WOOD TREATMENT

A. Site apply preservative treatment in accordance with manufacturer's instructions.

B. Treat site-sawn ends. Brush apply 2 coats of preservative treatment on untreated wood.

C. Allow preservative to cure prior to erecting members.
3.7 WORKMANSHIP AND INSTALLATION

A. Protect all carpentry, woodwork, metal work, hardware, and other materials from damage of any character during the progress of the Work. Store materials in accordance with manufacturer’s recommendations.

B. Furnish and install all rough hardware required, such as nails, screws, anchor bolts and devices (except those occurring in structural steel), shot anchors, similar devices. All rough hardware shall be of the proper type and size for the use intended. Provide adequate hardware to achieve substantial and positive anchorage. Nailing into wood plugs is not acceptable for any work.

C. Where mechanical attachment cannot be achieved using fasteners, use construction adhesive over entire area of items to be secured to achieve substantial and positive connection to substrate.

D. Fit and place all finish accurately and in a workmanlike manner. Gouges, dents, hammer marks, splits or other defects will not be permitted in the finished Work.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install Plate Connected Wood Trusses as specified and as shown on the Drawings including:
   1. Shop fabricated wood trusses for roof framing.
   2. Bridging, bracing, and anchorage.

1.2 RELATED SECTIONS

A. SECTION 06 10 00 – ROUGH CARPENTRY

1.3 REFERENCES


B. Truss Plate Institute (TPI):

C. Western Wood Products (WWPA): WWPA G-5 - Western Lumber Grading Rules; 1998.

1.4 SYSTEM DESCRIPTION

A. Design roof loads: Refer to Drawings.

1.5 SUBMITTALS

A. Shop Drawings: Indicate sizes and spacing of trusses, loads and truss cambers, framed openings. Submit design calculations and Drawings wet stamped by a Professional Engineer licensed in the State of Colorado.

B. Product Data: Provide truss configurations, connections, bearing and anchor details, bridging and bracing.

1.6 QUALITY ASSURANCE

A. Truss Design, Fabrication, and Installation: In accordance with TPI 1, TPI DSB-89, and HIB-91.

B. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 5 years of documented experience.

C. Design trusses under direct supervision of a Professional Engineer experienced in design of this Work and licensed in Colorado.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for loads, seismic zoning, other governing load criteria and fire retardant requirements.
1.8 DELIVERY, STORAGE, AND HANDLING
   A. Handle and erect trusses in accordance with TPI HIB-91.
   B. Store trusses in vertical position resting on bearing ends.

1.9 FIELD MEASUREMENTS
   A. Verify that field measurements are as indicated on Shop Drawings.

PART 2 PRODUCTS

2.1 MATERIALS
   A. Lumber Grading Rules: WWPA G-5.
   B. Steel Connectors: Hot-dipped galvanized steel sheet, ASTM A 653/A 653 M Structural Steel (SS) Grade 33/230, with G90/Z275 coating; die stamped with integral teeth; thickness as required.
   C. Truss Bridging: Type, size and spacing recommended by truss manufacturer.

2.2 ACCESSORIES
   A. Wood Blocking and Framing for Openings: In accordance with SECTION 06 10 00 softwood lumber, S/P/F species, construction grade, 19% maximum and 7% minimum moisture content.
   B. Fasteners: Hot dip galvanized steel, type to suit application.
   C. Bearing Plates: Hot dip galvanized, plain steel.
   D. Dimensions: To meet the geometry shown on the Drawings.

2.3 FABRICATION
   A. Fabricate trusses to achieve structural requirements specified or shown.
   B. Brace wood trusses in accordance with TPI DSB-89 and TPI HIB-91.

2.4 MANUFACTURERS
   A. ENGINEER approved.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Verify that supports and openings are ready to receive trusses.

3.2 PREPARATION
   A. Coordinate placement of bearing items.

3.3 ERECTION
   A. Install trusses in accordance with manufacturer's instructions.
   B. Set members level and plumb, in correct position.
C. Make provisions for erection loads, and for sufficient temporary bracing to maintain structure plumb, and in true alignment until completion of erection and installation of permanent bracing.

D. Do not field cut or alter structural members without approval of ENGINEER.

E. Place permanent bridging and bracing.

F. Place headers and supports to frame openings required.

G. Frame openings between trusses with lumber in accordance with SECTION 06 10 00.

H. Coordinate placement of decking with work of this Section.

3.4 TOLERANCES

A. Framing Members: 1/2 inch maximum, from true position.

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY:
A. Furnish and install Finish Carpentry including:
   1. Interior finish carpentry items.
   2. Wood casings, moldings and sills.
   3. Hardware and attachment accessories.

B. RELATED SECTIONS
   1. SECTION 06 10 00 – ROUGH CARPENTRY
   2. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES

1.3 SUBMITTALS
A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, accessories, to a minimum scale of 1-1/2 inch to one foot.

1.4 QUALITY ASSURANCE
A. Perform Work in accordance with AWI Architectural Woodwork Quality Standards Illustrated, Custom grade.

B. Fabricator Qualifications: Company specializing in fabricating the products specified in this Section with minimum 3 years of documented experience.

1.5 DELIVERY, STORAGE, AND PROTECTION
A. Protect Work from moisture damage.

1.6 PROJECT CONDITIONS
A. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

B. Coordinate the Work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.

PART 2  PRODUCTS

2.1 LUMBER MATERIALS
A. Hardwood Lumber: Hem-Fir species, No. 1 grade, plainsawn, maximum moisture content of 8%; with vertical grain.

2.2 FASTENERS
A. Fasteners: Of size and type to suit application; galvanized or plated finish in concealed locations and stainless steel finish in exposed locations.

B. Concealed Joint Fasteners: Threaded steel.
2.3 ACCESSORIES
A. Lumber for Shimming and Blocking: Softwood lumber of pine or cedar species.
B. Primer: Alkyd primer sealer type.
C. Wood Filler: Solvent base, tinted to match surface finish color.

2.4 FABRICATION
A. Shop assemble Work for delivery to Site, permitting passage through building openings.
B. When necessary to cut and fit on Site, provide materials with ample allowance for cutting. Provide trim for scribing and Site cutting.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify adequacy of backing and support framing.
B. Verify mechanical, electrical, and building items affecting Work of this Section are placed and ready to receive this Work.
C. See SECTION 06 10 00 for installation of recessed wood blocking.

3.2 INSTALLATION
A. Set and secure materials and components in place, plumb and level.
B. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.
C. Install trim with nails at 16 inch on center.

3.3 PREPARATION FOR SITE FINISHING
A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
B. Site Finishing: Refer to SECTION 09 90 00.
C. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.4 ERECTION TOLERANCES
A. Maximum Variation from True Position: 1/16 inch.
B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

3.5 SCHEDULE
A. Interior:
   1. Window Sills and Aprons: Clear Hem-Fir; prepare for painted finish.
SECTION 06 25 14
HARDBOARD PANELING

PART 1  GENERAL

1.1  SECTION INCLUDES

A. Furnish and install Hardboard paneling and trim boards including:
   1. Exterior fascia trim boards.
   2. Exterior soffit panels.
   3. Interior ceiling and wall panels.

B. RELATED SECTIONS
   1. SECTION 04 40 00 – GRANITE VENEER MASONRY
   2. SECTION 06 10 00 – ROUGH CARPENTRY
   3. SECTION 06 17 53 – PLATE CONNECTED WOOD TRUSSES
   4. SECTION 06 20 00 – FINISH CARPENTRY

1.2  REFERENCES

A. American Society for Testing and Materials (ASTM):

1.3  SUBMITTALS

A. Shop Drawings for fascia, soffit, ceiling and wall panels:
   1. Manufacturers product and installation data sheets.
   2. Manufacturers standard color chart.
   3. Manufacturers standard accessories including joint strips, fasteners and miscellaneous components.

1.4  DELIVERY, STORAGE, AND HANDLING

A. Inspect the materials upon delivery to assure that specified products have been received.
B. Store materials in safe area, away from construction traffic; store under cover and off ground, protected from moisture.
C. Keep materials clearly separated and identified. Keep damaged material identified as damaged and stored separately.

1.5  WARRANTIES:

A. Provide 30 year limited product warranty from the manufacturer against manufacturing defects.
B. Provide a 2 year workmanship warranty for repair or replacement of defective work.

PART 2  PRODUCTS

2.1  MANUFACTURERS

A. Fascia, Soffit, Ceiling and Wall Panels:
2.2 MATERIALS

A. Fascia: One-inch x 6-inches x 10-feet Harditrim Cedarmill siding trim boards in ENGINEER approved color.

B. Soffit: 16-inches x 12-feet x 1/4-inches venting Hardisoffit Cedarmill soffit panels in ENGINEER approved color.

C. Ceiling and Wall Panels: 4-feet x 10-inches x 5/16-inches Hardipanel Sierra 8 vertical siding panel in ENGINEER approved color.

D. Fasteners, joint strips and miscellaneous accessories:
   1. As recommended by fascia, soffit and wall panel manufacturer.
   2. Joints:
      a. Fascia and soffit joints shall be caulked joints.
      b. Wall panels shall have 1/4 inch x 3 inch wood batten strips installed over each joint. Ceiling panel joints shall be caulked.

E. Provide trim and panel materials that comply with the provisions of ASTM C 1186.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate Work with related trades; scribe and cope trim and panels for accurate fit. Allow installation of related work to avoid cutting and patching.

B. Select trim and panel pieces of longest possible lengths. Cut out and discard defects that render a piece unfit to serve its intended function.

3.2 INSTALLATION

A. Install trim and panel pieces square, plumb, and level, closely fitted and securely fastened.

B. Install fasteners and accessories as recommended by the manufacturer.

C. Coordinate exterior trim and panel work and interior panel work with Work of related Sections. Offset joints of wall panels and oriented strand board sheathing.

D. Install per manufacturer’s recommendations.

E. Prepare surfaces for painting.

3.3 FIELD QUALITY CONTROL

A. Verify and repair defects as required and as directed by the ENGINEER.

3.4 ADJUSTING AND CLEANING

A. As Work proceeds, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris related to this Work.

B. Clean trim and panels of any markings and prepare for touch-up painting.

END OF SECTION
SECTION 06 51 00
FIBERGLASS REINFORCED PLASTICS

PART 1  GENERAL

1.1  SUMMARY
A. Furnish and install fiberglass reinforced plastic grating as required, as shown on the Drawings and as specified herein.

1.2  REFERENCES
A. American Society for Testing and Materials (ASTM):
   1. D 635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

1.3  SUBMITTALS
A. Shop Drawings:
   1. Product Data: Catalog information and catalog cuts showing materials, design, load, span, and deflection; include manufacturer's Specifications.
   2. Submit calculations for fabricated items showing dimensions, materials of construction, weight, size, location, and verifying compliance with the specified design criteria. Calculations shall also include the following data on the structural elements:
      a. Section properties.
      b. Flexural, tensile, compressive and shear strengths.
      c. Weight per foot.
      d. Modulus of elasticity.

B. Quality Control Submittals:
   1. Handling and storage requirements.
   2. Manufacturer's installation instructions.
   3. Manufacturer's Certification of Compliance for specified products.
   4. Fabricator’s qualification experience.
   5. Manufacturer’s qualification experience.

1.4  QUALIFICATIONS
A. Fabricator: Minimum of 5 years experience.
B. Manufacturer: Minimum of 5 years experience in the manufacturing of products meeting these Specifications.

1.5  DELIVERY, STORAGE, AND HANDLING
A. Preparation for Shipment:
   1. Ladders shall be shipped fully shop-fabricated and assembled.
2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect the materials from damage, and facilitate identification and final assembly in the field.

B. Storage and Handling: In accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 PRODUCTS

2.1 HIGH STRENGTH FIBERGLASS GRATING

A. Duradek Series I-6000, 1-1/2 inch:

1. Manufactured from fire retardant vinyl ester resin meeting the requirements of a Class 1 rating or less per ASTM E 84 and meets the self extinguishing requirements of ASTM D 635, and produced by the pultrusion process.
2. Color: gray.
3. Resin: UV inhibited and the composite shall include a veil on all exposed surfaces.
4. Panels: 3 piece cross rod system
5. Cross Rods: consist of center core wedge and 2 spacer bars that are notched at each bearing bar so that each bearing bar is both mechanically locked and chemically bonded to the web of each bearing bar. Cross rods shall be spaced no greater than 6-inches apart.

2.2 FIBERGLASS GRITTED PLATE

A. SafPlate, Series 525, 1/8-inch:

1. Manufactured from fire retardant vinyl ester resin meeting the requirements of a Class 1 rating or less per ASTM E 84 and meets the self extinguishing requirements of ASTM D 635, and produced by the pultrusion process.
2. Surface: anti-skid, medium grit.
3. Color: gray
4. Bonded to Duradek Series I-6000 to make an integrated trench cover grating system.
5. Meeting the minimum mechanical property requirements of ASTM D 638, D 695, D 790 and D 953 as documented by the manufacturer.

2.3 MANUFACTURER

A. Strongwell, Chatfield Division: www.strongwell.com.

PART 3 EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's written instructions.

1. Install with bearing bars perpendicular to centerline of trenches.

B. Install plumb or level with adjacent surfaces, rigid and neat, as applicable.

1. Accurately cut all miters so there are no gaps greater than 1/32-inch between trench cover pieces when fully installed.
2. Accurately cut grating to fit into the formed concrete trenches, allowing no more than 1/8-inch total gap between grating and concrete edges.

C. Furnish all fasteners and anchorages for complete installation.
D. Seal all field cut holes, edges, and abrasions with a catalyzed resin compatible with original resin.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install Elastomeric underlayment for roofing.

B. Related Sections

1. SECTION 06 10 00 – ROUGH CARPENTRY
2. SECTION 07 31 00 – ASPHALT SHINGLES

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):


1.3 SUBMITTALS

A. Product Data: Provide data for membrane.

B. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

C. Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer's Installation Instructions: Indicate special procedures.

E. Warranty: Submit manufacturer warranty and ensure forms have been completed in OWNER's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

A. Membrane Manufacturer Qualifications: Company specializing in waterproofing sheet membranes with 5 years experience.

B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 3 years documented experience.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures above 40°F for 24 hours before and during application and until liquid or mastic accessories have cured.

1.6 WARRANTY

A. Correct defective Work within a 5 year period after Date of Substantial Completion.

B. Provide 5 year manufacturer warranty for waterproofing failing to resist penetration of water.

C. For warranty repair work, remove and replace materials concealing waterproofing.
PART 2 PRODUCTS

2.1 MANUFACTURERS
B. Other Acceptable Manufacturers:

2.2 MEMBRANE MATERIALS
A. Elastomeric Underlayment: Composite laminate membrane comprised of rubberized asphalt membrane and cross-laminated, high density polyethylene film; 0.040 inch total thickness.
   1. Manufacturers:
   2. Tensile Strength, Membrane: 250 psi, measured in accordance with ASTM D 412 Die C Modified.
   3. Elongation, Membrane: 250% tested per ASTM D 412 (Die C Modified.)
   5. Adhesion to Plywood: 3.0 lb/in. width per ASTM D903.
   6. Permanence (maximum): 0.05 perms per ASTM E 96.
B. Seaming Materials: As recommended by membrane manufacturer.
C. Membrane Sealant: As recommended by membrane manufacturer.
D. Flexible Flashings: Small sections of the membrane material or other compatible materials approved by manufacturer.
E. Liquid Conditioner/Primer: Provided by manufacturer, compatible with membrane.
F. Adhesives: As recommended by membrane manufacturer.
G. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.
H. Fasteners: As recommended by the membrane manufacturer, compatible with sheet membrane.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing membrane.
C. Verify items which penetrate surfaces to receive waterproofing are securely installed.

3.2 PREPARATION
A. Protect adjacent surfaces not designated to receive waterproofing.
B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions. Vacuum or broom substrate clean.
C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.
D. Seal cracks and joints with sealant using depth to width ratio as recommended by sealant manufacturer.

3.3 INSTALLATION - MEMBRANE

A. Install membrane waterproofing in accordance with manufacturer's instructions.
B. Roll out membrane. Minimize wrinkles and bubbles.
C. Self-Adhering Membrane: Remove release paper layer. Roll out on substrate with a mechanical roller to encourage full contact bond.
D. Overlap edges and ends and seal by method recommended by manufacturer, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
E. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.
F. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.
G. Install flexible flashings. Seal items penetrating through membrane with flexible flashings. Seal watertight to membrane.
H. Install one layer of elastomeric underlayment over eave or rake egde down face of fascia to extent that can still be covered by the edge or eave flashing. Extend up or over to point on roof at least 24 inches beyond interior face of wall below roof. Install prefinished roof flashing for shingle or metal panel roofing. Over drip edge, begin at roof edge and begin full coverage of roof surface, providing 2 full layers of underlayment at the roof eave or rake edges.
I. Seal membrane and flashings to adjoining surfaces.

3.4 PROTECTION

A. Do not permit traffic over unprotected or uncovered membrane.
B. Cover and protect membrane from ultraviolet exposure as recommended by the membrane manufacturer. Do not allow ultraviolet exposure beyond manufacturers recommended timeframe.

3.5 SCHEDULE

A. Roofs: One ply of elastomeric underlayment; 2 plies at roof edges extending a minimum of 3 feet up slope from building perimeter, self-adhered.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A. Furnish and install thermal insulation as specified and as shown on the Drawings.

B. Related Sections:
   1. SECTION 06 10 00 – ROUGH CARPENTRY
   2. SECTION 06 20 00 – FINISH CARPENTRY
   3. SECTION 06 25 14 – HARDBOARD PANELING

1.2  QUALITY ASSURANCE

A. Certify that thermal batt insulation is bonded with formaldehyde-free thermosetting resin.

B. Certify by Scientific Certification Systems (CSC) that thermal batt insulation glass fibers contain a minimum of 18% post-consumer and 7% pre-consumer recycled glass product.

1.3  SUBMITTALS

A. Submit Product Data with manufacturer's certification that insulation products comply with specified requirements.

B. Submit certification indicating compliance with the Quality Assurance requirements.

1.4  DELIVERY, STORAGE AND HANDLING

A. Do not deliver plastic insulation materials to the project site prior to time of installation. Protect the materials of this Section before, during and after installation. Protect at all times against ignition. Complete the installation and concealment of plastic materials as rapidly as possible.

B. Store materials in a safe, dry place with all labels intact and legible at time of installation. In the event of damage, repair, remove and replace materials to the approval and at no cost to the OWNER.

PART 2  PRODUCTS

2.1  MATERIALS

A. Thermal Batt Insulation: Glass fiber batts conforming to ASTM C 665, Type II or III, CSC certified for recycled material content and manufactured with no formaldehyde thermosetting resin.

   1. Thickness: As required to obtain the specified R-Value.
   2. R-Value: R-Value tested in accordance with ASTM C 518. Minimum R-19 in walls of the Control and Generator Rooms and R-30 in the ceiling.
   3. Facing:
      a. At insulation covered with hardboard paneling or other material; ASTM C 665, Type II or III, Class B. Kraft or foil faced with flame spread rating of 75 or less in accordance with ASTM E 84.
   4. Dimensional stability: linear shrinkage less than 0.1%
PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates to which construction attaches or abuts, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of construction of the Work of this Section.

B. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.

C. Failure to call attention to defects or imperfections will be construed as acceptance and approval of substrate conditions. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation and full responsibility for completed Work.

3.2 INSTALLATION

A. General: Install insulation in strict accordance with the manufacturer's printed instructions. Install insulation into all framing spaces, framing members and any other area in such a way as to form a complete insulating blanket around the heated/cooled areas of the structure. Protect kraft or foil faced insulation during and after installation.

END OF SECTION
SECTION 07 31 00
ASPHALT SHINGLES

PART 1  GENERAL

1.1 SUMMARY

A. Furnish and install Asphalt Shingle roofing system including:
   1. Asphalt shingle roofing.
   2. Associated metal flashings and accessories.

B. RELATED SECTIONS
   1. SECTION 06 10 00 – ROUGH CARPENTRY
   2. SECTION 07 15 00 – SHEET WATERPROOFING

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):


1.3 SUBMITTALS

A. Product Data: Provide data indicating material characteristics.

B. Shop Drawings: For metal flashings, indicate specially configured metal flashings.

C. Color: provide standard manufacturers color pallet for shingles and pre-finished flashing for ENGINEER approved color selection.

D. Samples: Submit 2 samples of shingle color indicating color range and finish texture/pattern; for color selection. Submit two samples of pre-finished flashing for selection of color.

E. Manufacturer's Instructions: Indicate installation criteria and procedures.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with the recommendations of NRCA Steep Roofing Manual.

B. Products Required to Comply with Fire Resistance Criteria: UL listed and labeled.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install shingles or eave protection membrane when surface temperatures are below 45°F.
1.6 EXTRA MATERIALS
A. Provide 500 square feet of extra shingles of color selected.

1.7 WARRANTY
A. Provide 40 year limited warranty including 5 year non-prorated umbrella coverage and including 5 year limited wind warranty at 110 mph (6 nails only with starter strip) maximum wind velocity, including manufacturer's hip and ridge shingles used in conjunction with roof shingles.

PART 2 PRODUCTS

2.1 SHINGLES
A. Manufacturers:
   1. Elk Corporation; Prestique Plus, High Definition (40 year): www.elkcorp.com
B. Asphalt Shingles: Asphalt-coated glass felt, mineral granule surfaced, complying with ASTM D 3462.
   1. Self-sealing type.
   2. Style: Laminated overlay.
   4. Color: ENGINEER approved
C. Sheet waterproofing membrane underlayment per SECTION 07 15 00.

2.2 ACCESSORIES
A. Nails: Ring-shank round wire shingle type, of hot-dipped zinc coated steel, 12 gage, 0.105 inch shank diameter, 3/8 inch head diameter, of sufficient length to penetrate through roof sheathing but not thru the steel deck of the garage building or one inch into roof sheathing.
B. Plastic Cement: ASTM D 4586, asphalt roof cement, Type I or II.
C. Ridge Vents: Aluminum with vent openings that do not permit direct water or weather entry; flanged to receive shingles.

2.3 METAL FLASHINGS
A. Metal Flashings: Provide sheet metal drip edge, ridge vents, and other flashing indicated.
   1. Form flashings to protect roofing materials from physical damage and shed water.
   2. Form sections square and accurate to profile, in maximum possible lengths, free from distortion or defects detrimental to appearance or performance.
   3. Hem exposed edges of flashings minimum 1/4 inch on underside.
B. Sheet Metal: Prefinished Kynar 500 fluoropolymer coated steel, 0.018 inch/26 gauge thick, unless otherwise shown or specified, color as selected.
C. Decorative Ridge Caps:
      a. Provide galvanized standard factory finished products. Prior to installation, prepare and paint to match other sheet metal components and as approved by the ENGINEER.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Verify existing conditions prior to beginning work.
   B. Verify that deck is of sufficient thickness to accept fasteners.
   C. Verify that roof penetrations and plumbing stacks are in place and flashed to deck surface.
   D. Verify roof openings are correctly framed.
   E. Verify sheet waterproofing underlayment is installed adequately for installation of shingle roofing and prefinished flashings.
   F. Verify sheet waterproofing underlayment is free of holes, tears and other damage prior to installing shingles.
   G. Verify sheet waterproofing underlayment is protected at the edges by a prefinished drip edge.

3.2 PREPARATION
   A. Broom clean sheet waterproofing underlayment before installing shingles.

3.3 INSTALLATION - METAL FLASHING AND ACCESSORIES
   A. Weather lap joints minimum 2 inches and seal weather tight with plastic cement.
   B. Secure in place with nails at 8 inches on center. Conceal fastenings.
   C. Items Projecting Through or Mounted on Roofing: Flash and seal weather tight with plastic cement.
   D. Drip edge flashing shall be installed integral with sheet waterproofing underlayment.

3.4 INSTALLATION - SHINGLES
   A. Install shingles in accordance with manufacturer's written instructions.
      1. Fasten individual shingles using 4 nails per shingle, as required by the manufacturer or as required by code, whichever is greater.
      2. Fasten strip shingles using 6 nails per strip, as required by the manufacturer or as required by code, whichever is greater.
   B. Place shingles in straight coursing pattern with manufacturer required weather exposure to produce double thickness over full roof area. Provide double course of shingles at eaves.
   C. Project first course of shingles 3/4 inch beyond fascia boards.
   D. Coordinate installation of roof mounted components or work projecting through roof with weather tight placement of flashings.
E. Complete installation to provide weather tight service.

3.5 PROTECTION

A. Do not permit traffic over finished roof surface.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install Joint Sealants as specified and as shown on the Drawings including:
  1. Sealants and joint backing.
  2. In coordination with sealants specified in other Sections.

B. RELATED SECTIONS

  1. SECTION 07 31 00 – ASPHALT SHINGLES
  2. SECTION 08 11 00 – STEEL DOORS AND FRAMES
  3. SECTION 08 51 00 – ALUMINUM WINDOWS
  4. SECTION 08 81 00 – GLASS GLAZING
  5. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES


1.3 SUBMITTALS

A. Product Data: Provide data indicating sealant chemical characteristics.
B. Samples: Submit 2 samples, 2-inches x 2-inches in size illustrating sealant colors for selection.
C. Manufacturer's Installation Instructions: Indicate special procedures.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years documented experience.
B. Applicator Qualifications: Company specializing in performing the Work of this Section with minimum 3 years documented experience.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.6 COORDINATION

A. Coordinate the Work with all sections referencing this Section.

1.7 WARRANTY

A. Correct defective Work within a 5 year period after Date of Substantial Completion.
B. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Silicone Sealants:

B. Polyurethane Sealants:

C. Butyl Sealants:

D. Acrylic Emulsion Latex Sealants:

2.2 SEALANTS

A. Type GPE - General Purpose Exterior Sealant: Polyurethane; ASTM C 920, Grade NS, Class 25, Uses M, G, and A; single component.
   2. Applications: Use for:
      a. Control, expansion, and soft joints in masonry.
      b. Joints between concrete and other materials.
      c. Joints between metal frames and other materials.
      d. Other exterior joints for which no other sealant is indicated.

B. Type EML - Exterior Metal Lap Joint Sealant: Butyl or polyisobutylene, nondrying, nonskinning, noncuring.
   1. Applications: Use for:
      a. Concealed sealant bead in sheet metal work.

C. Type GPI - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C 834, Type OP, Grade NF single component, paintable.
   2. Applications: Use for:
      a. Interior wall and ceiling control joints.
      b. Joints between door and window frames and wall surfaces.
c. Other interior joints for which no other type of sealant is indicated.

D. Type BT - Bathtub/Tile Sealant: White silicone; ASTM C 920, Uses M and A; single component, mildew resistant.
   1. Applications: Use for:
      a. Joints between plumbing fixtures and floor and wall surfaces.
      b. Joints between kitchen and bath countertops and wall surfaces.
      c. Color to match adjacent surfaces.

E. Type CP - Concrete Paving Joint Sealant: Polyurethane, self-leveling; ASTM C 920, Class 25, Uses T, I, M and A; single component.
   2. Applications: Use for:
      a. Joints in sidewalks and vehicular paving.

2.3 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50% larger than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are ready to receive Work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

A. Remove loose materials and foreign matter which might impair adhesion of sealant.

B. Clean and prime joints in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C 1193.

D. Protect elements surrounding the Work of this Section from damage or disfigurement.

3.3 INSTALLATION

A. Perform Work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C 1193.

C. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.

D. Install bond breaker where joint backing is not used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tool joints concave.

3.4 CLEANING

A. Clean adjacent soiled surfaces.

3.5 PROTECTION OF FINISHED WORK

A. Protect sealants until cured.

3.6 SCHEDULE

A. Exterior Joints for Which No Other Sealant Type is Indicated: Type GPE; colors as selected.

B. Control and Expansion Joints in Paving: Type CP.

C. Joints Between Precast Concrete Units and Between Precast Units and Adjacent Work: Type GPE.

D. Control, Expansion, and Soft Joints in Masonry, and Between Masonry and Adjacent Work: Type GPE.

E. Lap Joints in Exterior Sheet Metal Work: Type EML.

F. Butt Joints in Exterior Metal Work and Siding: Type GPE.

G. Joints Between Exterior Metal Frames and Adjacent Work: Type GPE.

H. Under Exterior Door Thresholds: Type EML.

I. Interior Joints for Which No Other Sealant is Indicated: Type GPI; colors as selected.

J. Control and Expansion Joints in Interior Concrete Slabs and Floors: Type CP.

K. Joints Between Plumbing Fixtures and Walls and Floors, and Between Countertops and Walls: Type BT.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A. Furnish and install Steel Doors and Frames as specified and as shown on the Drawings including:

1. Steel frames for wood doors.
2. Fire-rated steel doors and frames.
3. Thermally insulated steel doors.
4. Accessories, including glazing.

B. RELATED SECTIONS

1. SECTION 04 40 00 – GRANITE VENEER MASONRY
2. SECTION 06 10 00 – ROUGH CARPENTRY
3. SECTION 06 20 00 – FINISH CARPENTRY
4. SECTION 08 71 00 – DOOR HARDWARE
5. SECTION 08 81 00 – GLASS GLAZING
6. SECTION 09 90 00 – PAINTING AND COATING

1.2  REFERENCES

A. American National Standard (ANSI):

2. ANSI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames.
3. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.

B. American Society for Testing and Materials (ASTM):

1. A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.


E. National Fire Protection Association (NFPA):


F. Underwriters Laboratories Inc. (UL): UL (BMD) - Building Materials Directory.

1.3  SUBMITTALS

A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.
B. Shop Drawings: Details of each opening, showing elevations, frame profiles, and identifying location of different finishes, if any.

1.4 QUALITY ASSURANCE
A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years documented experience.
B. Maintain at the project Site a copy of all reference standards dealing with installation.

1.5 DELIVERY, STORAGE, AND PROTECTION
A. Store in accordance with NAAMM HMMA 840.
B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Steel Doors and Frames:
   2. Curries Company: www.curries.com

2.2 DOORS AND FRAMES
A. Requirements for All Doors and Frames:
   2. Door Edge Profile: Beveled on both edges.
   4. Hardware Preparation: In accordance with DHI A115 Series, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
   5. Finish: Factory primed, for field finishing.
   7. Insulated.

2.3 STEEL DOORS
A. Exterior and Interior Doors, Fire-Rated:
   1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
   2. Core: Polyurethane.
   3. Top Closures for Outswinging Doors: Flush with top of faces and edges.
   5. Texture: Smooth faces.
   6. Insulating Value: U-value of 0.067, when tested in accordance with ASTM C 236.
   7. Weatherstripping: include as part of door assembly.

2.4 STEEL FRAMES
A. General:
   1. Comply with the requirements of grade specified for corresponding door, except:
   2. Face Width: Nominal 2 inches.
   3. Depth: 5-3/4 inches, unless otherwise noted.
4. Finish: Same as for door.
5. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
6. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.
7. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

B. Exterior Door Frames: Face welded, seamless with joints filled.
   1. Weatherstripping: include as part of door assembly.

2.5 ACCESSORY MATERIALS
A. Removable Stops: Formed sheet steel, mitered or butted corners; prepared for countersink style tamper proof screws.
B. Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.
C. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
D. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.6 FINISH MATERIALS
A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.
B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

PART 3 EXECUTION
3.1 EXAMINATION
A. Verify existing conditions before starting Work.
B. Verify that opening sizes and tolerances are acceptable.

3.2 PREPARATION
A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.3 INSTALLATION
A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.
B. In addition, install fire rated units in accordance with NFPA 80.
C. Coordinate frame anchor placement with wall construction.
D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
E. Coordinate installation of hardware.
F. Touch up damaged factory finishes.
3.4 ERECTION TOLERANCES
A. Clearances between Door and Frame: As specified in ANSI A250.8.
B. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.5 ADJUSTING
A. Adjust for smooth and balanced door movement.

3.6 SCHEDULE
A. Refer to Door Schedule on the Drawings.

END OF SECTION
1.1 SUMMARY

A. Furnish and install Aluminum Windows as specified and as shown on the Drawings including:
   1. Extruded aluminum windows with fixed sash.
   2. Factory glazing.

B. RELATED SECTIONS

   1. SECTION 04 40 00 – GRANITE VENEER MASONRY
   2. SECTION 07 92 00 – JOINT SEALANTS
   3. SECTION 08 81 00 – GLASS GLAZING

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
   1. AAMA/NWWDA 101/L.S.2 - Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors; 1997 with revisions contained in "reprinting" of 12/99.
   4. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; 1997.


C. American Society for Testing and Materials (ASTM):


1.3 PERFORMANCE REQUIREMENTS

A. Performance Requirements: As specified in PART 2, with the following additional requirements:

   1. Design and size windows to withstand the following load requirements, when tested in accordance with ASTM E 330 using test loads equal to 1.5 times the design wind loads with 10 second duration of maximum load:
      a. Design Wind Loads: Comply with requirements of ASCE 7.
      b. Positive Design Wind Load: 35 pounds of force per square foot.
      c. Negative Design Wind Load: 35 pounds of force per square foot.
d. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.

B. Movement: Accommodate movement between window and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.

C. U-Value: Maximum of .60 at clear glass.

D. Air Infiltration: Limit air infiltration through assembly to 0.2 cubic feet per minute per square foot of wall area, measured at a reference differential pressure across assembly of 6.24 psf as measured in accordance with ASTM E 283.

E. Condensation Resistance Factor: CRF of 51 when measured in accordance with AAMA 1503.1.

F. Water Leakage: None, when measured in accordance with ASTM E 331 with a test pressure difference of 12 pounds of force per square foot for 15 minutes.

G. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly.

H. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, or migrating moisture occurring within system.

1.4 SUBMITTALS

A. Product Data: Provide component dimensions.

B. Shop Drawings: Indicate opening dimensions, elevations of different types, framed opening tolerances, method for achieving air and vapor barrier seal to adjacent construction, anchorage locations and installation requirements.

C. Samples: Submit 2 samples, 12-inches x 12-inches in size illustrating typical corner construction, accessories, and finishes.

D. Submit 2 samples of operating hardware.

E. Certificates: Certify that windows meet or exceed specified requirements.

F. Manufacturer's Installation Instructions: Include complete preparation, installation, and cleaning requirements.

1.5 QUALITY ASSURANCE

A. Comply with requirements of AAMA 101 Designation HC50.

B. Manufacturer and Installer: Company specializing in fabrication of commercial aluminum windows of types required, with not fewer than 5 years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Comply with requirements of AAMA CW-10.

B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.7 WARRANTY

A. Correct defective Work within a one year period after Date of Substantial Completion.
B. Provide ten year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

C. Provide ten year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Graham Architectural Products, Inc; Product indicated for each type.

B. Other Acceptable Manufacturers:

1. EFCO Corp.
2. Wausau Window and Wall Systems

2.2 WINDOWS

A. Windows: Tubular aluminum sections, factory fabricated, factory finished, thermally broken, vision glass, related flashings, anchorage and attachment devices.

1. Performance Requirements: AAMA/NWWDA 101/I.S.2 HC50 minimum

B. Fixed, Non-Operable Type:

1. Product: Graham 6700 Series.
2. Construction: Thermally broken with sightline that replicates historic steel profiles.
3. Glazing: Double, clear, Low-e.

2.3 COMPONENTS

A. Frames of width, profile and thickness as those indicated, thermally broken with interior portion of frame insulated from exterior, applied glass stops of snap-on type.

B. Fasteners: Stainless steel.

C. Glass and Glazing Materials: As specified in SECTION 08 81 00.

D. Sealant and Backing Materials: As specified in SECTION 07 92 00.

2.4 FABRICATION

A. Fabricate components with smallest possible clearances and shim spacing around perimeter of assembly that will enable window installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices.

D. Arrange fasteners and attachments to ensure concealment from view.

E. Provide internal drainage of glazing spaces to exterior through weep holes.

F. Double weatherstrip operable units.
G. Factory glaze window units.

2.5 FINISHES

A. High Performance Organic Finish: AAMA 2604; multiple coats, thermally cured fluoropolymer system; color as approved by ENGINEER.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that wall openings and adjoining air and vapor seal materials are ready to receive aluminum windows.

3.2 INSTALLATION

A. Install windows in accordance with manufacturer's instructions.
B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent Work.
D. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
E. Coordinate attachment and seal of perimeter air barrier and vapor retarder materials.
F. Install glass and infill panels in accordance with requirements specified in SECTION 08 81 00.
G. Install perimeter sealant in accordance with requirements specified in SECTION 07 92 00.

3.3 ERECTION TOLERANCES

A. Maximum Variation from Level or Plumb: 1/16 inches every 3 feet non-cumulative or 1/8 inches per 10 feet, whichever is less.

3.4 FIELD QUALITY CONTROL

A. Test installed window for water leakage in accordance with AAMA 501.2 (simple hose test). Test first window installed.
B. Report results of test to ENGINEER.
C. Execute factory-approved fix for any windows that have failed and retest until performance is satisfactory.

3.5 ADJUSTING AND CLEANING

A. Remove protective material from factory finished aluminum surfaces.
B. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.
C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.
PART 1  GENERAL

1.1 SUMMARY

A. Furnish and install Door Hardware as specified and as shown on the Drawings including:
   1. Hardware for fire-rated and insulated doors.
   2. Electrically operated and controlled hardware.
   3. Lock cylinders for doors.
   4. Thresholds.
   5. Weatherstripping, seals and door gaskets.

B. Related Sections:
   1. SECTION 08 11 00 – STEEL DOORS AND FRAMES

1.2 REFERENCES

A. Americans with Disabilities Act (ADA).


C. Builders Hardware Manufacturers Association, Inc. (BHMA):
   1. BHMA A156.1 - American National Standard for Butts and Hinges; Inc.; 2000 (ANSI/BHMA A156.1).
   2. BHMA A156.3 - American National Standard for Exit Devices; 1994 (ANSI/BHMA A156.3).
   3. BHMA A156.4 - American National Standard for Door Controls - Closers; 2000 (ANSI/BHMA A156.4).
   4. BHMA A156.6 - American National Standard for Architectural Door Trim; 1994 (ANSI/BHMA A156.6).
   6. BHMA A156.8 - American National Standard for Door Controls - Overhead Stops and Holders; Builders Hardware Manufacturers Association, Inc.; 2000 (ANSI/BHMA A156.8).
   8. BHMA A156.16 - American National Standard for Auxiliary Hardware; 1997 (ANSI/BHMA A156.16).

D. Door and Hardware Institute (DHI): DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; 1990.

1.3 SUBMITTALS

A. Shop Drawings (including Schedules and Product Data):
   1. Submit manufacturer's parts lists and templates.
   2. Schedules to be in vertical format, listing each door opening, and organized into "hardware sets" indicating complete designations of every item required for each door opening to function as intended. Note any special mounting instructions or
requirements with the hardware schedule. Schedules to include the following information:

a. Location of each hardware set cross-referenced to indications on Drawings, both on floor plans and in door and frame schedule.

b. Handing and degree of swing of each door.

c. Door and frame sizes and materials.

d. Keying information.

e. Type, style, function, size, and finish of each hardware item.

f. Elevation Drawings and operational descriptions for all electronic openings.

g. Name and manufacturer of each hardware item.

h. Fastenings and other pertinent information.

i. Explanation of all abbreviations, symbols and codes contained in schedule.

ej. Mounting locations for hardware when varies from standard.

3. Submit catalog cuts and/or product data sheets for all finish hardware

4. Submit separate detailed keying schedule for approval indicating clearly how the owner's final instructions on keying of locks has been fulfilled.

B. Samples:

1. Upon request, submit one sample of each type of hardware illustrating style, color, and finish.

2. Samples will be returned to supplier.

C. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

D. Project Record Documents: Record actual locations of installed cylinders and their master key code.

E. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

F. Electronic Hardware Systems:

1. Provide complete wiring diagrams prepared by an authorized factory employee for each opening requiring electronic hardware, except openings where only magnetic hold-open devices are specified. Provide a copy with each hardware schedule submitted after approval.

2. Provide complete operational descriptions of electronic components listed by opening in the hardware submittals. Operational descriptions to detail how each electrical component functions within the opening incorporating all conditions of ingress and egress. Provide a copy with each hardware schedule submitted for approval.

3. Provide elevation Drawings of electronic hardware and systems identifying locations of the system components with respect to their placement in the door opening. Provide a copy with each hardware schedule submitted for approval.

4. Prior to installation of electronic hardware, arrange conference between supplier, installers and related trades to review materials, procedures and coordinating related work.

5. The electrical products contained within this Specification represent a complete engineered system. If alternate electrical products are submitted, it is the responsibility of the distributor to bear the cost of providing a complete and working system including re-engineering of electrical diagrams and system layout, as well as power supplies, power transfers and all required electrical components. Coordinate with electrical engineer and electrician to ensure that line voltage and low voltage wiring is coordinated to provide a complete and working system.
G. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.

H. Warranty: Submit manufacturer’s warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum 3 years of documented experience.

B. Hardware Supplier Qualifications: Company specializing in supplying commercial door hardware with 2 years of experience.

C. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this Section.

D. Hardware supplier must be an authorized factory distributor of all products specified herein.

1.5 PRE-INSTALLATION MEETING

A. Convene one week prior to commencing work of this Section.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

1.7 COORDINATION

A. Coordinate the Work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware.

B. Furnish templates for door and frame preparation.

C. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

D. Coordinate OWNER’s keying requirements during the course of the Work.

1.8 WARRANTY

A. Provide 5 year warranty for door closers.

1.9 MAINTENANCE PRODUCTS

A. Provide special wrenches and tools applicable to each different or special hardware component.

B. Provide maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Hinges:

1. McKinney: www.mckinneyhinge.com
B. Cylindrical Locks:

C. Electric Strikes:
1. Hanchett Entry Systems, Inc. (HES): www.hesinovations.com:
   a. 1006 Series, Heavy Duty Electric Strikes
   b. 9500/9600 Electric Strikes
2. No substitutions.

D. Closers - Heavy Duty:
1. Sargent 351 Series.

E. Magnetic Hold-Opens:
1. Sargent
2. Rixson
3. HES

F. Manual and Automatic Bolts:
1. TRIMCO/Triangle Brass Manufacturing Co., Inc.: www.trimcobbw.com
2. Ives by Schlage: www.schlagelock.com
3. Rockwood Mfg Co.: www.rockwoodmfg.com

G. Gasketing:

H. Thresholds:
3. Reese Enterprises, Inc: www.reeseusa.com

I. Door Stops and Holders
1. TRIMCO/Triangle Brass Manufacturing Co., Inc.: www.trimcobbw.com
2. Ives
3. Rockwood Mfg Co.: www.rockwoodmfg.com

J. Silencers:
1. TRIMCO/Triangle Brass Manufacturing Co., Inc.: www.trimcobbw.com

K. Electronic Power Supplies:
2. No Substitutions.

2.2 GENERAL REQUIREMENTS FOR DOOR HARDWARE PRODUCTS

A. Provide products that comply with the following:
1. Applicable provisions of Federal, State, and local codes.

B. Finishes: ENGINEER approved.

2.3 DOOR HARDWARE

A. Hinges:
   1. Shall conform to ANSI A156.1 and shall be 5-knuckle design, ball bearing as specified with NRP (non-removable pin) feature.
   2. Provide one hinge or every 30 inches of door height.
   3. Hinges shall generally be 4-1/2 inches x 4-1/2 inches, except at doors exceeding 36 inches in width where 5-inches x 4-1/2inches hinges shall be provided.
   4. Heavy weight hinges (.180) shall be provided at all doors.
   5. Provide hinges with phillips flathead screws.

B. Cylindrical Locks:
   1. All locks shall be ANSI 156.2, Grade 1 furnished with standard 2-3/4 inch backset.
   2. Lock housing shall be fabricated of steel zinc dichromate and stainless steel.
   3. Latchbolt shall be brass with a minimum 1/2 inch throw.
   4. Locks shall be non-handed and fully field reversible.
   5. 6 pin series.

C. Electric Strikes:
   1. All electric unlatch strikes shall fit into a standard ANSI cutout with little or no modification.
   2. The strike shall be fail secure and shall maintain a higher security standard than a standard electric strike.
   3. The strike shall work with any cylindrical lockset with or without deadlatch feature and shall maintain operation of dead latch feature.
   4. The strike shall be rated at 250,000 or greater cycles of operation and shall manipulate the latch and deadlatch out of the strike without use of solenoids or drop away paddles.
   5. The strike shall have an integrated lock status monitor with a form C output.

D. Closers - Heavy Duty:
   1. Closers shall have non-ferrous covers, aluminum alloy bodies, forged steel arms, and separate valves for adjusting backcheck, closing and latching cycles and adjustable spring to provide up to 50% increase in spring power.
   2. Closers shall be constructed with a one-piece body.
   3. Closers shall be furnished with parallel arms mounting on all doors opening into corridors or other public spaces and shall be mounted to permit 180 degrees door swing wherever wall conditions permit.
   4. Furnish with non-hold open arms unless otherwise indicated.
   5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

E. Magnetic Hold-Opens:
   1. Magnetic door holders shall meet or exceed ANSI A156.15 and be UL listed 228 for Door Closer and Holders, with or without integral smoke detectors.
   2. Holding force shall be 40 pounds at 24VDC and shall be fail-safe.
   3. Pushpin release that eliminates residual magnetism shall be standard.
F. Gasketing:
1. Provide continuous weatherseal on exterior doors and smoke, light, or sound seals on interior doors where indicated or scheduled.
2. Provide intumescent seals as required to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and UBC 7-2, Fire Tests of Door Assemblies.
3. Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.

G. Thresholds:
1. Provide threshold units not less than 4 inches wide, formed to accommodate change in floor elevation where indicated, fabricated to accommodate door hardware and to fit door frames.
2. All threshold units shall comply with the Americans with Disabilities Act (ADA.)

H. Door Stops and Holders:
1. Where a door is indicated on the plans to strike a wall at 90 degrees, wall bumpers shall be provided.
2. Provide convex or concave design as indicated.

I. Silencers:
1. Provide rubber door silencers equal to Trimco 1229A for all new interior steel door frames, 2 per pair and 3 per single door frame.
2. Provide door silencers equal to Trimco 1229B for all interior wood frames.

J. Electronic Power Supplies:
1. Power supplies shall furnish regulated 24VDC and shall be UL class 2 listed and approved for UL and ULC applications.
2. LED’s shall monitor zone status (voltage/no voltage) and slide switches shall be provided to connect or disconnect the load from power; 1, 4 or 8 separate output circuit breakers shall be provided to divide the load.
3. Power supplies shall have the internal capability of charging optional 24VDC sealed lead acid batteries in addition to operating the DC load.
4. Power supplies shall be supplied complete requiring only 120VAC to the fused input and shall be supplied in an enclosure.
5. Power supplies shall be provided with emergency release terminals that allow the release of all devices upon activation of the fire alarm system.

2.4 FINISHES

A. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18 including coordination with traditional U.S. finishes shown by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer’s standards, but in no case less than specified by referenced standards for the applicable units of hardware.

2.5 KEYING

A. Door Locks: Grand master keyed.
1. Include construction keying and control keying with removable core cylinders.
B. Supply keys in the following quantities:

1. Six master keys per master level.
2. Three grand master keys.
3. Fifteen construction keys.
4. Two change keys for each lock.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that doors and frames are ready to receive work and dimensions are as indicated on shop Drawings.
B. Verify that electric power is available to power operated devices and of the correct characteristics.

3.2 INSTALLATION

A. Install hardware in accordance with manufacturer’s instructions and applicable codes.
B. Use templates provided by hardware item manufacturer.
C. Mounting heights for hardware from finished floor to center line of hardware item (except as specifically indicated or required to comply with the governing authorities):
   1. For steel doors and frames: Comply with DHI "Recommended Locations for Architectural Hardware for Steel Doors and Frames."
D. Care shall be exercised not to mar or damage adjacent work
E. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
F. Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.3 FIELD QUALITY CONTROL

A. Provide an Architectural Hardware Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer’s instructions and as specified.

3.4 ADJUSTING

A. Adjust hardware for smooth operation.
B. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
C. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore to proper function and finish of hardware and doors.
D. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

E. Instruct OWNER's personnel in the proper adjustment and maintenance of door hardware and hardware finishes and usage of any electronic devices.

3.5 PROTECTION OF FINISHED WORK

A. Do not permit adjacent work to damage hardware or finish.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A. Furnish and install Glass and Glazing as specified and as shown on the Drawings including:

1. Glass and security glass.
2. Glazing compounds and accessories.

B. RELATED SECTIONS

1. SECTION 07 92 00 – JOINT SEALANTS
2. SECTION 08 51 00 – ALUMINUM WINDOWS

1.2  REFERENCES


B. American Society for Testing and Materials (ASTM):


1.3  PERFORMANCE REQUIREMENTS

A. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:

1. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

B. Select type and thickness of exterior glass to withstand dead loads and wind loads acting normal to plane of glass at design pressures of 35 pounds per square foot positive and negative.

1. Use the procedure specified in ASTM E 1300 to determine glass type and thickness.
2. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.
3. Thicknesses listed are minimum.

1.4  SUBMITTALS

A. Product Data on Glass and Plastic Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

B. Samples: Submit 2 samples 6-inches x 6-inches in size of glass units.
C. Manufacturer’s Certificate: Certify that all glass meets or exceeds specified requirements.

1.5 QUALITY ASSURANCE
A. Perform Work in accordance with FGMA Sealant Manual for glazing installation methods.
B. Installer Qualifications: Company specializing in performing the Work of this Section with minimum 5 years documented experience.

1.6 ENVIRONMENTAL REQUIREMENTS
A. Do not install glazing when ambient temperature is less than 50°F.
B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.7 WARRANTY
A. Provide a 5 year warranty to include coverage for sealed glass units from seal failure, interpane dusting or misting, and replacement of same.
B. Provide a 5 year warranty to include coverage for delamination of laminated glass and replacement of same.

PART 2 PRODUCTS
2.1 GENERAL
A. Provide insulating safety glass (SG) exterior pane plus low E glass (LEG) interior pane for all windows.

2.2 FLAT GLASS MATERIALS
A. Manufacturers:
B. Clear Float Glass (Type CFG): Clear, heat strengthened.
   1. Comply with ASTM C 1048, Condition A uncoated, Type I, transparent flat, Class 1, Quality q3 glazing select.
   2. 6 mm minimum thick.
C. Safety Glass (Type SG): Clear; fully tempered, laminated.
   1. Comply with ASTM C 1048, Condition A uncoated, Type I, transparent flat, Class 1, Quality q3 glazing select.
   2. Comply with ANSI Z97.1.
   3. 6 mm minimum thick per layer.
   4. Two glass sheets bonded around a layer of polyvinyl butyral (PVB) resulting in one monolithic glass.
D. Low E Glass (Type LEG): Float type, heat strengthened or tempered at locations indicated SG, clear.
   1. Coating on inner surface.
2. Visible light transmittance of 82%, solar light transmittance of 65%, shading coefficient of .81.
3. 6 mm minimum thick.

2.3 SEALED INSULATING SAFETY GLASS MATERIALS

A. Manufacturers:
   1. Any of the manufacturers listed under Flat Glass Materials.

B. Insulating Safety Glass Units (Type SG): Double pane with Low E-type and safety glass with silicone sealant edge seal.
   1. Outer pane of Safety Glass (SG), inner pane of Low E Glass (LEG) glass.
   2. Place reflective coating on No. 3 surface within the unit.
   3. Comply with ASTM E 774 and E 773 Class A.
   4. Purge interpane space with dry hermetic air.
   5. Total unit thickness of one inch minimum.

2.4 GLAZING COMPOUNDS

A. Manufacturers:

B. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C 920, Type S, Grade NS, Class 25, Uses M, A, and G; cured Shore A hardness of 15 to 25; black color.

2.5 GLAZING ACCESSORIES

A. Manufacturers:
   1. Norton Performance Plastics Corp.

B. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness, ASTM C 864 Option I. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.

C. Glazing Tape: Preformed butyl compound; Shore "00" 76 @ 77° durometer hardness; coiled on release paper; 1/8-inch x 3/8-inch size, unless other size as recommended by manufacturer for particular glazing size and conditions; black color.

D. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C 864 Option I; black color.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement; weeps are clear, and ready to receive glazing.
3.2 PREPARATION
   A. Clean contact surfaces with solvent and wipe dry.
   B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
   C. Prime surfaces scheduled to receive sealant.
   D. Install sealants in accordance with ASTM C 1193 and FGMA Sealant Manual.
   E. Install sealant in accordance with manufacturer's instructions.

3.3 INSTALLATION - EXTERIOR DRY METHOD (TAPE AND GASKET SPLINE GLAZING)
   A. Cut glazing tape to length; install on glazing pane. Seal corners by butting tape and sealing junctions with butyl sealant.
   B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
   C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
   D. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
   E. Trim protruding tape edge.

3.4 INSTALLATION - INTERIOR DRY METHOD (TAPE AND TAPE)
   A. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
   B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
   C. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
   D. Place glazing tape on free perimeter of glazing in same manner described above.
   E. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
   F. Knife trim protruding tape.

3.5 CLEANING
   A. Remove glazing materials from finish surfaces.
   B. Remove labels after Work is complete.
   C. Clean glass and adjacent surfaces.

3.6 PROTECTION OF FINISHED WORK
   A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

3.7 SCHEDULE
   A. As shown on Drawings.

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY
A. Furnish and install Paint and Coatings as specified and as shown on the Drawings including:
   2. Field application of paints and other coatings.
   3. See Schedule - Surfaces to be Finished, at end of Section.

1.2 REFERENCES
A. American Society for Testing and Materials (ASTM):

1.3 DEFINITIONS
A. Conform to ASTM D 16 for interpretation of terms used in this Section.

1.4 SUBMITTALS
A. Product Data: Provide data on all finishing products.
B. Samples: Submit 2 paper chip samples, 8-inches x 8-inches in size illustrating range of colors and textures available for each surface finishing product scheduled.
C. Manufacturer's Instructions: Indicate special surface preparation procedures.
D. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years documented experience.
B. Applicator Qualifications: Company specializing in performing the Work of this Section with minimum 5 years experience and approved by manufacturer.

1.6 REGULATORY REQUIREMENTS
A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.7 DELIVERY, STORAGE, AND PROTECTION
A. Deliver products to Site in sealed and labeled containers; inspect to verify acceptability.
B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
C. Paint Materials: Store at minimum ambient temperature of 45°F and a maximum of 90°F, in ventilated area, and as required by manufacturer's instructions.
1.8 ENVIRONMENTAL REQUIREMENTS
A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
C. Minimum Application Temperatures for Latex Paints: 45°F for interiors; 50°F for exterior; unless required otherwise by manufacturer's instructions.
D. Minimum Application Temperature for Varnish Finishes: 65°F for interior or exterior, unless required otherwise by manufacturer's instructions.
E. Provide lighting level of 80 feet candles measured mid-height at substrate surface.

1.9 EXTRA MATERIALS
A. Supply one gallon of each color; store where directed.
B. Label each container with color in addition to the manufacturer's label.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Paints:
   3. Pittsburgh Paints.
B. Primer Sealers:
   1. Base Manufacturer: Benjamin Moore & Co.
   2. Pittsburgh Paints.
C. Block Fillers:
   1. Base Manufacturer: Benjamin Moore & Co.
   2. Pittsburgh Paints.

2.2 PAINTING AND COATING - GENERAL
A. Painting and Coating: Ready mixed, except field-catalyzed coatings. Prepare pigments:
   1. To a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.
   2. For good flow and brushing properties.
   3. Capable of drying or curing free of streaks or sags.

2.3 PAINT SYSTEMS - EXTERIOR
A. Paint HE-OP-2AL – Hardboard Panels and trim boards, opaque, acrylic latex, 2 coats:
   1. Over shop finish, 2 coats of acrylic latex enamel, semi-gloss.
B. Paint ME-OP-2AL - Ferrous Metals, Unprimed, Acrylic Latex, 2 Coat:

C. Paint ME-OP-3AU - Ferrous Metals, Primed, Acrylic Urethane
   1. Over shop primer, one coat of phenolic alkyd primer; BM M07.
   2. Gloss: 2 coats of acrylic urethane; BM M74/M75.

D. Paint ME-OP-2AL-P - Ferrous Metals, Previously Painted, Acrylic Latex, 2 Coat
   1. Low Lustre: 2 coats of acrylic latex enamel; BM Ironclad Latex Low Lustre Metal & Wood Enamel 363.
   2. Note: Dependent upon substrate, may require primer upon recommendation of paint manufacturer.

E. Paint MgE-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
   1. One coat galvanize primer.

2.4 PAINT SYSTEMS - INTERIOR

A. Paint WI-OP-3L - Wood, Opaque, Latex, 3 Coat:
   1. One coat of latex primer sealer; BM 253.
   2. Semi-gloss: 2 coats of latex enamel; BM 276.

B. Paint CI-OP-3EP - Concrete/Masonry, Opaque, Epoxy, 3 Coat:
   1. One coat of waterborne epoxy block filler; BM M31/M32.
   2. Semi-gloss: 2 coats of polyamide epoxy; BM M36/M38.

C. Paint MI-OP-2AL - Ferrous Metals, Unprimed and Primed, Acrylic Latex, 2 Coat:

D. Paint MI-OP-3UA - Ferrous Metals, Primed, Urethane Alkyd, 3 Coat:
   1. Over shop primer, one coat of phenolic alkyd primer; BM M07.
   2. Gloss: 2 coats of urethane alkyd; BM M22.

E. Paint MgI-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
   1. One coat galvanize primer.

F. Paint HI-OP-3L – Hardboard panels, Latex, 3 Coat:
   1. One coat of latex primer sealer; BM Super Spec Latex Enamel Undercoat & Primer Sealer 253
   2. Two coats of latex enamel.
      a. Eggshell: Walls of Rooms other than Bathrooms; BM Super Spec Latex Eggshell Enamel 274
      b. Flat: Ceilings of Rooms other than Bathrooms; BM Super Spec Latex Flat 275.
2.5 ACCESSORY MATERIALS

A. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive Work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of Work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:

   1. Hardboard panels and trim boards: 12%.
   2. Interior Wood: 15%, measured in accordance with ASTM D 4442.
   3. Concrete Floors: 8%.

3.2 PREPARATION

A. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

B. Surfaces: Correct defects and clean surfaces which affect Work of this Section. Remove or repair existing coatings that exhibit surface defects.

C. Marks: Seal with shellac those which may bleed through surface finishes.

D. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

E. Concrete and Concrete Block Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

F. Interior and Exterior Hardboard Panel and Trim Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

G. Insulated Coverings to be Painted: Remove dirt, grease, and oil from canvas and cotton.

H. Concrete Floors to be Painted: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.

I. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

J. Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric
acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

K. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

L. Interior Wood Items to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

M. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.3 APPLICATION
A. Apply products in accordance with manufacturer's instructions.
B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
D. Apply each coat to uniform appearance. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
E. Sand wood and metal surfaces lightly between coats to achieve required finish.
F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

3.4 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT
A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
B. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.5 CLEANING
A. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from Site.

3.6 SCHEDULE - SURFACES TO BE FINISHED
A. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically noted.
   2. Fire rating labels, equipment serial number and capacity labels.
   3. Stainless steel items.

B. Paint the surfaces described below under Schedule - Paint Systems.
C. Mechanical and Electrical: Use paint systems defined for the substrates to be finished.
   1. Paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment occurring in finished areas to match background surfaces, unless otherwise indicated.
2. Paint all equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.
3. Paint shop-primed items occurring in finished areas.
4. Paint interior surfaces of air ducts that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
5. Paint dampers exposed behind louvers, grilles, to match face panels.

D. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

### 3.7 SCHEDULE - PAINT SYSTEMS

A. Concrete, Concrete Block: Finish all surfaces exposed to view, except exterior concrete elements.

B. Hardboard panels and trim boards: Finish all surfaces exposed to view.
   1. Interior Ceilings and Bulkheads: GI-OP-3L, flat.

C. Wood: Finish all surfaces exposed to view.
   1. Interior items: WI-OP-3L, semi-gloss.

D. Steel Doors and Frames: Finish all surfaces exposed to view.

E. Steel Fabrications (except handrails and guardrails): Finish all surfaces exposed to view.
   1. Exterior: ME-OP-2AL, semi-gloss; finish all surfaces, including concealed surfaces, before installation.

F. Galvanized Steel: Finish all surfaces exposed to view.
   2. Interior: MgI-OP-3A, semi-gloss.

G. Shop-Primed and Previously Painted Metal Items (except handrails and guardrails): Finish all surfaces exposed to view.

H. Handrails and Guardrails: Finish all surfaces exposed to view.
   2. Interior: MI-OP-3UA, gloss.

I. Metal Conduit, Fittings, Boxes and Plates: Finish all surfaces exposed to view.
   1. Exterior: MgE-OP-3A.
   2. Interior: MgI-OP-3A.
J. Non-Metallic Conduit and Ducts: Finish all surfaces exposed to view.

1. Exterior: ME-OP-2AL
2. Interior: MI-OP-2AL

END OF SECTION
SECTION 13 00 50
INSTALLATION OF OWNER-FURNISHED PRODUCTS

PART 1 GENERAL

1.1 GENERAL
A. Furnish and install all tools, supplies, materials, equipment and labor necessary for the installation, testing, and placing into operation of all Upstream Control Gates, Spools, Hydraulic Power Unit, trashracks, standby generator and related appurtenances, complete and operable, in accordance with the requirements of the Contract Documents.

B. The provisions of this Section shall apply to all equipment specified, except where otherwise specified in the Contract Documents.

C. Specifications and Drawings for this equipment are in the OWNER's possession and shall be made available to the CONTRACTOR, related equipment shop drawings are located in the appendix.

1.2 DEFINITIONS
A. Manufacturer: Where “Manufacturer” is referred to in this Section only, it refers to the person, firm, or corporation retained by OWNER in separate Agreement to provide products purchased by OWNER. Such party may be referred to as “CONTRACTOR for OWNER-furnished products” or “OWNER-furnished equipment CONTRACTOR” in other Sections of these Contract Documents.

B. Transfer: “Transfer” of OWNER-furnished to the CONTRACTOR refers to the times when the following have occurred:
   1. Manufacturer’s instructions for unloading, handling, storage, and protection have been received by the CONTRACTOR.
   2. Products have been delivered F.O.B. to the jobsite or storage area and jointly inspected by Manufacturer and CONTRACTOR.
   3. OWNER has accepted such products as ready for unloading, storage, and protection by the CONTRACTOR.

1.3 SUBMITTALS
A. Shop Drawings:
   1. Detailed Drawings that indicate the layout, location, and identification of products and materials provided by CONTRACTOR.
   2. Detailed drawings showing final Spool and Gate locations.
   3. Detailed drawings showing final trashrack locations.
   4. Detailed drawings of proposed fixtures, templates or other aids to be used in the installation of trashracks.
   5. Anchor bolt core drilling procedures and bracing.

B. Prequalifications of Equipment Installers.

C. Survey Information:
   1. Submit per SECTION 01 71 23 to determine if modifications are required to the existing survey shown on the Contract Drawings

D. Demolition / Rock Removal Plan:
   1. Submit in accordance with SECTION 31 71 16.
E. Proposed Installation Sequencing and Procedures:

1. Procedures required for each gate, since methods will be unique.
2. Procedures required for each trashrack, since site conditions and required hardware and tools will vary.

F. Installation Schedule and Plan for Maintaining Facility Operation.

G. Videography and Photographic Records

H. Certificate of Proper Installation:

1. The Equipment Suppliers shall provide certification, addressed to the ENGINEER, stating that the equipment has been installed properly by the CONTRACTOR. Submit all such certificates to the ENGINEER.

1.4 PREQUALIFICATIONS OF EQUIPMENT INSTALLERS

A. Resume’s are required for all potential installers.

B. 5 years experience installing underwater equipment.

C. Information of installers past 5 projects of similar scope. Submit contact name and phone number of Owner and General Contractor on said projects.

D. List of tools and date of calibration of any precision instruments that will be used to install the equipment to the required tolerances.

E. Proposed schedule of events or methods that will be used to install the equipment.

1.5 DELIVERY AND STORAGE

A. Verify availability of OWNER-furnished products by contacting the ENGINEER before making final arrangements for, or committing resources to, handling, storage, protection, or installation of such products.

1. The OWNER-furnished products, except for trashracks, are located at Denver Water’s Storage Yard:
   a. 1600 W. 12th Ave. Denver, CO 80204

2. The OWNER-furnished trashracks will be stored at the manufacturer’s facility in Westcliff, Colorado and will be delivered by the manufacturer to the site. A delivery time and date shall be negotiated with the ENGINEER, who will coordinate with the manufacturer.

3. Delivery to and storage (with the exception of the trashracks) at Cheesman Reservoir shall be the CONTRACTOR’s responsibility and expense. The access road is a steep, one way gravel road. Verify that the expected delivery trucks can negotiate this road.

4. The gates are being stored in wooden crates in the horizontal position. The CONTRACTOR will need to arrange for cranes and appropriate rigging materials to move and load the gates and spools.

5. Provide a minimum of 15-day advance notice of intent of delivery, and a 48 hour notice of expected delivery date and time.

B. Equipment Storage:

1. Secure, exterior on site storage of Stainless Steel equipment shall be permitted.

2. Location shall be selected to minimize potential damage from CONTRACTOR or OWNER activities.

3. On site storage areas are limited and will probably be competing with staging. Staggered delivery of equipment when needed is suggested.
1.6 CONTRACTOR’S RESPONSIBILITY FOR COMPLETE SYSTEM

A. Storing, handling, installing, adjusting, and maintaining of OWNER-furnished products shall be the CONTRACTOR’s responsibility. Assist the Manufacturer with the pre-startup checks, and operational startup of OWNER-furnished products. Provide and coordinate the construction of interconnecting structures, equipment, piping, and appurtenances to achieve installation and operation of the OWNER-furnished products as shown and specified and as required to provide a complete and functional system.

B. Coordinate the electrical and instrumentation work with the OWNER to achieve installation and operation of the OWNER-furnished products as shown and specified and as required to provide a complete and functional system.

C. Conduct all field tests, as specified herein, and correcting all issues related to installation and testing.

D. Make field modifications to trashracks where indicated and approved by the ENGINEER.

1.7 MANUFACTURER’S RESPONSIBILITY FOR PRODUCTS

A. The Manufacturer of the equipment will be responsible for providing the following:

1. Complete manufacturer testing of equipment prior to shipment.
2. O&M manual, including installation and storage instructions.
3. Site visits required for testing and startup.
4. Inspection and acceptance of Spool and Gate installation.
5. Certification of Proper Installation.
6. List of special tools, materials and supplies furnished with equipment for use prior to and during start-up and for future maintenance.
7. Spare parts as required by their contract.
8. Training of OWNER’s personnel.
9. Trashracks delivered to site in sectional components as required by the contract with the manufacturer.

1.8 MANUFACTURER’S SERVICE REPRESENTATIVE:

A. Startup Assistance specified in Manufacturer’s Purchase contract with owner is as follows:

1. Start-up shall be provided by the manufacturer during the following periods:
   a. Two days for startup of Hydraulic Power Unit
   b. Two days for startup of the Low Level Gate.
   c. Two days for startup of the Mid Level Gate
   d. Two days for startup of the Auxiliary Level Gate
   e. Two days for startup of the Standby Generator

1.9 ENGINEER’S RESPONSIBILITY FOR INFORMATION

A. ENGINEER will make the following information available for CONTRACTOR’s use:

1. Shop Drawings of OWNER-furnished products, including revisions as they affect the installation work.
2. Manufacturer’s storage, installation, operation, and maintenance instructions for the OWNER-furnished products.

1.10 EQUIPMENT INSTALLATION

A. CONTRACTOR is entirely responsible for the ENGINEER approved method of installing the OWNER-furnished equipment.
B. Use ENGINEER approved and skilled equipment installers per this Section.

C. The equipment installation work shall include the installation of all OWNER-furnished equipment as defined in this Section, and as shown on the Contract Drawings. The equipment installed by the CONTRACTOR shall include, but not be limited to: the Spools, Gates, Hydraulic Power Unit, Trashracks, and the Standby Generator. All work associated with the equipment installation such as furnishing and installing anchor bolts, grout, steel reinforcing, field fabrications, and any required rigging or specialty work shall be performed by the CONTRACTOR. The field quality control work including the recording of all field measurements, assistance with equipment start-up, and conducting the functional and performance testing shall be performed by the CONTRACTOR. A complete history of the installation work, including all field measurements and testing information shall be provided to the ENGINEER in report form.

1.11 INSURANCE

A. Include in the insurance for Work under this Contract, sufficient coverage to protect the OWNER-furnished products against all losses during storage, handling, protection, and installation and until final acceptance of the Work by the OWNER. The OWNER and ENGINEER shall be named as additional insured(s) for this Work.

B. For purposes of this insurance coverage, the estimated value of the OWNER-furnished products is $1,400,000.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide products required to complete the Work under this Section, except where specifically specified as "OWNER-furnished." Such products include, but are not limited to, rock removal equipment, cranes, rigging materials, reinforcing steel, grout, hydraulic lines and valves, compressed air, construction specialties, and expendable materials, all as necessary to provide a complete and properly functioning system.

2.2 EQUIPMENT

A. Equipment Furnished by OWNER:

1. All owner furnished equipment as described in this Section, except for the trashracks were manufactured by:

2. OWNER-furnished equipment shall consist of the equipment described in this Section and appended in the Contract Documents.

3. The Stainless Steel Hydraulic Cylinders have been filled full of oil from the factory and the isolation valves have been closed to lock the cylinder in position.

4. The Gate Frame assembly shall be shipped with the Gate Leaf in the full open position and a steel cable attached to mechanically hold the gate in the full open position. The steel cable, the hydro-locked cylinder and gate friction snubbers should keep it in that position until the CONTRACTOR is ready for final installation and testing. If necessary, additional ENGINEER approved mechanical locking methods as required shall be provided by CONTRACTOR.

5. The OWNER-furnished equipment shall include, but is not limited to, the following:
   a. Low Level Spool and Gate:
      1) 4 feet wide X 7 feet tall (Nominal) Stainless Steel High Pressure Slide Gate with Stainless Steel Hydraulic Cylinder
2) 5 feet wide X 8 feet tall X 10 feet long (Nominal) Stainless Steel Spool

b. Mid Level Spool and Gate:
   1) 4 feet wide X 7 feet tall (Nominal) Stainless Steel High Pressure Slide Gate with Stainless Steel Hydraulic Cylinder
   2) 5 feet wide X 8 feet tall X 10 feet long (Nominal) Stainless Steel Spool

c. Auxiliary Level Spool and Gate:
   1) 8 feet wide X 8 feet tall (Nominal) Stainless Steel High Pressure Slide Gate with Stainless Steel Hydraulic Cylinder
   2) 9 feet wide X 9 feet tall X 15 feet long (Nominal) Stainless Steel Spool

d. Hydraulic Power Unit:
   1) Self contained unit complete with pumps, reservoir, switches, controls, local valving, mounted on a prefabricated skid
   2) 200 gallons of mobile DTE 11M hydraulic fluid.

e. Trashracks for each the Low Level, Mid level, and Auxiliary level.

B. Equipment furnished by CONTRACTOR, including but not limited to, the following:

1. Any appurtenant or supplemental equipment required for the spools or gates.
2. Hydraulic tubing, bubbler system tubing, grouting valves and piping, anchor bolts, grout, fasteners, mounting brackets, and accessories.
3. Any ancillary equipment not described as OWNER-furnished, but required for a complete installation.

2.3 MISCELLANEOUS PRODUCTS

A. General: Furnish incidental products as shown and as required for proper operation of equipment installed under this Section. Products shall conform to applicable Sections of these Specifications for the intended service.

B. Grout: Provide grout and grout application equipment suitable for the intended service.

C. Anchor Bolts/Rock Anchors: Provide anchor bolts, sleeves, fasteners, washers, adhesive, etc., and drilling / coring equipment needed for installation of OWNER-furnished equipment. Locate anchor bolts in accordance with Manufacturer's Shop Drawings, installation instructions and Contract Documents.

   1. Anchor Bolts shall conform to ASTM A 193, grade B8, class 2, carbide solution treated, strain hardened. The anchor bolts shall be all stainless steel construction, AISI, type 304.
      a. Minimum Ultimate Tensile Strength = 105,000 PSI
      b. Minimum Yield Strength = 80,000 PSI
      c. Size as shown on Contract Drawings
   2. Anchor Bolt Nuts: ASTM A 194, Grade 8, strain hardened, Stainless Steel, AISI Type 304.

D. Anchor Bolt Epoxy Adhesive:

   1. Two part, epoxy based, suitable for underwater installation. Water tightness provided for up to 100 psi of water pressure
   2. NSF 61 approved
   3. Bright, contrasting color, long working / gel time
   4. Compressive Strength = 12,000 PSI
   5. Tensile Strength = 6300 PSI
   6. Bond Strength = 1800 PSI
   7. Field Load Test to 20,000 PSI
8. Install per manufacturer’s instructions
9. Manufacturer: Hilti HIT RE 500 or ENGINEER Approved Substitution

E. Anchor bolt testing:
1. Provide at sample location before installation & testing actual anchors.
2. Required for 100% of the anchor bolts in field conditions after installation.
3. Filed load test to 20000 PSI.
4. Use bolt sleeve or similar apparatus to transfer the load back in the rock surface.
5. Alternatively, connect testing apparatus to opposite anchor bolts, since layout is symmetrical.
6. Apply the load to the rock anchors, either mechanically by torquing the nut, or hydraulically by use of a hydraulic jack. Nuts that are used for testing cannot be reused for the installation.

F. Anchor bolt Thread lubricant:
1. Provide per manufacturer’s recommendations.

PART 3 EXECUTION

3.1 GENERAL
A. Installation Work shall conform with Manufacturer’s recommended procedures, instructions, and Shop Drawings, as reviewed by the ENGINEER.
B. Perform all localized site surveys, shall provide demolition as required, and shall install and test all spools and gate assemblies complete per these Contract Documents.
C. Coordinate with OWNER and Manufacturer to verify equipment as installed is level and plumb, perform final equipment quality control checks.
D. The setting of the equipment by the CONTRACTOR shall be acceptable to the OWNER and Manufacturer.
E. Maintain complete inventory on all OWNER-furnished products after their transfer to CONTRACTOR.
F. Install tubing, valves, and miscellaneous fittings in accordance with Manufacturer’s instructions and appropriate Detail Drawings and Specifications.
G. Coordinate electrical connections with OWNER for proper operation of equipment.
H. The bottom assembly of a trashrack shall be placed, leveled, fully supported and grouted, and anchored prior to installing additional assemblies on top.

3.2 PRE-INSTALLATION MEETING
A. Organize and conduct a pre-installation meeting at the site with ENGINEER’s Consultants, the Equipment Manufacturer and CONTRACTOR to review general procedures, erection and installation instructions, and installation sequence.
B. Additional meetings before installation may be required, as determined by the ENGINEER or CONTRACTOR.

3.3 INSPECTION OF EQUIPMENT
A. Before transfer of OWNER-furnished products to the CONTRACTOR, CONTRACTOR and ENGINEER shall jointly inspect the condition of each product.
B. Record in writing the products transferred to the CONTRACTOR's care. Complete the Certification of Acceptable Delivery, Unloading, and Storage form included at the end of this Section.

C. Damage to or loss of equipment and materials shall be immediately reported to the ENGINEER.

D. Damage or loss of equipment and materials after the date of their transfer to the CONTRACTOR shall be repaired or replaced at the CONTRACTOR’s expense.

3.4 STORAGE AND PROTECTION

A. Following transfer of OWNER-furnished products and until final acceptance of the completed Work, protect and maintain products to prevent damage.

B. Damage to or loss of products after the date of their transfer to CONTRACTOR shall be repaired to original condition, or replaced with new identical products, as reviewed and accepted by ENGINEER.

C. The Manufacturer shall inspect the equipment for signs of deleterious effects of improper storage just before installation, and shall notify ENGINEER of the results of the inspection.

3.5 CORROSION PROTECTION

A. OWNER-furnished products will be delivered with prime and finish coats, hot-dip galvanized or stainless steel. Protect these finishes during unloading, storage, and installation.

B. Touch up or repair damage to coatings that results from unloading, storage, installation, testing, and startup in accordance with Manufacturer’s recommendations, or according to the Contract Documents. If finish coats are damaged extensively after transfer, completely repaint.

C. Touch up, repair, or complete repainting shall match color of original paint, and shall be fully compatible with primers and finish applied by equipment Manufacturer.

3.6 MANUFACTURER'S SERVICES

A. Manufacturer will provide services for the Hydraulic Power Unit Systems, including certification, training of OWNER's personnel, and startup assistance. Schedule and coordinate these services.

3.7 HYDRAULIC POWER UNIT INSTALLATION:

A. General:

1. Install the OWNER-Furnished Equipment in accordance with approved procedures submitted with the manufacturer's printed instructions and as shown, unless otherwise approved by the ENGINEER.

2. HPU skid design incorporated locations to insert forks from a pallet jack, or similar means to install through the building doorway and onto the equipment pad.

3. The HPU assembly is also furnished with 4 lifting lugs for use in transport.

B. Ancillary Connections:

1. Provide all required hydraulic line and valving connections. Coordinate all electrical work with the Electrical and I&C Contractor.
3.8 SPOOL AND GATE INSTALLATION

A. Provide supervision, labor, tools, construction equipment, incidental materials, and necessary services required to install the OWNER-furnished products.

B. Suggested sequence is intended to provide a level of detail and quality control that is required. Final means and methods are the CONTRACTOR’s responsibility.

C. Every outlined step shall require inspection by ENGINEER and ENGINEER’s Consultants. It is expected that there will be a cooperative effort towards achieving the common goal of a high quality installation.

D. Verify and coordinate proper facility shutout, lockout and tagout.

E. Based on OWNER and CONTRACTOR provided survey information, demolish the appropriate rock and supporting structures (trashracks, structural steel, or fill as required).

F. Verify proper tunnel opening and prepare spool approach area.

G. Prepare any rigging and approach / leveling / installation framework. If installation framework is used per the Contract Drawings, level the framework to the tolerances shown on the drawings. Construct in such a manner to allow the end pieces of the framework to be removed for complete grout immersion of the spool.

H. Prepare spool installation skids and leveling bolts (if used).

I. Build structural steel rebar per the Contract Drawings if applicable.

J. Install and level spool. If framework has been properly leveled, the spool should install level as well. Verify tolerances per Detail Drawings.

K. Conduct a pregrouting meeting with OWNER and OWNER’s Consultants per Grouting Specification Section. Conformance to Specifications, grouting equipment and means and methods will be discussed at the meeting.

L. Install anchor bolts and grouting manifold and valves. Every grout port shall have a valve connected to it per the Contract Drawings. At CONTRACTOR’s option, and if a possibility, the anchor bolts may be installed before or after the grouting process. All anchor bolts must be set in place with ENGINEER approved adhesive and strength tested. Test results must be submitted to ENGINEER for acceptance. The Spool shall not be used as a brace for the testing. Any anchor bolts that fail the testing must be removed, replaced, and retested. Install OWNER-furnished spare plugs following the successful installation of the anchor bolts. Use anti-seize compound on the threads.

M. Form and place grout. Grout shall be placed with the injection point at one end of the spool. Grout shall be pumped from the invert of the spool and from one end to the other. Venting provisions shall be provided per the Contract Drawings and SECTION 03 60 10.

1. The spool flange may be used with discretion as a support for the grouting forms. The flange must be protected from damage or any excessive loads from the grouting operation.

2. The spool flange contains tapped holes that accept the bronze frame to spool attachment bolts and alignment pins. These bolts must be threaded through the flange and protrude an inch or more on the downstream side of the flange. Provisions must be taken to allow the installation and removal of these bolts without interference from the grout. Propose means and methods to preclude grout in this location.
N. Allow the grout to cure per Manufacturer’s recommendations.

O. Arrange for inspection via videography by ENGINEER, MANUFACTURER and ENGINEER’s Consultants.

P. Assemble the Gate Frame Assembly onto the Spool per Manufacturer’s recommendations. The Gate Frame contains removable tapered guide pins to help with the initial installation.

1. The gate frame will need to be installed in two separate operations due to its design.
   a. Gate in the Fully Open Position:
      1) Frame-spool attachment bolts can be made on the bottom and two sides.
   b. Gate in the Fully Closed Position:
      1) Frame-spool attachment bolts can be made on the top.

2. The hydraulic power unit and related hydraulics will need to be connected and fully functional to complete the attachment of the top bolts.

Q. Install Hydraulic Tubing, Valves, and Connections.

R. Verify that the Hydraulic Power Unit has been successfully installed and tested and that the lines have been cleaned and filled with oil per SECTION 23 11 00.

S. Perform Functional and Performance Testing.

3.9 TRASHRACK INSTALLATION

A. Provide supervision, labor, tools, construction equipment, incidental materials, and necessary services required to install the OWNER-furnished products.

B. Suggested sequence is intended to provide a level of detail and quality control that is required. Final means and methods are the CONTRACTOR’s responsibility.

C. Every outlined step shall require inspection by ENGINEER and ENGINEER’s Consultants. It is expected that there will be a cooperative effort towards achieving the common goal of a high quality installation.

D. Based on OWNER and CONTRACTOR provided survey information and from visual inspection, verify that the trashrack support conditions shown in the Contract Documents do not differ appreciably from actual observed conditions. If significant differences exist, notify ENGINEER so that a solution may provided.

E. Prepare any rigging, templates, or other aids used to locate and core rock anchoring holes.

F. It is anticipated that the trashracks themselves may be used to support coring equipment. Coordinate any required modifications with the ENGINEER (if applicable).

G. The trashracks have been provided with jacking points that, in conjunction with CONTRACTOR-provided hydraulic jacks, may be used to level the lower assemblies of the trashracks.

H. One possible sequence of installation is as follows:

   1. Place the bottom assembly of the trashrack in the appropriate location. Level using the attached leveling jacks.
   2. Place grout between the rock/grout pad surface and the bearing plates as shown in the Contract Documents.
3. Core holes for rock anchor installation using the trash rack bottom assembly as a guide.
4. Place and lock in the bottom rock anchors according to the Contract Documents.
5. Pretension the rock anchors according to the Contract Documents.
6. Grout the rock anchor holes according to the Contract Documents.
7. Place and bolt the remaining trashrack assemblies as shown in the Contract Documents.
8. Using the trashracks as a mounting platform, core horizontal rock anchor holes.
9. Place and lock in the horizontal anchors, but do not pretension.
10. Connect the trashrack mounting plate to the rock anchor according to the Contract Documents. Note that the mounting plate is removable for easier access.
11. Place grout between the trashrack horizontal anchors and the rock face as shown in the Contract Documents.

I. Allow the grout to cure per grout manufacturer's recommendations before applying load.
J. Arrange for inspection via videography by ENGINEER, Manufacturer and OWNER's Consultants.

3.10 MAINTENANCE
A. Follow Manufacturer's instructions for maintenance during storage, after installation but prior to testing and startup, and after startup but prior to OWNER's acceptance.

3.11 FIELD QUALITY CONTROL
A. General: Give full access to Work by, and cooperate with, Manufacturer during testing to enable gathering of data and information necessary to evaluate performance and develop recommendations for acceptable operation and maintenance instructions.

3.12 PREPARATION
A. Cleaning and Checking: Prior to beginning functional testing:
   1. Inspect and clean equipment, devices, connecting piping, and structures to ensure they are free of foreign material.
   2. Verify all connections are tight, leak free, and stress free.
   3. Verify proper installation of Gate and proper tightening and torquing of all fasteners.
B. Ready-to-test determination will be by ENGINEER based on the following:
   1. Testing time frame and methods can be accommodated by OWNER
   2. Notification by CONTRACTOR of equipment readiness for testing.
   3. Receipt of Manufacturer's Certificate of Proper Installation.
   4. Adequate completion of Work adjacent to, or interfacing with, equipment to be tested, including items to be furnished by OWNER.
   5. Availability and acceptability of manufacturer's representative.
   6. Satisfactory fulfillment of other specified manufacturer's responsibilities.
   7. Delivery of all spare parts and special tools.

3.13 QUALITY ASSURANCE:
A. Functional Testing:
   1. General:
a. The intent of the functional testing is to ensure that all equipment is installed and connected properly and that all systems / subsystems of the Gates and Actuating Systems are ready for the performance testing.
b. The CONTRACTOR, ENGINEER, OWNER’S Consultants and Manufacturer’s representatives must be present and witness proper functional testing.
c. Following the functional testing, all parties must agree that Performance testing can commence.

2. Hydraulic Power Unit:
   a. Verify that all piping is connected, tested and stress free.
   b. Verify that all electrical connections are made and that all Instrumentation and Control is functional.
   c. Verify that emergency backup power is available and functional and that the backup hand pump is also operational.
   d. Verify that the Hydraulic Lines have been purged and cleaned and that fresh oil is introduced per Specification SECTION 23 11 00.
   e. Follow Manufacturer’s recommendations for HPU Startup Procedures.
   f. Arrange for Functional Test Meeting per this Section.

3. Spools and Gates:
   a. Verify that gates are installed level and plumb per Drawings and Specifications. Verify that all fasteners are properly installed.
   b. Verify that all grout and miscellaneous reinforcing steel and concrete has been placed. Ensure that anchor bolts have been properly installed and tested.
   c. Verify that all hydraulic tubing and valves have been connected, tested, and filled with oil.
   d. Arrange for a Functional Test Meeting with the personnel listed in this Section. Address any concerns and correct any deficiencies that are found.

4. Trashrack Rock Anchors:
   a. The vertical rock anchors at the base of each trashrack shall be tested by pretensioning to the values shown in the Contract Documents. Follow the rock anchor manufacturer’s published procedure for pretensioning using a hydraulic jack. The pretension shall be locked in by tightening the rock bolt hex nut while the anchor is tensioned to the required load. Pressure in the hydraulic jack system shall be monitored using a pressure gage. Maximum pressure and pressure at the time of lock-in shall be recorded for each vertical rock anchor. The hydraulic cylinder diameter shall also be reported. These data shall be submitted to the ENGINEER as documentation of the pretensioning process.
   b. Provide 48 hours of notice to the ENGINEER prior to pretensioning. The ENGINEER shall have the option of being present at the pretensioning to observe the procedure.
   c. Provide a means of monitoring the pressure gage used in the pretensioning process from the surface control room. The ENGINEER shall be able to observe hydraulic gage pressures during pretensioning.

B. Performance Testing:

1. General:
   a. The intent of the performance testing is to ensure that all of the OWNER-Furnished Equipment functions per the intent of the Contract Documents.
   b. The performance Testing shall be as specified in the applicable equipment Specifications. Such testing shall be performed by the CONTRACTOR assisted by the Manufacturer.
   c. Record and correct any performance.

2. Hydraulic Power Unit:
a. Initial Factory Performance Testing has been provided. Results shall be made available to the CONTRACTOR.
b. Provide field performance testing to verify that all required functions of the HPU are operational.
c. Work with Hydraulic Power Unit Manufacturer to perform the performance testing per their recommendations and procedures.
d. When operating the individual gates, adjust any pressure reducing valves, time delay relays, or any other field adjustable devices.

3. Spools and Gates:
   a. Perform individually for each of the three gates
   b. Under balanced head, begin lowering the gate. Observe the thrust nut and verify that it loses contact with the gate disc. This will verify that the neoprene stoppers are holding the weight of the disc. Coordinate with the manufacturer if adjustment is required.
   c. Under balanced head, stroke the gate for three complete open – close cycles. Measure the amount of oil used for each cycle and record the measured pressure on each the supply and return lines.
   d. Verify that all operating functions work as intended. Verify that the gate operation has a dwell period and positively stops in the full close or full open position via pressure settings in the Hydraulic power Unit.
   e. Verify with divers that the gates have smooth, vibration free operation.
   f. Provide videography showing how the gates operate during the testing.
   g. Verify that the existing air valves in the tunnel are in good working order.
   h. Once the gates are verified to perform adequately under balanced head, close the gates and slowly drain the tunnel per ENGINEER’s instructions. This operation is expected to take 48 hours.
   i. With cooperation from the manufacturer measure and quantify the water leakage past the gate, if any, by using a calibrated measuring device and a stopwatch at the outlet.
   j. Ensure that the total leakage does not exceed 0.1 gallons per minute per linear foot of gate seat.
      1) Verify the source of leakage
      2) If leakage is a result of the contractors work, correct the problem and retest.
      3) If the leakage is a result of the manufacturer’s workmanship, work with the manufacturer to correct the problem. This could require the removal and reinstallation of the gate.
   k. Under unbalanced head, and with the valvehouse discharge valves closed, open the gate to 1/2 inch open beyond seat disengagement and allow water to slowly fill the tunnel. Measure the required pressures and verify that dwell period is correctly set.
   l. Once the tunnel is filled and pressure equalized, close the gate and allow for the OWNER to slowly drain the tunnel. This operation is expected to take 48 hours.
   m. Repeat unbalanced head test, record and verify measurements.

3.14 SUPPLEMENTAL INFORMATION

A. The Supplement listed below is a part of this Specification.

1. Form: Certificate of Acceptable Delivery, Unloading, and Storage.

END OF SECTION
CERTIFICATE OF ACCEPTABLE DELIVERY, UNLOADING, AND STORAGE

To: ENGINEER

__________________________________________________________

__________________________________________________________

__________________________________________________________

Attention: ________________________________________________

Regarding: ________________________________________________

The undersigned representing ________________________________, hereinafter called the CONTRACTOR, certifies that the variable frequency drives and motors were delivered, unloaded, and stored in accordance with the recommended procedures and precautions; and accepts the transfer of the above equipment, with observed defects noted as follows (if any):

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

Signed this _______ day of _____________________, 20____.

By: _____________________________________________________
PART 1 GENERAL

1.1 SCOPE
A. This Section describes the air compressor systems required for this project.

1.2 REFERENCES
A. The equipment and Work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:

1. American Society of Mechanical Engineers (ASME): PTC 10-86, Compressors and Exhausters.
2. Institute of Electrical and Electronics Engineers (IEEE).
3. Instrument Society of America (ISA).
8. Underwriters Laboratories, Inc. (UL).

B. Standard Cubic Foot Per Minute (scfm): Volume flow rate of air at standard conditions of 60°F, 14.7 psia, and 36% relative humidity.

1.3 SUBMITTALS
A. Shop Drawings:
1. Make, model, weight, and horsepower of each equipment assembly.
2. Manufacturer's catalog information, descriptive literature, and Specifications.
3. Detailed mechanical and electrical drawings showing equipment fabrications. Include dimensions, size, and locations of connections to other Work.
4. External utility requirements such as air, water, power, and drain for each component.
5. Functional description of internal and external instrumentation and controls including list of parameters monitored, controlled, or alarmed.
6. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
7. Power and control wiring diagrams, including terminals and numbers.
8. Manufacturer's diagrams for air compressor piping.

B. Quality Control Submittals:
1. Manufacturer's recommended vibration limits of compressed air system.
2. Field performance test procedures.
3. Manufacturer's Instructions:
   a. Installation of equipment.
   b. Installation of vibration isolators.
4. Factory test reports of each test and inspection.
5. Field test reports for each functional and performance test of equipment.
7. Manufacturer's Certificate of Proper Installation for equipment.
8. O&M Manuals:
   a. Legends Abbreviation Lists.
   b. Refer to paragraph Shop Drawings for the following items:
      1) Bill of materials.
      2) Catalog cuts.
      3) Component data sheets.
4) Final as-built drawings and wiring diagrams in hardcopy and electronic (ACAD 2000) formats.
5) Factory and field certified test reports
c. Device O&M manuals for components, electrical devices, and mechanical devices shall include:
   1) Operations procedures.
   2) Installation requirements and procedures.
   3) Maintenance requirements and procedures.
   4) Troubleshooting procedures.
   5) Internal schematic and wiring diagrams.
d. List of spares and expendables required and recommended.
e. Manufacturer’s certificate of warranty.

1.4 QUALITY ASSURANCE
A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.
B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.
C. Manufacturer shall provide certificate of ISO 9002 Compliance.

1.5 PROJECT & SITE ENVIRONMENTAL CONDITIONS
A. All materials and equipment shall be designed and constructed for continuous operation, at rated current and voltage, at 7,000-ft above mean sea level, 40°C ambient and 95% relative humidity.

1.6 WARRANTY
A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.

1.7 EXTRA MATERIALS
A. Furnish, box, tag and clearly mark on exterior, (identify each item with manufacturer’s name, description and part number), for shipment and long-term storage and deliver prior to 75% Project completion the following extra materials:
   1. V-Belts: One set per compressor type.
   2. Intake Air Filter Cartridges: Three per compressor type.
   3. Fuses: A minimum of ten of each type and each current rating installed.

PART 2 PRODUCTS
2.1 EQUIPMENT
A. General:
   1. Furnish air compressors as a complete system that includes compressor, motor, controls, and accessories.
   2. Reference data sheet and schematic located at the end of this Section as a supplement and on the Drawings.
B. Oilless Scroll Air Compressors (AC-1 and AC-2):
   1. Manufacturers and Products: Atlas-Copco
2. Capacity and Schedule: Reference Contract Drawings
3. Continuous duty rated full feature oil-free scroll type including air cooled aftercooler and integral refrigerated air dryer
4. Packaged unit containing all items specified and located in a sound deadening enclosure
5. High temperature shutdown switch.
6. High pressure shutdown switch
7. Manual and electronic dirty air filter indication
8. Safety valve
9. Hourmeter
10. Internal check valve
11. Air cooled. Ventilation provided through the front and top of the unit
12. O-120 psi liquid filled pressure gauge.
14. Compressor connected to motor by V-belt drive system with guard, and convenient method of belt tensioning.
15. Capable of operating continuously at 95°F at specified output without overheating.
16. Equip with combination air intake filter silencer, Discharge air filter / separator
17. Adjustable Control Pressure: 70 psig to start and 110 psig to stop
18. Motor: Refer to Induction Motor Data Sheet.
19. Aftercooler:
   a. Compressor mounted.
   b. Air to air heat exchanger.
   c. Capacity to match air compressor.
   d. Locate moisture separator downstream of after-cooler and include automatically trapped drain.
20. Refrigerated Air Dryer:
   a. Integral component of the compressed air package.
   b. R134a refrigerant.
   c. Capacity to match that of compressor
   d. 115V single phase power.
   e. Dewpoint temperature gauge

C. Combination Separator/Air Filter:
1. Two required – one mounted on each compressor discharge.
2. Remove liquid and solid particles down to .01 microns.
3. Two Stage.
5. Automatic drain trap for removing collected compensate.

D. Receiver Tank (RT-1)
1. Vertical welded steel receiver bearing ASME code stamp and with inspection openings.
4. Safety relief valve set for 150 psig.
5. Pressure gauge with gauge cock.
6. Automatic 120 Volt condensate drain valve with isolation valve.
7. Manual blowdown valve located at low point in receiver.
8. NPT threaded fittings for shop air connections
9. Overall Diameter: 1 foot 6 inches or less.
11. Weight: 110 pounds
12. Manufacturer and Schedule: Reference the Contract Drawings

E. Accessories:
1. Air Hose:
2. Anchor Bolts:
   a. Zinc plated – sized per manufacturer

3. Vibration isolators:
   a. Neoprene pads designed per manufacturer

4. Flexible Discharge Connection:
   a. Braided Stainless Steel construction
   b. 250 psi rated
   c. Manufacturer and Product: U.S. Flex; BMH.

5. Safety Valve:
   a. Fabrication: Bronze body, bronze base, disc with steel spring, top outlet, and malleable iron lifting lever.
   b. In accordance with ASME Code for Unfired Pressure Vessels.
   c. Set to relieve at 150 psig and relieve full capacity of 20 scfm.

6. Automatic Drain Valve:
   a. Located on receiver tank.
   b. Electronic drain, manual blow down valve, strainer ball valve.
   c. Automatic operation 115V electrical requirement.

F. Electrical, Instrumentation and Control:

1. Related Sections: The Electrical Drawings and the following sections expand on the electrical, instrumentation and control requirements of the Compressed Air System and this Section.
   a. SECTION 40 90 00.
   b. DIVISION 26, including but not limited to:
      1) SECTION 26 05 10.
      2) SECTION 26 05 19.
      3) SECTION 26 05 26.
      4) SECTION 26 05 33.

2. Provide all functions and components necessary for a complete, operational system of controls that provide the specified performance and functionality, as indicated in the Contract Documents and as recommended by the Manufacturer. Provide all items of an incidental nature which may be necessary for proper system operation and performance.

3. Provide the Compressed Air System local control panel LCP-AC and devices, as indicated on the Electrical Contract Drawings. The LCP shall be provide and installed by the Generator Instrumentation and Controls Systems (GICS) Contractor.

4. The Compressed Air System manufacturer shall provide a recommended sequence of operation in an automatic and manual mode and coordinate with the Generator Instrumentation and Controls Systems (GICS) Contractor to provide an LCP-AC and control requirements required for a complete operational system, as intended by the Contract Documents and as approved by the ENGINEER. The system manufacturer shall review the sequence of operation, GICS provided and installed equipment and certify proper operation and compliance with the manufacturers recommendations.

5. Alarms and control instruments: The following devices shall be provided as a minimum and mounted on the system equipment as listed below. The devices shall be suitable to perform the indicated function directly or through auxiliary devices in the generator control panel (GCP). Protective devices shall meet the requirements of SECTION 40 90 00.
   a. PS3 – High pressure shutdown
   b. TS1 – High air temperature shutdown
   c. dPF – differential pressure filter - dirty filter.

6. Controls, also reference Electrical Contract Drawings:
a. HOA switches on each air compressor.
b. Air compressor 1/ Alternate / Air compressor 2 selector switch.
c. Automatic high air temperature shutdown with indicating light.
d. Air compressor overload with indicating light.
e. Local Control Panel: Mount in accessible location on the air compressor
   unit as indicated on the Drawings and as approved by the ENGINEER.
f. Control Components: Operate on 125VDC power supply, except air
dryer and automatic drain valve that operate on 120 VAC, single-phase,
60-Hz.

G. Lifting Lugs: Provide suitably attached for equipment assemblies and components
weighing over 100 pounds.

H. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate
securely mounted on each separate equipment component and control panel in a readily
visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled
equipment identification number and letters indicated in this Specification.

2.2 HOP/FACTORY FINISHING
A. Prepare, prime, and finish coat in accordance with SECTION 09 90 00.

2.3 SOURCE QUALITY CONTROL
A. Factory Inspections: Inspect equipment for required construction, electrical connection,
and intended function.

PART 3 EXECUTION

3.1 INSTALLATION
A. General: Install equipment on vibration isolators in accordance with manufacturer's
instructions.

1. Piping: Equip with full-size flexible discharge connection and isolation valve.
   Piping details are shown on the Contract Drawings

B. Air Compressor Piping:

1. Install in accordance with manufacturer's piping diagrams.
2. Pipe relief valve, tank drain, and separator drain to common field determined
   location for collection in 5 gallon bucket.

3.2 FIELD QUALITY CONTROL
A. Functional Tests: Conduct on each piece of equipment in the system.

3.3 SUPPLEMENTS
A. The supplement(s) listed below, following "END OF SECTION," are a part of this
   Specification.

1. Data Sheets: Induction Motor Data Sheet.

END OF SECTION
### INDUCTION MOTOR DATA SHEET

<table>
<thead>
<tr>
<th>Project: Cheesman Dam Upstream Control Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner: Denver Water</td>
</tr>
<tr>
<td>Equipment Name: Air Compressors (AC-1 and AC-2)</td>
</tr>
<tr>
<td>Equipment Tag Number(s):</td>
</tr>
</tbody>
</table>

**Type:** Squirrel-cage induction meeting requirements of NEMA MG 1

**Manufacturer:** For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer

**Hazardous Location:** Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark

- **Motor Horsepower:** 5
- **Guaranteed Minimum Efficiency at Full Load:** 90 percent
- **Voltage:** 230
- **Guaranteed Minimum Power Factor at Full Load:** 80 percent
- **Phase:** 1
- **Service Factor (@ rated max. amb. temp.):** □ 1.0 □ 1.15
- **Frequency:** 60
- **Synchronous Speed:** 1,800 or 3,600 rpm
- **Enclosure Type:**
- **Mounting Type:** □ Horizontal □ Vertical
- □ Multispeed, Two-Speed:
  - □ Vertical Shaft:
    - □ Solid
    - □ Hollow
  - □ Vertical Thrust Capacity (lb):
    - □ Up
    - □ Down
- □ Constant Horsepower
- □ Variable Torque
- □ Constant Torque
- □ Adjustable Speed Drive:

**Operating Speed Range:** _____ to _____% of Rated Speed

- **Winding:** □ One □ Two
- □ Thermal Protection: ________________________
  - □ Space Heater: _____ volts, single phase
  - □ Oversize main terminal (conduit) box for motors
  - □ Terminal for connection of equipment grounding wire in each terminal box

**Additional Motor Requirements:** □

**Special Features:** Class F insulation.
SECTION 23 05 00
COMMON WORK RESULTS FOR MECHANICAL

PART 1  GENERAL

1.1 SCOPE OF WORK
   A. This Section includes general administrative and procedural requirements for the
      construction and installation of mechanical systems.

1.2 QUALIFICATIONS
   A. The Mechanical Systems Subcontractor for the Hydraulic Lines, and Mechanical Systems
      installation work shall have no less than 10 years of experience working on industrial
      projects of a similar scope and size. The Mechanical Subcontractor shall employ and
      use skilled and experienced personnel conforming to the qualifications of the individual
      Specifications.

1.3 REFERENCE STANDARDS
   A. Comply with the requirements of the latest edition of the referenced standards noted
      herein, except where more stringent requirements are listed herein or otherwise required
      by the Contract Documents.
   C. International Mechanical Code (IMC).
   D. International Plumbing Code (IPC).
   E. Jefferson County Amendments to International Codes.
   F. National Electric Code (NEC).
   G. National Fire Protection Association (NFPA).
   I. American Society of Mechanical Engineers (ASME).

1.4 REGULATORY REQUIREMENTS
   A. Conform to NFPA 90A, Installation of air conditioning and ventilating systems.

1.5 LOCAL CONDITIONS
   A. Examine site and staging area. Become familiar with existing local conditions affecting
      work, such as access, obstructions, altitude, weather conditions, necessary cutting,
      excavating or filling, before submitting proposal. No allowance will be made by reason of
      any misunderstanding with respect to existing site conditions.

1.6 PERMITS, LICENSES, FEES, AND INSPECTIONS
   A. Obtain, pay for, and maintain all required permits, licenses, and certificates of inspection.
1.7 QUALITY ASSURANCE
A. Products, materials, testing and systems shall comply with the following:
   1. Welder's Qualifications: Submit qualifications for the welder to the OWNER for review.
   2. Steel Support Welding:
      a. Qualify processes and operators according to AWS D1.1, “Structural Welding Code – Steel”
   3. Steel Pipe Welding:
      a. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications”
   4. Soldering and brazing procedures:
   5. Identify pipe with marking on pipe, including size, ASTM material, class, ASTM Spec., and pressure rating.

B. Quality Control Submittals: Welders’ certificates and procedures are required per Quality Assurance above.

1.8 SUBMITTALS
A. Provide submittal data as per SECTION 01 33 00 and individual Specification Sections prior to purchasing equipment or starting installations:
   1. Failure to submit any item required to be submitted may cause that item to be rejected and replaced at CONTRACTOR's expense, even if CONTRACTOR has provided an equivalent.

1.9 PRODUCT STORAGE AND HANDLING
A. Provide for proper storage of all of the materials and equipment and assume complete responsibility for losses due to any cause. All equipment and materials must be stored out of the elements: any item which has become rusted from exposure to the elements will not be permitted to be used.

1.10 DRAWINGS AND SPECIFICATIONS
A. The Drawings are diagrammatic in character indicating the design concept and do not indicate every required piping offset, valve, fitting, etc.
B. All drawings together with these Specifications shall be considered in bidding and construction. The drawings and Specifications are complementary, and what is called for in either of these shall be binding as if called for by both. Bring any conflict to the attention of the ENGINEER for resolution.

1.11 RECORD DOCUMENTS
A. Provide Record Documents in accordance with the requirements of SECTION 01 77 00.

1.12 GUARANTEE
A. Guarantee all materials, workmanship and the successful operation of all equipment and apparatus installed for a period of one year from the date of the final acceptance of the entire work and shall guarantee to repair or replace at his own expense any part of the apparatus which may show defect during that time, provided such defect is, in the opinion
of the OWNER due to imperfect material or workmanship and not due to carelessness or improper use.

B. Longer periods of guarantee shall be provided where customary for the piece of equipment or system installed. If the manufacturer’s warranty is longer than one year, it shall be used and copies of warranty be provided to OWNER.

1.13 SCAFFOLDING, RIGGING, AND HOISTING

A. Furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus to be furnished. Remove the same from the premises when no longer required.

1.14 QUIET OPERATION

A. All equipment shall operate under all conditions of loading without any sound or vibration which is objectionable in the opinion of the ENGINEER. In the case of moving machinery, any sound or vibration noticeable inside of the occupied space or excessive noise and/or vibration inside the equipment room will be considered objectionable and will require correction at no cost to the OWNER.

1.15 ACCESSIBILITY

A. The adequate clearance for the proper installation of the work shall be the CONTRACTOR’s responsibility. The Mechanical Contractor shall cooperate with the CONTRACTOR and all other subcontractors whose work is in the same space and shall advise the CONTRACTOR of his requirements. All such spaces and clearances shall be to the size required.

B. The Mechanical Contractor shall locate all equipment which must be serviced, operated or maintained in fully accessible positions. If required for accessibility, he shall furnish access doors, etc., for this purpose. Minor accessibility and any changes for accessibility shall be approved by the ENGINEER prior to making the change.

C. The Mechanical Contractor shall provide the CONTRACTOR with the exact locations of access panels for each concealed valve, control damper, or other device requiring service. Locations of these panels shall be submitted in sufficient time to be installed in the normal course of work.

1.16 ALTITUDE CORRECTION

A. All air moving equipment shown on the Drawings, and specified herein, shall be at the operating altitude of 6900 feet. The manufacturer and/or supplier shall make whatever adjustments are necessary to deliver the specified CFM. The manufacturer and/or supplier shall provide at no cost to the OWNER any sheaves or motors required to produce the specified capacities at the operating altitude.

PART 2 PRODUCTS

2.1 IDENTIFICATION

A. Equipment Labels:

1. Metal Labels for Equipment:
   a. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   b. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   c. Minimum Letter Size: 1/4 inch for name of units. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   d. Fasteners: Stainless-steel rivets or self-tapping screws.
e. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

C. Pipe Labels:

1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
2. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
4. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   a. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   b. Lettering Size: Match pipe diameter

D. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

E. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. Workmanship shall be first rate. The finished appearance of the mechanical work is of equal importance as its mechanical efficiency.

B. All work shall be done in accordance with good commercial practices.

C. Install all materials in accordance with manufacturer’s recommendations and the governing codes.

3.2 ROUGH IN

A. Final locations for rough-ins are to be verified with field measurements and with the requirements of the actual equipment to be connected.

B. Rough-in requirements should be included in the equipment criteria in the technical sections of the manuals.
3.3 CLEARANCE FROM ELECTRICAL EQUIPMENT

A. Provide clearance above and not locate any mechanical equipment or piping within 3 feet of:

1. Transformers
2. Equipment control panels and disconnects
3. Switchgear
4. Switchboards
5. Motor control centers
6. Motors, except for branch piping to driven equipment

B. Electrical panels, controllers, motor control centers, disconnects, and similar equipment which can be opened to expose energized parts must, without exception, have working clearances as specified in the latest edition of the National Electrical Code. All piping, ductwork, equipment, and auxiliary items installed shall be configured, routed and located so as to maintain the required clearances.

3.4 SUPERVISION

A. The Mechanical Foreman or Superintendent shall be responsible for the work of all subcontractors working under him and all questions or directions shall be routed through him.

3.5 PREPARATION

A. The required preparation of piping for installation shall include the following procedures:

1. Ends of pipes and tubes shall be reamed to remove burrs; plain ends of steel pipe are to be beveled.
2. Scale, slag, dirt, and debris shall be removed from inside and outside of piping and fittings before assembly.

3.6 GENERAL MECHANICAL INSTALLATIONS

A. General: It is the responsibility of the CONTRACTOR to sequence, coordinate and integrate the various elements of mechanical systems, materials, and equipment. Compliance with the following is required:

1. Coordination of mechanical systems and material installation with other structure components and systems.
2. Coordinate interface between mechanical and electrical work before submitting any equipment for review or commence installation.
3. All dimensions shall be verified by field measurements.
4. Coordination of the installation during construction of required supporting devices and sleeves which are to be cut into concrete and other structural components.
5. The sequencing, coordination and integration of installations of mechanical materials and equipment for efficient flow of the Work.
6. Where mounting heights are not to be specifically detailed or dimensioned, systems, materials, and equipment are to be installed so as to provide the maximum headroom possible.
7. Coordination of connection of mechanical systems with any utilities and services.
8. Systems, materials, and equipment installation to conform with approved submittal data, to greatest extent possible. Conformance is required to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, conflicts are to be referred to the OWNER’s representative.
9. Systems, materials, and equipment are to be installed level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

3.7 PIPE INSTALLATION

A. General Locations and Arrangements: Contract Drawings indicate the general location and arrangement of the piping systems. The location and arrangement of piping layout shall take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations.

B. Installed piping shall be free of sags or bends and with ample space between piping to permit proper insulation applications.

C. Piping shall be installed in shoes and guides mounted tight to support steel, concrete trenches, beams, joists, columns, walls, and other permanent elements of the building.

3.8 FITTINGS AND SPECIALTIES

A. Fittings are required for all changes in direction and all branch connections, except on welded piping.

B. New materials shall be provided for remaking leaking joints.

C. Unions are required adjacent to each control valve, and at the final connection to each piece of equipment and plumbing fixture having 2 inches and smaller connections, and elsewhere as dictated by good practice.

D. Flanges are required in piping 2-1/2 inches and larger, where required, adjacent to each valve, and at the final connection to each piece of equipment.

3.9 CUTTING AND PATCHING

A. Protection of Installed Work: During cutting and patching operations, protection of adjacent installations is required.

B. Cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed Work.
2. Remove and replace defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Uncover and restore Work to provide for observation of concealed Work upon written instructions from the OWNER's representative.

3.10 FINAL OBSERVATION

A. All work under the Contract shall be completed and all systems shall be in proper working order and placed in operation.

B. All equipment shall be cleaned. All debris and construction materials shall be removed from the premises.

END OF SECTION
PART 1 GENERAL

1.1 SCOPE

A. This Section specifies the procedure for the HVAC systems testing, adjusting and balancing.

B. The main intent of this Specification Section is to document performance of HVAC components and correct any deficiencies that are found.

C. Testing, Adjusting and Balancing is required for all HVAC Components and the Standby Generator.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

3. Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA): 
   b. HVAC Air Duct Leakage Test Manual.

1.3 SUBMITTALS

A. Quality Control Submittals:

1. Qualifications and experience record of air balancing and test agency.
2. Written verification of calibration of testing and balancing equipment.
3. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.4 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.
3. Certified by a national balancing association.
4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing and inspecting HVAC equipment and systems.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Calibrate test instruments to a recognized standard before beginning the Work.
B. Adjust and balance air systems in accordance with standard procedures and recognized practices of the Associated Air Balance Council or SMACNA “HVAC Testing, Adjusting, and Balancing Manual.”

3.2 ADJUSTING AND BALANCING AIR SIDE

A. Measure fan system performance in accordance with AMCA 203. Include measured and rated:
   1. Flow
   2. Inlet and outlet pressures
   3. Motor RPM and Drive RPM
   4. Voltage
   5. Current

B. Adjust and correct any deficiencies found with allowable variation of +10%/-0%.

C. Adjust Fan Air Volumes:
   1. After final adjustments, do not operate motor above nameplate amperage on any phase.
   2. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust.
   3. Provide and make drive changes on motors or fans as required to adjust equipment to specified conditions. Provide written notice to the equipment manufacturer and ENGINEER if drive changes were made.
   4. Correct fan and airflow adjustments for the site elevation.

D. Adjust terminal devices for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.

3.3 FIELD QUALITY CONTROL

A. General: Perform functional tests as required by SECTION 01 75 16.

B. Balancing Log Report Requirements:
   1. Log and record information from every test, reading, and adjustment necessary to accomplish the services described. In addition, record the following data:
      a. Equipment identification number.
      b. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
      c. Motor data (frame, hp, volts, FLA and rpm).
      d. Starter and heater data.
   2. Include a reduced set of HVAC Drawings in the balance log showing the final air and water flow readings for each system.
   3. Indicate the recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
   4. Include a separate section in the log, if necessary, that describes operating difficulties in the air or water systems that could not be eliminated by the specified procedures. Identify these problems by system and location within the building, include an outline of a summary of the condition and its effect on the building, and describe corrective actions attempted.
   5. After readjustment for vibration, measure and record the displacement only of the readjusted equipment to determine its conformance with the design.
C. Quality Control Verification: After adjustments have been completed and the balance logs submitted, the balancing and testing agency shall be available to demonstrate the air and water balancing procedures and vibration tests, and verify the test results.

1. Perform spot tests with measuring equipment used in the original tests, at random points selected by ENGINEER.
2. Results of these spot tests shall agree with the balance logs within ±10%. Where this accuracy cannot be verified, rebalance portions of the system as requested by ENGINEER.
3. At completion of the rebalance procedures, perform another spot test if required to verify those results.

END OF SECTION
SECTION 23 09 00
HVAC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: HVAC controls.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:


1.3 SYSTEM DESCRIPTION

A. Description:

1. Control Type: Design and provide electric control system with supplementary electric or electronic devices as required.
2. Control Narrative:
   a. Reference Contract Drawings
3. Control Room will have heating, humidity control, and cooling (provided by ventilation), subject to constraints of the outside air temperature.
4. Generator Room will have heating and cooling (provided by ventilation), subject to the constraints of the outside air temperature.

B. Performance Requirements: Design system and equipment to perform under the following conditions:

1. Temperature, Indoor:
   a. Heated and Cooled Control Area:
      1) Summer maximum 85°F.
      2) Winter minimum 55°F.

C. Design Requirements:

1. Provide controls necessary for the entire system to have fail-safe operation.
2. Interface controls properly with factory supplied components of the mechanical systems. Coordinate special control interfacing requirements.
3. For equipment specified that requires special interfacing with the control system, provide equipment with integral controls necessary to operate properly with this control system, or provide accessory devices required for operation of the total mechanical system.

1.4 SUBMITTALS

A. Shop Drawings:

1. Complete Specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions of equipment, and electrical schematics, for all control system components.
2. Complete system power, interlock, control, and data transmission wiring diagrams no smaller than 11 inches by 17 inches in size.
3. Complete drawings and schematics of proposed control system, including panel power requirements.

B. Quality Control Submittals:
1. Recommended procedures for protection and handling of equipment and materials prior to installation.
2. Manufacturer's Certificate of Proper Installation.
3. Experience and qualifications of Controls Supplier.
5. Detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt the arrangement or details shown to the equipment and materials furnished.

C. Contract Closeout Submittals:
1. Record Documents: Complete as-built wiring diagrams.
2. Recommended spare parts list:
   a. Quantities and replacement frequency.
   b. Current list prices, valid for 90 days after Substantial Completion.
   c. Availability and nearest distributor.
3. Record of system adjustments.

1.5 QUALITY ASSURANCE
A. Qualifications of Controls Supplier: Capable of furnishing factory trained technicians, competent to provide instruction, routine maintenance, and emergency service on the site within 48 hours after receipt of request.
B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.

1.6 PROJECT & SITE ENVIRONMENTAL CONDITIONS
A. All materials and equipment shall be designed and constructed for continuous operation, at rated current and voltage, at 7,000-ft above mean sea level, 40°C ambient and 95% relative humidity.

1.7 WARRANTY
The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.

PART 2 PRODUCTS
2.1 CONTROL SYSTEM COMPONENTS
A. Control voltage shall not exceed 30 volts, except in starter pilot circuits.
B. Furnish components from the same manufacturer, unless a specific manufacturer is specified.
C. Master Thermostat:
   1. One required for control room, one required for generator room
   2. Programmable, digital, two stage heating and cooling.
3. Thermostat shall be Honeywell T7300.
4. Subbase shall be Honeywell Q7300B.
5. Or ENGINEER approved substitute.

D. Supporting Control Components:
1. Reference the Electrical Contract Drawings

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION
A. Mount room thermostat level and bottom 5 feet above the floor.
B. Conceal control wiring where possible; install exposed wiring to be as unobtrusive as possible.
C. Nameplates: Provide engraved laminated plastic adjacent to the following control devices, and for equipment whose function is not readily apparent, as per the electrical drawings.
D. Create a label explaining proper operation and current settings for all devices in the control system. Laminate and mount label on the thermostat control panel in visible area.

3.2 MANUFACTURER'S SERVICES
A. Provide manufacturer's representative at site for 1/2 person day for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of OWNER's personnel for specified control system.

3.3 ADJUSTING AND CALIBRATING
A. Inspection:
   1. At the completion of the Work, thoroughly check out the entire control system by simulating each control function to determine that the system performs in accordance with the Specifications.
   2. Advise OWNER and ENGINEER accordingly in writing.
   3. Upon notice from ENGINEER, assist ENGINEER in making a review and operating check of the control system.
B. Adjust and calibrate the entire control system.
C. Calibrate control devices at time of installation to ensure measuring and reading accuracy.
D. Prepare a complete record of system adjustments for each air supply system and miscellaneous control system. Indicate deviations from the specified temperatures.

END OF SECTION
1.1 SUMMARY

A. This Section describes the Hydraulic Tubing that will be installed from the connections at the Hydraulic Power Unit to the Gate Cylinders.

B. The tubing shall run inside mechanical trenches, inside tunnel bores, and finally, surface mounted to rock, before being connected at the gate cylinders.

C. Portions of the work may be performed in the dry, and portions of the work will need to be performed submerged in water in a depth over 200 feet.

D. The life expectancy of the tubing is expected to be greater than 100 years, so extreme care needs to be used to not contaminate the tubing with any corrosive material, including carbon steel.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section and any supplemental Data Sheets:

1. American National Standards Institute (ANSI):
   b. B16.25, Butt Welding Ends.
   c. B16.11, Forged fittings, socket welding and threaded

2. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessels.
   b. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
   c. B 31.1, Power Piping.
   d. B 16.11, Forged fittings, socket welded and threaded

   c. A 269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
   f. A 380, Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems
   g. A 774/A 774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

   a. D1.1, Structural Welding Code—Steel.
   b. QC 1, Standard for AWS Certification of Welding Construction Project
   

      Construction Project Inspectors.
5. International Organization for Standardization (ISO)
   a. ISO 6162-1 Hydraulic Fluid power Flange Connections with split or one-piece flange clamps and metric or inch screws
   b. ISO 8434-3, Metallic Tube Connections for Fluid Power and General Use – O-Ring Face Seal Connectors
   c. ISO 4572, Multi-pass Filter Performance beta test

1.3 DEFINITIONS

A. Hydraulic Lines (Hyd): fluid power transmission tubing for the purpose of transferring high pressure fluid from the Hydraulic power Unit to the Gate Cylinders and back.

B. Submerged or Wetted: Service is partially or completely immersed in water with a depth of up to 200 feet

C. Embedded: Embedded in the walls or slabs of concrete structures.

D. Exposed:
   1. Aboveground.
   2. Inside structures including vaults and buildings.
   3. Below water, but not encased.

E. Standard Specifications: When referenced in this Specification shall mean the latest version thereof.

F. Descaling: The removal of heavy, tightly adherent oxide films resulting from hot-forming, heat treatment, welding, and other high-temperature operations

G. Pickling: Chemical descaling

H. Passivation: Removal of exogenous iron or iron compounds from the surface of a stainless steel by means of a chemical dissolution, most typically by a treatment with an acid solution that will remove the surface contamination, but will not significantly affect the stainless steel itself

I. OD: Outside diameter

J. ORFS: O-ring Face Seal

K. Psi: Pounds per square inch

1.4 DESIGN REQUIREMENTS

A. Piping and valves:
   1. Provide specified performance with a minimum safety factor of 4 against bursting above the rated service

1.5 SUBMITTALS

A. Shop Drawings:
   1. Detailed material Specifications and catalog literature proving conformance with Specifications for every component in the system
   2. Detailed material construction drawings
   3. Layout drawings showing proposed details of installation
      a. Provide Details of bends and fittings required
      b. Show locations where mechanical fittings or welded connections are proposed
c. Show proposed support and installation methods

B. Quality Control Submittals:

1. Manufacturer's Certification of Compliance.
2. Qualifications:
   a. Welders:
      1) List of qualified welders and welding operators.
      2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
   b. Weld Procedures: All welders and welding procedures shall be prequalified under provisions of AWS D1.1. and ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
3. Nondestructive inspection and testing procedures.
4. Hydrostatic test results, where applicable.
5. Method of making up mechanical fittings

1.6 QUALIFICATIONS

A. Welder and Welding Operator Qualifications:

1. Qualified by accepted inspection and testing agency before starting work in accordance with AWS D1.1 and ASME Boiler and Pressure Vessel Code.
2. Qualified to perform groove welds in position 6G for each welding process and pipe material specified.
3. Retesting: Upon ENGINEER's written request, retest qualified welder(s).

1.7 DELIVERY, STORAGE, AND HANDLING

A. General:

1. All tubing and related components shall be stored in a dry, temperature and humidity controlled environment free from dirt or other contaminating material until ready for installation.
2. Fresh rubber gloves shall be worn whenever handling the tubing
3. Any type of contact with carbon steel or carbon steel residue is to be strictly avoided. Do not use any tools that are also used with carbon steel.
4. Flanges: Securely attach metal, hardboard, or wood protectors over entire surface.
5. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.

1.8 WARRANTY

A. All equipment and materials shall be covered under a full one-year warranty commencing 18 months from the date of delivery, or one year from the date of installation, whichever is greater

PART 2 PRODUCTS

2.1 HYDRAULIC TUBING (HYD)

A. Tubing Specifications:

1. Weldable Seamless Stainless Steel Tubing, meeting the requirements of ASTM A 269, Type 304L or 316L
2. Heat treated and annealed
3. Pickled and passivated per ASTM A 380
4. Ability to field cold bend to a radius of three times the tube diameter
5. Ability to be field cold reformed using proprietary forming machines to make up specified fittings
6. Dimensionally accurate to +/- .005 inches for OD, and ±10% for wall thickness

B. Size and Pressure Rating:
   1. One inch OD X 0.148 inch wall thickness for all
   2. Rated pressure = 6300 psi

2.2 JOINTS

A. Welded:
   1. Socket Welded joints are to be provided in all inaccessible areas where the procedure can be performed in the dry, including the tunnel bores
   2. Welding procedure per ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
   3. Perform per the intent of ASME B 16.11
   4. Visual and Non-Destructive testing required on all welded joints
   5. Joint connector material to match tubing

B. Flanged Joints:
   1. Flanged joints to be provided for connections to valves and equipment and as shown in Contract Drawings
   2. SAE 4 Bolt with captive O-Ring seal,
   3. Forged Stainless Steel – ASTM A 276, type to match tubing and fittings
   4. Conforms to ISO 6162-1, Code 61, 3000 psi rated
   5. Ends to match adjoining tubing (Socket Weld, or O-Ring Face Seal)
   6. Stainless steel fasteners provided through drilled holes
   7. Manufacturer: Parker Hydraulics or Engineer approved substitution

C. Mechanical Joints:
   1. Mechanical joints to be provided where Socket Welded Joints are impractical, such as underwater. Tubing that will be accessible in the dry (such as the piping trenches) can be fitted with mechanical or socket welded joints at the CONTRACTOR’s option.
   2. O-Ring Face Seal (ORFS) with captive elastomeric O-Ring
   3. Forged Stainless Steel construction – ASTM A 276, type to match tubing and fittings
   4. Conforms to ISO 8434-3,
   5. Flat faced flange to be created in adjoining tubing with proprietary flanging machine. Welding or brazing is not allowed
   6. Manufacturer: Parker Hydraulics O-Lok, or Engineer approved substitution

2.3 VALVES FOR HYDRAULIC SYSTEM (V-305)

A. Extreme Duty 1/4 turn Ball Valves – suitable for continuous submergence under 225 feet of water. Manufacturer to provide statement of compliance

B. Size and Rating: one inch, 6000 psi nominal

C. All Forged Stainless Steel construction – ASTM A 276, type to match tubing and fittings

D. Block Body, SAE 4 Bolt Code 61 Companion Flanges.

E. Valve designed to be independently bolted to mating flanges to facilitate removal of connected equipment. Sandwiched, or wafer style valves are not acceptable.
F. Elastomer O-ring and backup ring seals at stem connections

G. Delrin ball seal

H. Manufacturer and Model: Delaware Manufacturing Industries Corporation (DMIC), BVH-1000FM-2211.

2.4 CUSTOM SPACER – SLIDERS

A. General:
1. Use spacer – sliders or other ENGINEER approved method to install the piping assemblies through the bore holes
2. The intent is to construct the assembly on land in the dry while the assembly is being installed through the tunnel bores.
3. Assembly to be stainless steel and custom designed by supplier:
   a. Provide rigid framework for installing up to 400 feet of piping
   b. Dielectrically insulate piping
   c. Ability to be grouted in place after installation

B. Design Requirements:
1. Calculations, drawings, and material submittals to prove conformance
2. Manufacturer must have 10 plus years in providing custom spacer assemblies

C. Size, Dimensions and Layout:
1. Custom designed – reference Contract Drawings for the design intent

D. Specifications:
1. Band:
   a. Fourteen gauge or thicker ASTM A 276 Type 304 or 316 Stainless Steel.
   b. Removable sections required for piping installation
   c. Minimum 8 inches wide.
2. Liners:
   a. Flexible PVC construction
   b. 0.09 inch thick or greater with durometer “A” 85-90 hardness and a minimum 58,000 volt dielectric strength.
3. Runners:
   a. Provide securely attached runners at a minimum of four quadrants designed to help slide the assembly through the bore holes.
   b. Material: Glass reinforced polymer
   c. Size: 2 inches wide X one inch tall with length to match band.
   d. Tapered on both ends to provide efficient sliding
   e. Low Coefficient of friction (submerged in water). Provide design calculations showing the required installation force.
   f. Tensile Strength = 17,600 psi minimum
   g. Flexural strength: 25,300 psi minimum
   h. Compression strength: 18,000 psi minimum
   i. Recessed fasteners installed below the wearing surface, and filled with a corrosion inhibiting filler
4. Studs, nuts, and Washers:
   a. Stainless steel for all
5. Manufacturer: Pipeline Seal and Insulator (PSI)

2.5 PIPE SPACER MATERIAL

A. Custom stamped / machined per Contract Drawings.
2.6 MOUNTING CHANNEL
A. Twelve gauge stainless steel, 1-5/8 inches X 7/8 inch.
B. Ability to accept clamps and be rigidly attached to mounting surface through predrilled holes in channel.
C. Manufacturer: Tyco Unistrut.
D. Style: Reference Contract Drawings.

2.7 TUBING CLAMPS
A. Stainless Steel construction – compatible with channel.
B. Thermoplastic elastomer cushion. Ability to withstand submerged service indefinitely.
C. Ability to hold piping weight plus a safety factor of 4.
D. Stainless steel hardware.

PART 3 EXECUTION

3.1 WORKMANSHIP
A. Provide layout and installation to the highest workmanship standards. The visual appearance is as important as the functional ability.

3.2 EXAMINATION
A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing tubing to be connected to new tubing or new equipment.
B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.
C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.3 LAYOUT
A. Run all tubing level and true. Anticipate bends and offsets and make these by bending the tubing where practical
B. Minimize the number of joints

3.4 PREPARATION
A. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
3.5 WELDING

A. Perform in accordance with ASME Boiler and Pressure Vessel Code for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.

B. Visual Inspection and Non-Destructive testing shall be required on 100% of the hydraulic tubing welds.

C. All tools in contact with stainless steel shall only be in contact with stainless steel. Do not contaminate with other metals.

D. Weld Identification: Mark each weld with symbol identifying welder.

E. Pipe End Preparation:
   2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.

F. Surfaces:
   1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
   2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
   3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

G. Alignment and Spacing:
   1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
   2. Root Opening of Joint: As stated in qualified welding procedure.
   3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or one inch, whichever is greater.

H. Climatic Conditions:
   1. Do not perform welding if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32°F.
   2. Stainless Steel and Alloy Piping: If the ambient is less than 32°F, local preheating to a temperature warm to the hand is required.

I. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures. Remove tack welds prior to placing permanent weld.

J. Surface Defects: Chip or grind out those affecting soundness of weld.

K. Weld Passes: As required in welding procedure.

L. Weld Quality: Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.
3.6 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Couplings:
   1. General:
      a. Install in accordance with manufacturer's written instructions.
      b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
      c. Remove pipe coating, if necessary, to present smooth surface.

D. Penetrations:
   1. Watertight Penetrations:
      a. Provide wall pipes with thrust collars.
      b. Provide taps for stud bolts in flanges to be set flush with wall face.
   2. Nonwatertight Penetrations:
      a. Pipe sleeves with modular mechanical seal may be provided where fabrication of seep ring on pipe sleeve is impractical.

3.7 INSTALLATION-EXPOSED TUBING

A. Exposed tubing includes the tubing that will be run inside the building mechanical trench and also surface mounted to the rock underwater.

B. Piping Runs:
   1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
   2. Provide long runs or expansion loops on connection to equipment to allow for vibration

C. Supports: Provide spacing as shown on the Contract Drawings

D. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

E. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

F. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

3.8 INSTALLATION – CONCEALED TUBING

A. Concealed tubing includes the tubing bundles that will be installed in the rock borings

B. Install bundle as an assembly sequentially from the surface

C. Provide primary and secondary support systems for installation

D. Do not induce any stress on the tubing system along the installation length or in the entrance and exit locations

E. Provide adequate restraint during the grouting process
3.9 TESTING

A. Tubing:
   1. Testing is required sequentially during the installation as determined by the Contractor.
   2. Failure of any test shall result in immediate correction and retesting
   3. All hydraulic tubing and connections shall be pressure tested at a minimum pressure of 4500 psi and held for a minimum of 30 minutes. There shall be zero leakage. The testing media shall be fresh, filtered water

3.10 CLEANING

A. Perform after assembly and testing of hydraulic lines.
B. Fluid: Mobil DTE 11M Hydraulic Fluid
C. Flushing Velocity: 10 feet per second
D. Final Cleanliness level: 5 Microns, BETA5 – 75, per ISA 4572
E. Perform with use of an off-line reservoir, pump and filtering system.
F. Flush for a minimum of one hour after final cleanliness has been achieved

3.11 SYSTEM CHARGING

A. Perform with cooperation from Engineer and HPU Supplier; Rodney Hunt Company
B. Remove all flushing oil from system
C. Introduce fresh, filtered Mobil DTE 11M Hydraulic Fluid to a cleanliness of 5 microns, BETA5 – 75, per ISA 4572
D. Arrange the valving at the hydraulic cylinders to provide means to circulate the hydraulic oil
E. Run Hydraulic Power Unit to circulate and clean the oil for a minimum of 60 minutes
F. Furnish and install new oil filters
G. Arrange valving at the hydraulic cylinders to provide oil to the cylinders and to block the recirculation loop

END OF SECTION
PART 1 GENERAL

1.1 SCOPE

A. This Section specifies the ductwork and accessories required for the project.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

   b. A 525-91a, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
   b. 255-90, Test of Surface Burning Characteristics of Building Materials.
4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. HVAC Duct Construction Standards.
   c. Fibrous Glass Duct Construction Standards.
5. Underwriters Laboratories Inc. (UL):
   a. 181-90, Standard for Safety Factory-Made Air Ducts and Air Connectors.
   b. 555-90, Standard for Safety Fire Dampers.

1.3 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's data and descriptive literature for duct accessories.

B. Quality Control Submittals: Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the ductwork installation.

PART 2 PRODUCTS

2.1 DUCTWORK

A. Metal:

1. Material: galvanized steel, ASTM A 525 and A 527 galvanized steel sheet, lock forming quality, having zinc coating in conforming with ASTM A90, except as otherwise indicated.

2. Fabricate in accordance with SMACNA “HVAC Duct Construction Standards” and UMC 10-1.
3. Duct sizes shown are inside clear dimensions. For lined ducts, maintain sizes inside lining.
4. Balancing Dampers: 90% unobstructed free area.
5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible, maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

B. Hanger Rod, Straps, Half and Full Rounds:
1. ASTM A 36 galvanized steel.
2. Applicable to attaching method and supports.

C. High Pressure Ductwork:
1. High Pressure (10-inch WC) ductwork includes ductwork between the generator radiator and the exhaust damper.
   a. Design gauge and reinforcement per SMACNA standards, but not smaller than 16 ga.
      1) Joint Seal Material: Tape and sealer as manufactured by:
         a) Hardcast; Type DT tape and HD-20 adhesive.
         b) United; duct sealer.

D. Mechanical Joint Option:
1. Fabricate ducts and joints, including gauge and reinforcing, in accordance with SMACNA Manuals.
2. Construct transverse joints with Ductmate 25/35 duct connector systems, W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system.
3. When using the W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the "W.D.C.I. Heavy "J" and Light "H" Assembly Manual and Duct Construction Standards."
4. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's "Rectangular Duct Construction Manual for Low, Medium, and High Pressure."
5. For longitudinal seams, use the Pittsburgh lock seam sealed internally with a permanently elastic sealer such as Ductmate 5511M mastic.
6. Conform to SMACNA Class A sealing requirements.

2.2 DUCT ACCESSORIES

A. Flexible Connections to Noninternally Spring-Isolated Rotating Fan Equipment:
1. Furnish neoprene-coated, fire-resistant glass fabric, with 2-inch minimum clearance between casing and ductwork.
2. Coat outdoor flexible connectors with Hypalon for UV protection.
3. Manufacturers and Products:
   a. Ventfabrics; Ventglas.
   b. Duro-Dyne; Durolon.

B. Duct Inspection Doors:
1. Size: 12-inch by 12-inch with gasketing around periphery.
2. Panels: Hinged, insulated, and fabricated of same material as ductwork or galvanized in fiberglass ductboard.
3. Manufacturers:
   a. Ventlok.
   b. Duro-Dyne.
C. Sheet Metal Plenums:
   1. Fabricate from minimum 18-gauge metal of the same material as the ductwork. Use standing seam construction.
   2. Brace with an angle frame for rigidity.
   3. Schuller Products
   4. ENGINEER approve alternate

2.3 AUTOMATIC INTAKE DUAL COMBINATION LOUVER DAMPER (L-7, L-8)

A. General:
   1. All aluminum construction
   2. Color anodize – submit color for approval
   3. Extended sill
   4. Security bars
   5. Bird screen
   6. 40% free area with backdraft damper blades fully open
   7. Gravity operated blades start to open at .16” w.g. static pressure and are fully open at .25” w.g. static pressure
   8. Can withstand a windload of 20 lbs/ft^2

B. Frame:
   1. 4” deep – extruded aluminum
   2. .081” nominal wall thickness
   3. Flange Mount
   4. Downspouts and caulking surfaces provided

C. Louver Blades:
   1. Stationary design
   2. 6063T5 extruded aluminum
   3. .081 inch nominal wall thickness
   4. J-style blades spaced 5 inches center to center

D. Backdraft Damper Blades
   1. .050 inch extruded aluminum

E. Screen
   1. 3/4 inch x .051 inch expanded, flattened aluminum bird screen in removable frame

F. Seals
   1. Extruded vinyl blade edge seals

G. Manufacturer and schedule: Reference the drawings

2.4 FIXED LOUVERS (L-1 - L-6)

A. General
   1. Stationary drainable type
   2. Welded aluminum construction
   3. 54% free area
   4. High performance frame system with drainable head
   5. Drain gutter in each blade
   6. Color anodize – submit color for approval
7. Security bars
8. Bird screen
9. Extended sill
10. Can withstand a windload of 20 lbs/ft^2

B. Frame:
1. 4 inches deep – extruded aluminum
2. .081 inch nominal wall thickness
3. Flange Mount
4. Downspouts and caulking surfaces provided

C. Blades:
1. 6063T5 extruded aluminum
2. .081 inch nominal wall thickness
3. Drainable and spaced at approx 5 inches center to center

D. Screen:
1. 3/4" X .051" expanded, flattened aluminum bird screen in removable frame

E. Manufacturer and schedule: Reference the drawings

2.5 CONTROL DAMPERS (D-1, D-2, D-3, D-5, D-6, D-7)

A. General:
1. Low leakage – less than 3cfm/ft^2 at 1" of static pressure
2. Galvanized steel construction
3. Parallel Blade

B. Frame:
1. Five inches by one inch by 16 gage galvanized steel, reinforced for structural strength equal to 11 gage
2. One piece interlocking design
3. Dual flange construction

C. Blades:
1. Galvanized steel airfoil shaped
2. Double skin construction of 14 gage equivalent thickness
3. Low pressure drop and noise design
4. Edge seals mechanically lock into the blade for superior sealing

D. Seals:
1. Proprietary neoprene edge seals
2. Flexible metal compressible jamb seals

E. Bearings:
1. Stainless steel sleeve – corrosion resistant
2. Permanently lubricated

F. Linkage:
1. Concealed in the frame
2. Out of the airstream
G. Axles:
1. 1/2 inch plated steel hex. Removable control shaft extends 6 inches beyond frame
2. Positive lock

H. Electric Actuator:
1. Factory Installed
2. 120V, single phase
3. Power Open – Spring Return
4. Extended ambient operating temperature of -25 to 140 deg
5. Sized for operating conditions
6. Ruskin, Belimo, or equivalent

I. Manufacturer and Schedule: Reference the drawings

2.6 HEAVY DUTY COUNTERBALANCED BACKDRAFT DAMPER (D-4)

A. General:
1. Industrial grade
2. Gravity Operation

B. Frame:
1. Nine inches by two inches by twelve gage galvanized steel channel
2. Two inch flanged ends

C. Blades:
1. Seven inch wide heavy gage extruded aluminum
2. Airfoil shaped
3. 6-1/2 inches center to center spacing
4. Integral structural reinforcing tube running the full length of each blade

D. Axles:
1. 3/4” diameter plated steel

E. Bearings:
1. Ball bearings pressed into frame

F. Linkage:
1. 3/16 inch x 3/4 inch bar heavy duty face linkage exposed to air stream

G. Blade Seals:
1. Silicone Rubber

H. Finish:
1. Mill

I. Temperature Rating:
1. 300°F

J. Manufacturer and Schedule: Reference the drawings
PART 3  EXECUTION

3.1  INSTALLATION

A. General:

1. Install all Ductwork and accessories level, plumb, and true.
2. The external appearance shall be top quality and is as important as the mechanical functionality.
3. Provide interior and exterior installation details for a quality and pleasing finish.
4. Verify and test the operation of all devices to ensure smooth, balanced movement, free of any binding or vibrations.
5. Install sheet metalwork in accordance with the latest edition of the SMACNA “HVAC Duct Construction Standards”.
7. Install additional bracing as required to prevent ballooning or breathing.
8. For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape. For exterior ductwork, tape joints with Hardcast outdoor tape and rosin. Tape joints according to the following table:

<table>
<thead>
<tr>
<th>Pressure Class</th>
<th>Sealing Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-inch WC or less</td>
<td>Transverse joints</td>
</tr>
<tr>
<td>More than 2-inch WC</td>
<td>Transverse joints and longitudinal seams</td>
</tr>
</tbody>
</table>

9. Seal joints of ductwork in accordance with manufacturer's instructions.
10. Make duct size transitions with the maximum inclusive angle of 30 degrees, unless otherwise indicated on the Drawings.
11. Make offsets with maximum angle of 45 degrees.

B. Mechanical Joint Option: Install specified transverse duct joints in accordance with manufacturer's instructions and installation manuals.

END OF SECTION
PART 1 GENERAL

1.1 SCOPE

A. This Section describes the ventilation devices required for this project.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

2. Air Moving and Conditioning Association (AMCA):
3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   a. 52-76, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
   a. 70-93, National Electric Code (NEC).
   b. 90A-93, Standard for the Installation of Air Conditioning and Ventilating Systems.
   c. 90B-93, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
7. Occupational Safety and Health Act (OSHA).

1.3 SUBMITTALS

A. Shop Drawings: Complete Specifications, descriptive drawings, catalog cuts, and descriptive literature, which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.

B. Quality Control Submittals:

1. Certificates of Conformance:
   a. Motors specified to be energy-efficient type.
   b. Fans.
2. Recommended procedures for protection and handling of products prior to installation.
3. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.

C. Contract Closeout Submittals: Operation and maintenance manuals for equipment specified.
PART 2  PRODUCTS

2.1  GENERAL

A. The structure and appurtenant facilities have been designed around the first-named manufacturer’s equipment. Equipment furnished by all qualified interested manufacturers will be considered, provided that necessary structural, electrical, and mechanical changes are submitted in conformance with the General Conditions and DIVISION 1 - GENERAL REQUIREMENTS. The CONTRACTOR shall bear all costs for necessary changes for a complete and satisfactory installation.

B. Furnish fused disconnects on fan units.

C. Shafts and Safety Devices:
   1. Protective Guards: Meet federal and State of Colorado OSHA requirements for safety protection, and be easily removable by one person.
   2. Tachometer Access Holes: Large enough to accept standard tachometer drive shaft.
   3. Center punch fan shaft to accommodate tachometer readings.

D. Fan Equipment: Rated and tested in accordance with AMCA Standards 210 and 2401 for Class I service, unless otherwise specified.

E. Ball Bearings:
   1. For Forward-Curved Fans: Size for minimum life L-10 of over 80,000 hours.
   2. For Airfoil and Backward Inclined Fans: Size for minimum life L-10 of over 40,000 hours, with an average life L-50 of over 200,000 hours.

F. Drives for Belt-Driven Fans:
   1. Sheaves shall be capable of providing 150% of motor horsepower.
   2. Mount motors on adjustable motor brackets.
   3. Furnish motors 10 hp and under with adjustable speed sheaves that allow for 20% speed variation.
   4. Furnish belt-driven fans with cast iron or flanged steel sheaves.

G. Air Filters, Fans, Air Handlers, and Air Conditioners: Meet requirements of NFPA 90A-93 and 90B-93.

H. Altitude: 6,900 feet above MSL.

2.2  SUPPLEMENTS

A. See supplements to this Section for additional product information.

2.3  PROPELLER WALL FANS (EF-1, EF-2, EF-3)

A. Direct drive propeller fan suitable for wall mounting in sleeve.

B. Drive frame assemblies and fan panels shall be bolted or welded construction, and shall have prepunched mounting holes, formed flanges, and a deep formed inlet venturi.

C. Self-aligning permanently lubricated grease-packed ball bearings

D. Propeller:
   1. Heavy duty, reinforced epoxy coated steel blades
   2. Standard square key and set screw, or tapered bushing shall lock the propeller to the motor shaft
3. Statically and dynamically balanced

E. Wall mounting collar, compatible with specified damper and louver.

F. Bird screen

G. Removable safety guards on motor side, and propeller discharge side where fan is accessible.

H. Standard factory baked enamel finish in color selected.

I. Capacity at given altitude: as shown on Drawings.

1. Units shall be operational from 0-1.00 in H2O differential pressure and shall be non-overloading at a minimum of 1.00 in H2O differential pressure

J. Manufacturers and Products: as shown on Drawings.

2.4 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

PART 3 EXECUTION

3.1 INSTALLATION

A. Fans and Air Handlers:

1. Isolate sheet metal duct connections from all noninternally spring-isolated fan units or other rotating equipment.

2. Locate units to provide access spaces required for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.

3.2 ADJUSTING AND CLEANING

A. Air Balancing: As specified in SECTION 23 05 93.

B. Fans:

1. Lubricate nonsealed bearings prior to startup.

2. Do not operate units until safety guards are installed.

C. Vibration:

1. Statically and dynamically balance fan equipment.

2. Perform field testing on rotating equipment, as specified in SECTION 23 05 93, to determine actual operating vibration.

3. If vibration limits described therein are exceeded, rebalance equipment in-place, if directed by ENGINEER, until design tolerances are met.
3.3 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.

1. Data Sheets: Motors.

END OF SECTION
## INDICTION MOTOR DATA SHEET

**Project:** Cheesman Upstream Control Project  
**Owner:** Denver Water  
**Equipment Name:** Exhaust Fan  
**Equipment Tag Number(s):** EF-1  

**Type:** Squirrel-cage induction meeting requirements of NEMA MG 1  
**Manufacturer:** For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer  
**Hazardous Location:** Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark  

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motor Horsepower:</strong></td>
<td>1/4 (Guaranteed Minimum Efficiency at Full Load: 90 percent)</td>
</tr>
<tr>
<td><strong>Voltage:</strong></td>
<td>120 (Guaranteed Minimum Power Factor at Full Load: 80 percent)</td>
</tr>
<tr>
<td><strong>Phase:</strong></td>
<td>1 (Service Factor (@ rated max. amb. temp.): ❌ 1.0 ✗ 1.15)</td>
</tr>
<tr>
<td><strong>Frequency:</strong></td>
<td>60 (Enclosure Type: )</td>
</tr>
<tr>
<td><strong>Synchronous Speed:</strong></td>
<td>(rpm)</td>
</tr>
<tr>
<td><strong>Mounting Type:</strong></td>
<td>✗ Horizontal ❌ Vertical</td>
</tr>
<tr>
<td><strong>Multispeed, Two-Speed:</strong></td>
<td>❌ Vertical Shaft: ❌ Solid ✗ Hollow</td>
</tr>
<tr>
<td></td>
<td>❌ Vertical Thrust Capacity (lb): Up _____ Down _____</td>
</tr>
<tr>
<td><strong>Constant Horsepower</strong></td>
<td>❌ Adjustable Speed Drive:</td>
</tr>
<tr>
<td><strong>Variable Torque</strong></td>
<td>FREQUENCY, CONTROLLED SPEED, DRIVE SYSTEMS.</td>
</tr>
<tr>
<td><strong>Constant Torque</strong></td>
<td>Operating Speed Range: _____ to _____% of Rated Speed</td>
</tr>
<tr>
<td><strong>Winding:</strong></td>
<td>❌ One ✗ Two</td>
</tr>
<tr>
<td><strong>Thermal Protection:</strong></td>
<td>✗ Space Heater: _____ volts, single phase</td>
</tr>
<tr>
<td></td>
<td>✗ Oversize main terminal (conduit) box for motors</td>
</tr>
<tr>
<td></td>
<td>✗ Terminal for connection of equipment grounding wire in each terminal box</td>
</tr>
</tbody>
</table>

**Additional Motor Requirements:** ❌ See SECTION 16405 - AC INDUCTION MOTORS  

**Special Features:**  
Permanently lubricated bearings, Class F insulation, limited to B rise, nonoverloading motor.
## Project: Cheesman Upstream Control Project

**Owner:** Denver Water

**Equipment Name:** Exhaust Fan

**Equipment Tag Number(s):** EF-2, EF-3

### Type: Squirrel-cage induction meeting requirements of NEMA MG 1

**Manufacturer:** For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer

**Hazardous Location:** Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark

**Motor Horsepower:** 1 1/2

**Guaranteed Minimum Efficiency at Full Load:** 90 percent

**Voltage:** 240

**Guaranteed Minimum Power Factor at Full Load:** 80 percent

**Phase:** 1

**Service Factor (@ rated max. amb. temp.):** □ 1.0  ■ 1.15

**Frequency:** 60

**Enclosure Type:**

**Synchronous Speed:** rpm

**Mounting Type:** ■ Horizontal  □ Vertical

**Multispeed, Two-Speed:**

□ Vertical Shaft: □ Solid  □ Hollow

□ Constant Horsepower

□ Adjustable Speed Drive:

□ Variable Torque  FREQUENCY, CONTROLLED SPEED, DRIVE SYSTEMS.

□ Constant Torque  Operating Speed Range: _____ to _____% of Rated Speed

**Winding:** □ One  ■ Two

□ Thermal Protection:

□ Space Heater: _____ volts, single phase

■ Oversize main terminal (conduit) box for motors

■ Terminal for connection of equipment grounding wire in each terminal box

### Additional Motor Requirements:

□ See SECTION 16405 - AC INDUCTION MOTORS

### Special Features:

Permanently lubricated bearings, Class F insulation, limited to B rise, nonoverloading motor.
SECTION 23 82 00
CONVECTION HEATING UNITS

PART 1 GENERAL

1.1 SCOPE
A. This Section specifies the convection terminal heat transfer units.

1.2 REFERENCES
A. The following is a list of standards which may be referenced in this Section:
   1. American Gas Association (AGA).
      a. 70-93, National Electric Code (NEC).

1.3 SUBMITTALS
A. Shop Drawings:
   1. Complete Specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.
   2. Manufacturer's standard finish color selection for cabinet finishes.

B. Quality Control Submittals:
   1. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.

C. Contract Closeout Submittals: Operation and maintenance manuals.

1.4 QUALITY ASSURANCE
A. Heating Equipment: Minimum operating efficiencies, specified in Chapter 6 of ASHRAE 90A-80.

PART 2 PRODUCTS

2.1 ELECTRIC UNIT HEATER (EUH-1, EUH-2, EUH-3)
A. Characteristics:
   1. Multi-blade propeller fan.
   2. Direct-drive motor.
   3. Heating coil.
   4. Integral speed control switch.
   5. Cabinet mounted.
   6. No integral thermostat (control to be performed separately).

B. Cabinet:
1. 16-gauge steel arranged for wall mounting with bracket.
2. Baked enamel finish of a color selected by the OWNER from manufacturer's standard color chart.

C. Electric Heating Coil:
1. Low surface temperature type with sheath element inserted in finned-tube coil.
2. Factory wiring shall include operating and safety controls required by UL and NEC, and carry the UL label.
3. Control wiring shall include 120-volt control transformer.

D. Capacity: as shown on Drawings.

E. Manufacturers and Products: as shown on Drawings.

2.2 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test equipment identical to that furnished.
1. Functional Test: Perform manufacturer's standard test on equipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

3.2 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at site for one person day per SECTION 01 43 33 for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of OWNER's personnel for specified equipment.

END OF SECTION
PART 1 GENERAL

1.1 SCOPE

A. DIVISION 26 covers the Work necessary for the complete electrical system. Furnish materials, labor, and equipment in accordance with these Specifications and the accompanying Drawings.

B. This Section covers general requirements applying to DIVISION 26 and all other Divisions.

1.2 GENERAL REQUIREMENTS

A. Electrical Contractors shall include the following information with their bid form, at bid time:

1. Indication that the I&C/PICS Subcontractor, Communication Systems Subcontractor, Electrical Systems Commissioning Subcontractor, and the Electrical Systems Analysis Subcontractor shall be Subcontractors to the Electrical Contractor. The Electrical Contractor shall provide a letter indicating the following:
   a. All the prequalified I&C/PICS/Systems Integrator Subcontractors that provided a bid to the Electrical Contractor. The I&C/PICS/Systems Integrator Subcontractor the Electrical Contractor has selected for use.
   b. The Communication Systems Subcontractor the Electrical Contractor has selected to use.
   c. The Commissioning of Electrical Systems Subcontractor the Electrical Contractor has selected to use.
   d. The Electrical Systems Analysis Subcontractor the Electrical Contractor has selected to use.
   e. Verification the Electrical Contractor shall be providing and installing the 150kW engine-generator.
   f. Verification that the Electrical Contractor shall provide and install all raceways and conductors, except for the communications and intercom cables which shall be provided, terminated and tested by the communications Subcontractors.

2. Provide the following Schedule of Values, for all work including quantities and pricing in sufficient detail to serve as the basis for progress payments during construction. Prices shall include an appropriate amount of overhead and profit:
   a. General Electrical Requirements.
   b. Basic Electrical Materials and Methods, not including items c-h.
   c. 167kVA Transformers, including primary overcurrent devices.
   d. 75kVA Transformers, including primary overcurrent devices.
   e. Panelboards PB-VH-1, PB-VH-2, PB-CB-1, PB-CB-2, PB-SG, PB-OFFICE, PB-MW.
   f. Manway exhaust fan motor starter.
   g. Lighting Control Cabinets, LCC-1, 2.
   h. Miscellaneous Control Building Motor Disconnects.
   i. Raceways & Conductors.
   j. Grounding & Bonding.
   k. Grounding grid system laid on the Reservoir bottom.
   l. Electrical Systems Analysis.
   m. Commissioning of Electrical Systems.
   n. Switchboard SWBD-1
   o. Low Voltage Motor Control
   p. 150kW Engine-Generator (indicated Manufacturer)
q. TVSS-1, 2, 3, 4, 5.

r. Lighting.

s. Communications System.


3. A letter describing what is considered the most difficult electrical parts of the Cheesman Upstream Control Project-Phase 1A.

4. Organization Chart: Showing organization structure for the Company and this Project. Identify key personnel who will be assigned to do this Project.

5. Qualification of Personnel:
   a. Resumes giving management and technical qualifications of project manager, project foreman and all key personnel shown on organization chart.

B. Project electrical work shall be performed or supervised by an electrical foreman who is a Colorado Licensed Journeyman or Master Electrician. The electrical foreman on the project shall not be replaced without written notice to the ENGINEER except under extraordinary circumstances. The ratio of electrical apprentices to Colorado licensed journeymen (or masters) shall be no greater than 2:1.

   1. The Electrical Contractor awarded the project shall submit current copies of Colorado Journeyman Electricians License, Master Electricians License or Apprentice registration information/license, for all foreman, electricians and apprentices, that work on the Cheesman Upstream Control Project-Phase 1A.

1.3 REFERENCES, STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all Work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and Specifications of the following:

   1. Local laws and ordinances.
   2. State and federal laws.
   4. Underwriters Laboratories, Inc. (UL).
   6. Institute of Electrical and Electronics Engineers (IEEE).
   7. Insulated Cable Engineers Association (ICEA).
   8. Occupational Safety and Health Act (OSHA).

B. Conflicts, if any, that may exist between the above items will be resolved at the discretion of the ENGINEER.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the Work. Arrange all inspections required by these agencies. On completion of the Work, furnish satisfactory evidence to the ENGINEER that the Work is acceptable to the regulatory authorities having jurisdiction. Turn over all signed permits to the ENGINEER.
1.4 ELECTRICAL COORDINATION

A. Electric Utility (Intermountain Rural Electric Association (IREA)):
   1. Coordinate and obtain approval by the electric utility providing service, where required.
   2. Arrange for, coordinate, and pay for a temporary electrical service sized for the required construction trailers. Monthly electrical billing will be paid for by the OWNER.

1.5 TEMPORARY POWER, COMMUNICATIONS, SIGNALS AND TELEPHONE

A. Meet all requirements of SECTION 01 50 00.

B. Coordinate construction and equipment testing & commissioning power with the OWNER. Where construction and equipment testing & commissioning power is not available from the OWNER, provide portable electric generators. Coordinate portable generator locations with the OWNER. Provide ENGINEER approved spill containment for all portable generators located on the crest of the dam or in the Control Building.

C. Provide and install all equipment and devices, necessary to provide temporary power, controls, and communications for facilities.

D. Provide and install all equipment and devices necessary to maintain power and communications to existing services and equipment.

E. Provide and install a temporary, waterproof lighting and ventilation system in the Manway and upper and lower entrances for the OWNER's continued use of the Manway during construction. Provide an ENGINEER approved overcurrent protection and lighting and ventilation control and power system.

F. Demolition and Temporary Construction Sequence:
   1. The temporary power, lighting, control, and communications installation and materials shall be pre-approved by the ENGINEER.
   2. Provide and install all equipment, materials and devices required for temporary power including, but not limited to, overcurrent protection devices, metering sockets and other utility required equipment, disconnects, transformers, conduit, conductors, poles, overhead power lines, terminations, and distribution equipment. The general location of the new service is indicated on the Drawings, but will need to be coordinated with the CONTRACTOR and the OWNER for exact trailer placement and the numbers of trailers to be provided. The CONTRACTOR shall provide temporary phone and fiber optic circuits to the OWNER's and CONTRACTOR's trailers as indicated on the Drawings.
   3. The temporary construction trailers electrical service shall be provided from an ENGINEER approved location. Power poles and lines shall be modified as required and as approved by the ENGINEER and IREA to provide temporary construction power.
   4. The existing facilities ground rings shall be repaired and restored to their original condition after the construction. The existing ground rings shall be connected to the any new ductbank grounding and to the new equipment.
   5. The ENGINEER has attempted to indicate underground interferences, but it is the CONTRACTOR's responsibility to repair damaged underground utilities on the complete project site and permanently relocate underground electrical feeder and branch circuit conduits as required.
1.6 PROJECT & SITE ENVIRONMENTAL CONDITIONS
A. All materials and equipment shall be designed and constructed for continuous operation, at rated current, at 6,900-feet above mean sea level, 40°C ambient and 95% relative humidity.

1.7 MATERIALS AND EQUIPMENT FURNISHED AND INSTALLED UNDER OTHER DIVISIONS WITH RACEWAY, ELECTRICAL CONDUCTORS, CABLES AND CONTROLS FURNISHED, INSTALLED, AND CONNECTED UNDER DIVISION 26, (INCLUDING BUT NOT LIMITED TO)
A. Instrumentation and Control Systems
B. Communications Systems
C. Heating and Ventilation Systems
D. Process Integration

1.8 INSPECTION OF THE SITE AND EXISTING CONDITIONS
A. The electrical Drawings were developed from past record Drawings. Verify all scaled dimensions and existing equipment, devices, conduits, etc., prior to submitting bids.
B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical systems which will, in any way or manner, affect the Work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the CONTRACTOR’s failure to fulfill this requirement.
C. Carry out any work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the Owner. Do such work when approved by the ENGINEER.
D. After award of Contract, confer with ENGINEER and OWNER to verify at each area of construction activity, the location of existing underground utilities. Protect all existing underground utilities during construction. Pay for all required repairs without increase in Contract cost should damage to underground utilities occur during construction.

1.9 RESPONSIBILITY
A. Complete systems in accordance with the intent of these Contract Documents.
B. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under DIVISION 26.
C. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
D. Complete electrical installation compliance with the requirements of the latest editions the National Electrical Code, Uniform Building Code, NFPA code, and all applicable federal, state, county and city laws, ordinances, codes and regulations. Study all Drawings and report any errors or omissions to the ENGINEER prior to bidding. The exact fitting of all materials and equipment in the building is the CONTRACTOR’s responsibility.

1.10 INTENT OF DRAWINGS
A. Electrical Plan Drawings show only general locations of new structures, piping, equipment, devices, and raceways, unless indicated otherwise and specifically dimensioned. Review with the OWNER the final location, mounting heights, orientation of the structures, equipment, and conduit routing. The proper routing and installation of raceways, equipment, etc., and providing as-built Drawings with locations of all
raceways, grounding system conductors, equipment, etc., subject to the approval of the ENGINEER, shall be the CONTRACTOR’s responsibility.

B. Submit as-built Drawings with dimensioned locations of all raceways, equipment, and devices. The as-builds shall indicate number, size, tag numbers and type of equipment, devices, conductors and cables. Keep a photo album of construction. Submit current as-built Drawings and the photo album at 25%, 50%, 75% and 100% completion of the project, as determined by the ENGINEER. The ENGINEER shall be delivered the as-built Drawings and the photo album within 48 hours of the request. If acceptable, as determined by the ENGINEER, The ENGINEER shall return the as-built Drawings and the photo album to the CONTRACTOR within 72 hours. If as-built Drawings and photo album are unacceptable, as determined by the ENGINEER, revise and resubmit as-built Drawings and the photo album. At 100% completion of the project, give all as-built Drawings, (required by this Section and all other Sections), and the photo album to the ENGINEER for approval.

C. Any discrepancies between the Plan Drawings and the Specifications shall be resolved by the ENGINEER.

1.11 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. In accordance with provisions elsewhere in these Contract Documents, manufacturers’ names and catalog numbers stated herein are intended to indicate the type and quality of equipment or materials desired. Unless substitution is specifically forbidden, proposed alternatives may be submitted for approval.

1.12 INSPECTION

A. In accordance with provisions elsewhere in these Contract Documents, allow materials, equipment, and workmanship to be inspected at any time by the ENGINEER or OWNER, or their representatives. Correct work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the ENGINEER and OWNER.

1.13 SUBMITTALS

A. Make submittals in accordance with DIVISION 1.

B. Provide complete manufacturers’ descriptive information and Shop Drawings for all equipment, material, and devices furnished under DIVISION 26, including certified outline drawings, arrangement drawings, elementary (schematic) diagrams, interconnection and connection diagrams, characteristic curves for all protective devices in accordance with provisions elsewhere in these Contract Documents. Provide the number of copies specified therein.

C. Refer to Item 1.10, INTENT OF DRAWINGS, for required as-built submittals.

D. Provide certified Shop Drawings, literature, and requested samples showing items proposed for use, size, dimensions, capacity, special features required, schematic (elementary) control diagrams, equipment schedules, rough-in, etc., as required by the ENGINEER for complete review and for use during installation. Use NEMA device designations and symbols for all electric circuit diagrams submitted. Make content of schematic (elementary) connection or interconnection diagrams in accordance with the latest edition of NEMA ICS1.

E. Manufacturer’s standardized elementary diagrams will not be acceptable unless applicable portions of the diagram have been clearly identified and nonapplicable portions deleted or crossed out.
F. Provide operations and maintenance manuals in accordance with provisions of DIVISION 1 in these Contract Documents. Provide additional information listed under individual Specification items.

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide all first-quality, new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

2.2 STANDARD PRODUCTS

A. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers’ latest standard design that conforms to these Specifications.

2.3 EQUIPMENT FINISH

A. Provide materials and equipment with manufacturers’ standard finish system. Provide manufacturers’ standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with ANSI No. 61, light gray color.

2.4 OUTDOOR EQUIPMENT

A. Provide equipment and devices to be installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of -15°F to 105°F.

PART 3 EXECUTION

3.1 GENERAL

A. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled and licensed in the electrical trade. Provide work which has a neat and finished appearance. Carry out Work in accordance with NECA Standard of Installation unless otherwise specified.

B. Coordinate electrical work with OWNER and work of other trades to avoid conflicts, errors, delays, and unnecessary interference with operation of the plant during construction.

C. Check the approximate locations of light fixtures, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify the ENGINEER in writing. The ENGINEER’s decision shall govern. Make modifications and changes required to correct conflicts.
3.2 PROTECTION DURING CONSTRUCTION

A. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions elsewhere in these Contract Documents. Throughout this Contract, follow manufacturers’ recommendations for storage. Protect everything from the effects of weather. Prior to installation, store items in clean, dry, indoor locations. Store in clean, dry, indoor, heated locations items subject to corrosion under damp conditions, and items containing electrical insulation, such as transformers, conductors, motors, and controls. Energize all space heaters furnished with equipment. Provide temporary heating, sufficient to prevent condensation, in transformers, switchboards, and motors which do not have space heaters.

B. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. When equipment intended for indoor installation is installed at the CONTRACTOR’s convenience in areas where it is subject to dampness, moisture, dirt, or other adverse atmosphere until completion of construction, ensure that adequate protection from these atmospheres is provided that is acceptable to the ENGINEER. Cap conduit runs during construction with manufactured seals. Keep openings in boxes or equipment closed during construction. Energize all space heaters furnished with equipment.

C. Protect the existing equipment and facilities during construction. This shall include, but not be limited to, protection of the Valvehouse floors with plywood or other ENGINEER approved method.

3.3 MATERIAL AND EQUIPMENT INSTALLATION

A. Follow manufacturers’ installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between the manufacturers’ instructions, codes and regulations, and these Contract Documents, follow ENGINEER’s decision. Keep copy of manufacturers’ installation instructions on the jobsite available for review at all times.

B. Use appropriate conduit and conductor entry fittings with enclosures which maintain the specified enclosure environmental capability after proper installation.

3.4 REMOVAL OR RELOCATION OF MATERIALS AND EQUIPMENT

A. Where existing materials and equipment are removed or relocated, remove all materials no longer used such as studs, straps, conduits, and wires. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least 3/4 inch below the final finished surface when directed by the ENGINEER.

B. Repair affected surfaces to conform to the type, quality, and finish of the surrounding surface in a neat and workmanlike manner. In the Valvehouse, provide colored grout and colored aggregate for patching holes on the building exterior. Provide a grout mock-up to the ENGINEER for approval. Follow any specific instructions given under SECTION 09 90 00. Utilize skilled craftsmen of the trades involved.

3.5 CUTTING, PATCHING, AND DRILLING

A. Layout Work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of ENGINEER. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition. Use skilled craftsmen of the trades involved.
B. Prior to core drilling or cutting existing structures, floors, walls, concrete slabs, etc., the proposed location shall be x-rayed to ensure existing conduits and utilities are not damaged, unless otherwise approved by the ENGINEER. Repair all existing damaged conduits and utilities, unless otherwise approved by the ENGINEER.

3.6 LOAD BALANCE
A. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as nearly as possible on switchgear, motor control centers, panelboards, etc.
B. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.7 MOTOR ROTATION
A. After final service connections are made, check and correct the rotation of all motors.
B. Coordinate rotation checks with the ENGINEER and the CONTRACTOR responsible for the driven equipment.

3.8 CLEANING AND TOUCHUP PAINTING
A. Keep the premises free from accumulation of waste material or rubbish. Upon completion of Work, remove all materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides a finish equal to or better than the factory finish, that meets the requirements of the Specifications, and that is acceptable to the OWNER.

3.9 SERVICE CONTINUITY
A. Maintain continuity of electric service to all functioning portions of the process or buildings during hours they are normally in use. Temporary outages will be permitted during cutover work at such times and places as can be praranged with OWNER in accordance with provisions of DIVISION 1. Such outages shall be kept to a minimum number and minimum length of time. Include all costs for temporary wiring and overtime work required in the Contract price. Remove all temporary wiring at the completion of the Work.

3.10 CHECKOUT AND STARTUP
A. During checkout and startup of the various plant systems, provide a crew of skilled craftsmen to be available for checkout and troubleshooting activities. Since coordination with other crafts and CONTRACTOR’s will often be required, the craftsmen assigned to checkout must be available outside normal working hours when necessary.

3.11 TESTS
A. General: Carry out tests specified hereinafter and as indicated under individual items of materials and equipment specified in other Sections.
B. Operations: After the electrical system installation is completed and at such time as the ENGINEER may indicate, conduct an operating test for approval. Demonstrate that the equipment operates in accordance with the requirements of these Specifications and Drawings. Demonstrate that protective functions are operating properly and are properly incorporated in control system and circuit breaker circuitry. Perform the test in the
presence of the ENGINEER. Furnish all instruments and personnel required for the tests. The OWNER will furnish the necessary electric power.

C. Voltage:

1. When the installation is essentially complete and the facility is in operation, check the voltage at all panelboards and motor control centers. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

2. Record the voltage (all phases simultaneous on the same graph) for 24 hours during a normal working day. Submit the recording with a letter of transmittal to the OWNER and his authorized representative within 5 days of the date the test was taken.

3. If an unbalance (as defined by NEMA) exceeds one percent, or if the voltage varies throughout the day and from loaded to unloaded conditions more than ±4% of nominal, determine the cause of the problem and submit it in writing to the ENGINEER.

D. Equipment Line Current: Check the line current in each phase for each piece of equipment. If any phase current in any piece of equipment is above the rated nameplate current, determine the cause of the problem and submit it in writing to the ENGINEER.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A. Section Includes:

1. Basic Electrical Materials and Methods

B. Related Sections:

1. DIVISION 01: ADMINISTRATIVE AND PROCEDURAL WORK REQUIREMENTS.
2. DIVISION 26: ELECTRICAL
3. DIVISION 40: PROCESS INTEGRATION

1.2  GENERAL REQUIREMENTS

A. Include General Conditions, Supplementary Conditions and DIVISION 1, as they apply to work specified in this Section.

B. Examine all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.3  SCOPE

A. Work included in this Section are miscellaneous materials not specifically mentioned in other Specification Sections, but necessary or required for equipment or system operation or function, and the labor to install them.

B. The work under this Section shall include the furnishing of all material, labor, equipment and supplies and the performance of all operations to provide a complete working system as required by the drawings and details and as specified herein.

C. The Specifications and Drawings describe the minimum requirements that must be met by the Electrical Subcontractor for the installation of all work as shown on the Drawings and as specified herein to include the following items:

1. Outlet and Device Boxes.
2. Junction and Pull Boxes.
3. Wiring Devices.
4. Device Plates.
7. Circuit Breaker, Individual, 0 to 600 Volts.
8. Separately Mounted Molded Case Switch, Individual, 0 to 600 Volts.
9. Disconnect / Safety Switches, Fused and Non-fused, Individual, 0 to 600 Volts.
10. Fuse, 0 to 600 Volts.
12. Terminal Junction Box.
13. Terminal Block (0 to 600 Volts).
15. Mechanically Latched Lighting Contactor.
17. Support and Framing Channels.
18. Nameplates.
19. Demolition.

1.4 REFERENCES
A. The equipment and work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
2. International Society of Automation (ISA).
8. Underwriters Laboratories, Inc. (UL).

1.5 SUBMITTALS
A. Shop Drawings:
1. Itemized bill of material including manufacturer, complete model number and options included.
2. Descriptive information, manufacturer's descriptive and technical literature.
3. Catalog Cuts: components, electrical devices, and mechanical devices:
   a. Catalog information.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled, legible drawings showing exterior dimensions and locations of all electrical and mechanical interfaces.
4. Dimensional drawings.
5. Protective Devices:
   a. Copies of time-current characteristics.
   b. Protective device trip settings
6. Anchoring instructions and details.
7. One-line diagrams.
8. Schematic (elementary) diagrams.
10. Interconnection diagrams.
11. Installation Details: Include all mounting methods, size and detail of supports, channels and steel; provide weight(s) from which supports, channels and steel are to carry. Include all modifications or further details required.
12. Spares, expendables, and test equipment.

B. Quality Control Submittals:
1. Testing Related Submittals.
2. O&M Manuals:
   a. Legends Abbreviation Lists.
   b. Refer to paragraph Shop Drawings for the following items:
      1) Itemized bill of material including manufacturer, complete model number and options included.
      2) Catalog cuts.
      3) Component data sheets.
      4) All final as-built Drawings shall be provided in electronic media, (AutoCAD version 2009 or earlier), on standard IBM computer
compatible 2GB Hi-Speed Flash Drives and in hard three ring 11" x 17" binders in unfolded quality hard copy media.

5) Factory and field certified test reports.

c. Device O&M manuals for components, electrical devices, and mechanical devices shall include:
   1) Operations procedures.
   2) Installation requirements and procedures.
   3) Maintenance requirements and procedures.
   4) Troubleshooting procedures.
   5) Internal schematic and wiring diagrams.

   d. List of spares and expendables required and recommended.

1.6 QUALITY ASSURANCE

A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.

B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.

C. Manufacturer shall provide certificate of ISO 9002 Compliance.

1.7 PROJECT & SITE ENVIRONMENTAL CONDITIONS

A. All materials and equipment shall be designed and constructed for continuous operation, at rated current, at 6,900-feet above mean sea level, 40°C ambient and 95% relative humidity.

1.8 WARRANTY

A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.

1.9 EXTRA MATERIALS/SPARE PARTS AND MATERIALS

A. Furnish, box, tag and clearly mark on exterior, (identify each item with manufacturer’s name, description and part number), for shipment and long-term storage and deliver prior to 75% Project completion the following extra materials:

   1. Fuses, 0 to 600 Volts: A minimum of ten of each type and each current rating installed.
   2. Two boxes of lamps and LEDs for each type and color of indicating lights used.
   3. Two spray cans of enclosure touchup paint of each kind and color used.

PART 2 PRODUCTS

2.1 OUTLET AND DEVICE BOXES

A. Furnish and install as a part of the raceway system all outlet and device boxes required for the proper installation of all components of the Electrical System.

B. Outlet and device boxes shall, in general, be as follows:

   1. Exposed, surface and pendant mounted outlet and device boxes installed in or near wet locations shall be of the PVC-coated cast metal type with threaded hubs.
2. Exterior mounted outlet and device boxes not subject to wet location conditions shall be of the cast metal type with threaded hubs.

3. Recessed drywall outlet boxes serving interior dry locations shall be of the pressed sheet steel, zinc coated, cadmium plated type.

4. Outlet and device boxes shall not be less than 1 1/2" deep unless shallower boxes are required by structural conditions and are approved by the ENGINEER.

5. Ceiling and bracket outlet and device boxes shall not be less than 4 inch octagonal except that smaller boxes may be used where required by the particular fixture to be installed.

C. Cast Metal:
   1. Box: Malleable iron.
   2. Cover: Gasketed, weatherproof, malleable iron, with stainless steel screws.
   3. Hubs: Threaded.
   4. Lugs: Cast Mounting.
   5. Manufacturers and Products:
      a. Crouse-Hinds: Type FS or FD.
      b. Appleton: Type FS or FD.

D. Box Type (Steel Raceway System):
   1. Outdoor Locations:
      a. Exposed Raceways: Cast Metal.
   2. Interior Dry Locations:
      a. Exposed Rigid conduit: Cast Metal.

E. PVC-Coated Cast Metal:
   1. Type: FS or FD, same as 2.1.C with PVC coating.
   2. Coating: All surfaces; 40-mil PVC.
   3. Manufacturers:
      a. Robroy Industries.
      b. Ocal, Inc.

2.2 JUNCTION AND PULL BOXES

A. Large Sheet Steel Box: NEMA 250, Type 1.
   2. Cover: Full access, screw type.

B. Large Cast Metal Box: NEMA 250, Type 4.
   1. Box: Cast malleable iron, with drilled and tapped conduit entrances.
   2. Cover: Hinged with clamps.
   3. Hardware and Machine Screws: ASTM A 167, Type 316 stainless steel.
   4. Manufacturers, Surface Mounted Type:
      a. Crouse-Hinds; Series W.
      b. O.Z./Gedney; Series Y.

C. Large Stainless Steel Box: NEMA 250, Type 4X.
   1. Box: 14-gauge, ASTM A 240, Type 304 stainless steel, with white enamel painted interior mounting panel.
   2. Cover: Hinged with clamps
   4. Manufacturers:
D. Large Steel Box: NEMA 250, Type 4.

1. Box: 14-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces, with final ANSI Z55.1, No. 61 gray enamel on exterior surfaces.
2. Cover: Hinged with clamps.
3. Hardware and Machine Screws: ASTM A 167, Type 316 stainless steel.
4. Manufacturers:
   b. Robroy Industries.

E. Large Steel Box: NEMA 250, Type 3R.

1. Box: 14-gauge steel, with ANSI Z55.1, No. 61 gray enamel on interior and exterior surfaces. Integral drip shield top with seam-free sides, front, and back.
2. Cover: Hinged with clamps.
3. Hardware and Machine Screws: ASTM A 167, Type 316 stainless steel.
4. Options: Padlockable hasp and staple.
5. Manufacturers:

F. Mounting Hardware:

1. Stainless Steel.

2.3 WIRING DEVICES

A. Toggle switches and receptacles shall be labeled to indicate the panelboard and circuit number(s) that is connected to the device.

B. Toggle Switches:

1. Complies with NEMA WD 1, UL 20 and FS W-S-896E.
2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100% tungsten filament and fluorescent lamp loads. Capable of controlling up to 1hp motor load at 120 volts.
5. Color: Brown, unless otherwise indicated.
6. Manufacturers:
   a. Hubbell.
   b. Leviton.
7. Where 2 or more switches are shown at one location, they shall be installed under a common wall plate. All switches shall be mounted approximately 4 feet above finished floor and shall be located on the knob side of all doors.

C. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Color: Brown, unless otherwise indicated.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
7. Manufacturers:
   a. Hubbell.
   b. Leviton.
8. Mounting height: 18 inches above the floor, unless noted otherwise.

D. Receptacle, Ground Fault Circuit Interrupter: Duplex, Specification grade, tripping at 5mA:

1. NEMA WD 1.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG, and provisions for testing.
3. High strength, thermoplastic base color.
4. Color: Brown, unless otherwise indicated.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5000 amps without damage.
7. Manufacturers:
   a. Hubbell.
   b. Leviton.
8. Mounting height: 18 inches above the floor, unless noted otherwise.

2.4 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.
2. Screw: Oval-head stainless steel.

D. Engraved:

1. Character Height: 1/8 inch.
2. Filler: Red.

E. Weatherproof:

1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
   b. Cap Spring: Stainless steel.
   c. Manufacturers:
      1) General Electric.
      2) Hubbell.
      3) Crouse-Hinds: Type WLRD or WLRS.
2. For Switches: Gasketed, cast metal incorporating external operator for internal switch.
   b. Manufacturers:
      2) Appleton: FSK-1VTS or FSK-1VS.
F. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.5 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Referenced Standards: NEMA PB 1, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers:

1. Suitable for use with 75°C wire at full NFPA 70, 75°C ampacity.
2. Rated for 120/240 volts, single phase, three wire operation as shown on the schedules in the Contract Drawings.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable. Minimum of 10,000 amperes rms symmetrical, unless otherwise approved by the ENGINEER. Rating shall apply to the panelboard as a complete unit with short circuit current rating equal to or greater than the integrated equipment rating shown on the panel schedule or on the plans.

D. Cabinet: NEMA 250, Type 12, Industrial Use, unless otherwise indicated.

2. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
3. Front: Fastened with adjustable clamps.
   a. Trim Size: Same as box.
   b. Finish: Rust inhibitor prime, with manufacturer's standard baked enamel or lacquer.
4. Interior:
   a. Factory assembled, complete with circuit breakers.
   b. Capable of circuit breaker replacement without disturbing adjacent circuit breakers or without removing main bus.
   c. Spaces: Cover openings with easily removable metal cover.
5. Door Hinges: Concealed.
6. Locking Device:
   a. Flush type.
   b. Doors Over 30 Inches in Height: Multipoint.
   c. Identical keylocks, with two milled keys each lock.
7. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door. A neatly typed directory properly identifying each circuit shall be provided in the directory holder with date of installation provided.

E. Bus Bar:

1. Material: Tin-plated copper full sized throughout length.
2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
3. Neutral: Insulated; rated same as phase bus bars with at least one terminal screw for each branch circuit.
4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
5. Lugs and Connection Points:
   a. Suitable for either copper or aluminum conductors.
   b. Solderless main lugs for main, neutral, and ground bus bars.
6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

F. Circuit Breakers:
1. Referenced Standards: NEMA AB 1 and UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Noninterchangeable, in accordance with NFPA 70.
4. Locking: Provisions for handle padlocking, unless otherwise shown.
5. Type: Bolt-on circuit breakers in all panelboards.
6. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
7. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
9. Ground Fault Interrupter:
   a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
   b. Sensor with same rating as circuit breaker and a push-to-test button.
10. All circuit breakers with trip sizes larger than 100 Ampere rating shall have interchangeable trips.

G. Manufacturers:
1. General Electric.
2. Square D.

2.6 EXISTING PANELBOARDS – LIGHTING AND POWER DISTRIBUTION PANELBOARD
A. The existing panelboards are suitable for 120/240 volts, single phase, three wire operation as previously installed.
B. Where connections and/or circuit modifications are made in existing panelboards, the panel index shall be revised to indicate the new loads served. All existing panelboards that do not have a circuit directory card mounted in a frame with a noncombustible plastic cover shall have one installed on the inside of the door. All directory cards shall be properly filled in legible using a word processor/printer and indicating areas, devices and dates of installation served by each unit.
C. New circuit breakers added to existing panelboards shall meet the following requirements:
   1. Frame size shall match existing.
   2. Breaker shall not compromise the UL rating of the existing panelboard assembly.
   3. Ampere interrupting capacity shall match the rating of the existing panelboard(s).

2.7 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS
A. NEMA AB 1, UL 489 listed for use at location of installation.
B. Minimum Interrupt Rating: 10,000 Amps unless shown otherwise.
C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.
D. Suitable for use with 75°C wire at full NFPA 70, 75°C ampacity.
E. Locking: Provisions for padlocking handle.
F. Multipole breakers to automatically open all poles when an overload occurs on one-pole.
G. Enclosure: NEMA 250, Type 12, Industrial Use, unless otherwise shown.
H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multipole circuit breakers are shown.

J. Manufacturers:
   1. General Electric.
   2. Square D.

2.8 SEPARATELY MOUNTED MOLDED CASE SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB 1, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: 65,000 Amps unless shown otherwise.

C. Discriminator instantaneous trip, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75°C wire at full NFPA 70, 75°C ampacity.

E. Locking: Provisions for padlocking handle in the OPEN position.

F. Multipole breakers to automatically open all poles when the handle is operated or an overload occurs.

G. Enclosure: NEMA 250, enclosure type as indicated on the Drawings.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multipole circuit breakers are shown.

J. Manufacturers:
   1. General Electric.
   2. Square D.

2.9 DISCONNECT / SAFETY SWITCHES, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS1, UL listed and horsepower rated. Each switch shall be heavy-duty, three-pole, 600 volt with continuous current rating as indicated on the Drawings.

B. Enclosure: NEMA 250, Type 3R or 12, UL 98 listed, Industrial Use, unless otherwise shown.

C. NEMA KS 1 and UL 98 Listed for application to system with available short-circuit current as shown.

D. Thermal-magnetic, quick-make, quick-break, the ON/OFF positions of the operating handle shall be clearly marked.

E. Locking: Provisions for padlocking handle in the OFF position.

F. Switches shall have high conductivity copper, visible blades; non-teasible, positive, quick-make, quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base.
G. Switches shall be fused or non-fused as indicated on the Drawings. Switches shall have fuse clips suitable for the required fuse type.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Switches shall have defeatable door interlocks.

I. Suitable for use with 75°C wire at full NFPA 70, 75°C ampacity.

J. Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

K. Manufacturers:
   1. General Electric.
   2. Square D.

2.10 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000 ampere RMS interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPS-RK.
      b. Littelfuse; Type LLS-RK.

D. Feeder and Service Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPS-RK.
      b. Littelfuse; Type LLS-RK.

E. Feeder and Service Circuits, 0- to 600-Volt:
   1. Amperage: 601 to 6,000.
   2. UL 198C, Class L, double O-rings and silver links.
   3. Manufacturers:
      a. Bussmann; Type KRP-C.
      b. Littelfuse; Type KLPC.

F. Branch Circuits and Control Circuits, 0- to 600-Volt:
   1. Amperage: 1/2 to 30.
   2. UL listed, Class CC, rejection type, current limiting, with time delay.
   3. Manufacturers:
      a. Bussmann; Type FNQ-R.
      b. Littelfuse; Type KLDR or CCMR.

G. Transformer, 0- to 600 volt: Disconnect switch fuses shall be Class-J, current limiting, time delay fuses unless the equipment manufacturer indicates otherwise.
2.11 PUSH BUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. General:
   1. Function: Select, initiate, and display discrete control functions.
   2. Type: Heavy-duty, watertight, oiltight, industrial.
   3. Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.
   4. Legend Plate: Large size square style aluminum field and black markings, unless otherwise noted. Minimum letter and number height: 7/64-inch. Markings as indicated on the Drawings and as approved by the ENGINEER.
   5. Configuration: Light, pushbutton, or switch as indicated.

B. Light Features:
   1. Lights: Full voltage 120VAC DC high-visibility LED, push-to-test type, unless otherwise indicated or approved by the ENGINEER.
   2. Lens Color: Color as specified and indicated.

C. Push Button and Switch Features:
   1. Guard: Full guard with flush button, unless otherwise noted.
   2. Push Button Color, unless otherwise indicated on the Drawings:
      a. Off, Emergency Stop, Stop, Reset: Red.
      b. All Others: Black.
   3. Switches shall be maintained or spring-return to center position as required and as approved by the ENGINEER.
   4. Push buttons and selector switches lockable in the OFF position where indicated.

D. Signal Interface:
   1. Contact Block:
      a. Type: Silver-coated butting, unless otherwise noted.
      b. Rating: 10 amps continuous at 125V DC.
      c. Sequence: Break-before-make, unless otherwise indicated.
      d. Arrangement: Normally open or normally closed as indicated and to perform functions required.
      e. Terminals: Screw with strap clamp, unless otherwise noted.
      f. All switches and pushbuttons shall have a minimum of one spare contact in addition to all required contacts.
      g. Contact Rating: NEMA ICS 2, Type A600

E. NEMA Rating: NEMA 4, watertight and dusttight and NEMA 13, oiltight.

F. Manufacturers:
   1. General Electric; CR104P.
   2. Allen-Bradley; Bulletin 800T.
   3. Unless otherwise approved by the ENGINEER.

2.12 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Terminal Blocks: Provide separate connection point for each conductor entering or leaving box.
   1. Spare Terminal Points: 25%.

C. Interior Finish: Paint with white enamel or lacquer.
2.13 TERMINAL BLOCK (0 TO 600 VOLTS)

A. General:
1. Accommodate present and spare indicated needs.
2. One wire per terminal.
3. Wire spare and unused panel mounted elements to their panels' terminal block.
4. Spare Terminals: 20% of all connected terminals, but not less than 10 per terminal block.

B. General Purpose (#8 AWG - #4 AWG):
1. Connection Type: Washer head blinding screws into molded one piece terminal boards, conductors and cables terminated with heavy duty ring terminals.

C. Terminal Block, General Purpose:
1. Use for all conductors and cables terminations, unless otherwise indicated or approved by the ENGINEER.
2. Rated Voltage: 600V ac.
3. Rated Current: 30 amp.
4. Wire Size: 18-10 AWG.
5. Connection Type: Washer head binding screws, conductors and cables terminated with heavy duty ring terminals.
6. Provide manufacturer’s mounting kit and marking strip. Marking shall be permanent machine produced.
7. Manufacturer’s:
   a. Weidmuller.
   b. Ideal.
   c. Allen-Bradley.

D. Terminal Block, Fuse/Disconnect plug:
1. Use: Provide one for each analog input and output field interface cable.
2. Rated Voltage: 300V ac.
4. Wire Size: 30-14 AWG.
5. Manufacturer and Product: Phoenix Contact; V10K 1, 5-D/TG/D/PE with Type ST.

2.14 MAGNETIC CONTROL, MACHINE-TOOL AND INDUSTRIAL RELAYS

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control with, a minimum of four, field convertible contacts.

B. Time Delay Relay Attachment:
1. Solid-state type, timer adjustable range available from 0.1 to 180 seconds as required.
2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. All magnetic control relays shall be provided and installed with manufacturer recommended and provided surge suppressors across the coil terminals. The surge suppressor shall be designed to absorb all energy surges that appear on the line.

E. Manufacturers:
1. General Electric; Type CR120B.

2.15 MECHANICALLY LATCHED LIGHTING CONTACTOR

A. Referenced Standards: NEMA ICS 2, UL 508.
B. Electrically operated by a dual coil mechanism.
C. Mechanically held in the CLOSED position.
D. Main Contacts:
   1. Power driven in both directions.
   2. Double-break, continuous-duty, rated at a minimum 30 amps, 600 volts, withstand rating of 5,000 amps RMS symmetrical at 250 volts.
   3. Rated to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding.
   4. Visual indication for each contact.
   5. Shall have finger safe terminals and normally open and normally closed poles shall be interchangeable where the installation of the pole on the contactor base determines if the pole is normally open or normally closed and not the pole itself. Contactor shall be field convertible from electrically held to mechanically held.
   6. Provide with six poles minimum.
E. Fully rated neutral plate.
F. Clamp type, self-rising terminal plates for solderless connections.
G. Enclosure:
   1. Valvehouse: NEMA 250, type 12, Dust-Tight, Drip-Tight, Industrial use, unless otherwise shown.
   2. Manway: NEMA 250, type 4X, Dust-Tight, Corrosion Resistant, Industrial use, unless otherwise shown.
H. Accessories:
   1. Provide (1) normally open and (1) normally closed auxiliary contact.
I. Provided and installed with manufacturer recommended and provided surge suppressors across the coil terminals. The surge suppressor shall be designed to absorb all energy surges that appear on the line.
J. Manufacturers:
   1. Cutler-Hammer, Type C30CNM60AG3AO.
   2. General Electric.

2.16 MAGNETIC CONTACTOR

A. NEMA ICS 2, UL 508.
B. Electrically operated, electrically held.
C. Contactors shall have UL certification to achieve IEC 947, type 2 coordination when subjected to 100,000 ampere short-circuit fault currents.
D. Main Contacts:
   1. Power driven in one direction with gravity dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated at a minimum of 20 amperes, 600-volt.

E. Control: As shown.

F. Provided and installed with manufacturer recommended and provided surge suppressors across the coil terminals. The surge suppressor shall be designed to absorb all energy surges that appear on the line.

G. One normally open and one normally closed auxiliary contacts rated 10 amperes at 480-volt shall be provided.

H. Enclosure: NEMA 250, Type 12, Dust-Tight, Drip-Tight, Industrial use, suitable for outdoor installations.

I. Manufacturers:
   1. General Electric; CR 305.

### 2.17 SUPPORT AND FRAMING CHANNELS

A. All supporting means, channel, and fastener materials in the Manways shall be stainless steel.

B. All channel members shall be fabricated from structural grade steel conforming to one of the following ASTM Specifications: A 575, A 576, A 36 or A 635.

C. All fittings shall be fabricated from steel conforming to one of the following ASTM Specifications: A 575, A 576, A 36 or A 635.

D. Channel:
   1. Cold formed, manufactured from low carbon strip steel.
   2. Finish: Stainless Steel.

E. Nuts and Hardware:
   1. Manufactured from mild steel bars, case hardened with positive biting action.
   2. Finish: Stainless Steel.

F. General Fittings:
   1. Manufactured from hot-rolled, pickled and oiled steel plates, strip or coil, and conform to ASTM Specifications A 575, A 576, A 635 or A 36.
   2. Finish: Stainless Steel.

G. Concrete Inserts:
   1. Cold formed manufactured from standard 12 gauge conforming to ASTM A 1011 SS GR33 or ASTM A 653 GR33. Hot rolled inserts, where indicated shall be manufactured from carbon steel meeting ASTM A 283 GR D.
   2. Finish: Stainless Steel.

H. Manufacturers:
   1. B-Line.
   2. Unistrut.
2.18 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color:
   1. General Labels: White surface, engraved to a black core, (white with black letters).

D. Engraving:
   1. Push Buttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
   2. Panelboards: Panelboard designation, service voltage, and phases.
   5. Terminal Junction Boxes: Terminal junction boxes shall generally indicate the circuit or circuits installed and associated voltage level on a general label. Specific wording will be provided by the ENGINEER or OWNER.
   6. Pull and Junction Boxes: Pull and junction box general labels shall generally indicated the circuits installed. Specific wording will be provided by the ENGINEER or OWNER.
   7. Light switches and receptacles shall be labeled to indicate the panelboard and circuit number(s) that is connected to the device.

E. Letter Height:

2.19 DEMOLITION

A. All demolition work shall be performed by the Electrical Contractor. Demolished items shall be removed from the premises by the General Contractor.

B. All existing lighting fixtures, devices, switches, wiring, etc. in renovated shall be demolished unless otherwise noted or indicated on the drawings. Care shall be taken during demolition work to maintain the integrity of existing raceway systems which may be reused as indicated.

C. Care shall be taken to maintain any existing feeder, branch circuit and auxiliary systems wiring/raceways passing through renovated areas which serves existing equipment or areas which are to remain in present or future operation.

D. The Electrical Contractor shall be responsible for verifying the mechanical integrity of any existing raceway system intended to be reused. Where the existing raceway system does not meet the requirements indicated in the Electrical Specifications, DIVISION 26, the raceway system shall be repaired and/or replaced before any new wiring is installed.

E. All existing exposed raceways and raceway components that are not to be reused shall be demolished. Where existing raceways are embedded in building construction, they
shall be cut flush with finished surfaces, plugged with a suitable and compatible plate and abandoned in place. All existing wiring shall be removed.

F. Where required, the existing raceway system shall be matched and extended to new outlet/device locations as indicated on the drawings. In general, all new raceways in finished areas shall be run concealed in building construction, above hung ceilings, in stud walls, etc. The contractor shall obtain approval from the OWNER regarding location and routing of any exposed raceways prior to installing the same.

PART 3 EXECUTION

3.1 GENERAL

A. Install equipment in accordance with NECA 5055.

B. Refer to all drawings associated with the project, prior to the installation or roughing-in of the electrical outlets, conduit and equipment, to determine the exact location of all outlets.

C. It shall be the responsibility of the CONTRACTOR to determine and ensure that all electrical equipment shall be accessible, such as junction boxes, pull boxes, panelboards, switches, controls and such other apparatus as may require maintenance and operation from time to time.

D. After installation, electrical equipment shall be protected to prevent damage during the construction period. Openings in conduits and boxes shall be closed to prevent the entrance of foreign materials.

3.2 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Locations:

1. Drawing locations are approximate. The Electrical Contractor shall study the project plans in relating to the spaces and equipment surrounding each outlet so that receptacles, switches or other electrical devices are symmetrically located and mounted in or on the walls, ceiling and floor.

2. Outlet and device boxes that interfere with the installation of mechanical equipment, structural or architectural features or that will be inaccessible due to the work of other trades shall be relocated accordingly as a part of construction conditions encountered during the course of the construction program at no cost to the Owner. Notify ENGINEER prior to any relocation.

3. Light Switch: Install on lock side of doors.

4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

C. Mounting Height:

1. General:
   a. Measured to centerline of box.
   b. Where specified heights do not suit building construction or finish, mount as directed by ENGINEER.

2. Devices: 48 inches above floor, or match existing.

3. Thermostat: 54 inches above floor, or match existing.

D. Install plumb and level.

E. Flush Mounted:
1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

F. Support boxes independently of conduit by attachment to building structure or structural member.

G. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

H. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

I. Provide plaster rings where necessary.

J. Boxes embedded in concrete or masonry need not be additionally supported.

K. Install galvanized mounting hardware in industrial areas.

L. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

M. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

N. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

O. All Locations cast metal, unless otherwise approved by the ENGINEER.

3.3 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends, unless otherwise approved by the ENGINEER.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Mounting Hardware:
   1. Noncorrosive Areas: Stainless Steel.

M. Location/Type:
   1. Indoor, Dry: NEMA 250, Type 12.
   2. Indoor and Outdoor, Wet: NEMA 250, Type 4.
   3. Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.4 WIRING DEVICES

A. Switches:
   1. Mounting Height: See Item 3.2, OUTLET AND DEVICE BOXES.
   2. Install with switch operation in vertical position.
   3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:
   1. Install with grounding slot up except where horizontal mounting is shown, in which case install with neutral slot up.
   2. Ground receptacles to boxes with grounding wire only.
   3. Weatherproof Receptacles:
      a. Install in cast metal box.
      b. Install such that hinge for protective cover is above receptacle opening.
   4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles, use only when approved by the ENGINEER. In the Manways, install individual GFCI protection for each outlet. Do not install them so there is protection for the entire circuit (other receptacles) downstream of the GFCI.
   5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

3.5 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16-inch.

E. Engrave with designated titles, when indicated on the Drawings.

F. Types (Unless Otherwise Shown):
   1. Outdoor and in Manways: Weatherproof.
   2. Indoor:
      a. Surface-Mounted, Cast Metal Boxes: Cast Metal, unless otherwise approved by the ENGINEER.
3.6 LIGHTING AND POWER DISTRIBUTION PANELBOARD
A. Install securely, plumb, in-line and square with walls.
B. Install top of cabinet 6 feet above floor unless otherwise shown.
C. Provide typewritten circuit directory for each panelboard.

3.7 SAFETY SWITCHES, SEPARATELY MOUNTED CIRCUIT BREAKERS, MOLDED CASE SWITCHES, AND LIGHTING CONTACTORS
A. Install in accordance with the manufacturer’s instructions and recommendations.
B. Install equipment as indicated on the Drawings and in accordance with NFPA 70.
C. Install equipment so that it is readily accessible for inspection, operation and maintenance.
D. Location/Type:
   1. Indoor, Dry: NEMA 250, Type 12.
   2. Indoor and Outdoor, Wet: NEMA 250, Type 4X.
   3. Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.8 CONTROL STATIONS
A. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   1. Locations (unless otherwise shown): Nonhazardous, outdoor, or normally wet areas.
   3. Mounting Height: 4 feet above floor or finished grade.
B. Do not install on finished outdoor surfaces.

3.9 TERMINAL JUNCTION BOX
A. Install in accordance with Item 3.3, JUNCTION AND PULL BOXES.
B. Label each block and terminal with permanently attached, nondestructible tag.
C. Do not install on finished outdoor surfaces.
D. Location:
   1. Indoor, Dry: NEMA 250, Type 12.
   2. Indoor and Outdoor, Wet: NEMA 250, Type 4X.
   3. Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.10 SUPPORT AND FRAMING CHANNEL
A. Furnish zinc-rich primer; paint cut ends prior to installation.
B. Furnish and install all supplementary steel, channels and supports required for the proper installation, mounting and support of all lighting fixtures and electrical equipment to be installed under this Contract, as required.
C. All supplementary steel, channels and supports shall be furnished, installed and secured with all fittings, support rods and appurtenances required for a complete support or mounting system.

D. Supplementary steel and channels shall be firmly connected to the building construction in a manner approved by the ENGINEER prior to the installation of the same. Submit to the ENGINEER the locations proposed for using supplementary steel and channels for the support of equipment, fixtures and raceways.

E. The type and size of the supporting channels and steel shall be of sufficient strength and size to allow only a minimum deflection in conformance with the channel and steel manufacturer’s requirements for loading.

F. All supplementary steel and channels shall be installed in a neat and workmanlike manner parallel to the walls, floor and ceiling construction. All turns shall be made with 90 degrees and 45° Fittings, as required to suit the construction and installation conditions.

G. All support and framing means within the Manways shall be stainless steel, channel, rods, and hardware.

3.11 CLEANING UP

A. Upon completion of all installations, thoroughly inspect all exposed portions of the electrical installation and completely remove all exposed labels, markings and foreign materials.

B. The interior of all boxes and cabinets shall be left clean; exposed surfaces shall be cleaned and plated surfaces polished.

C. Repair damage to finish surfaces resulting from work under this Section.

END OF SECTION
PART 1 GENERAL

1.1 SCOPE
A. Provide and install conductors, cables and accessories as specified herein and as shown on the Contract Drawings.

1.2 REFERENCES
A. The equipment, materials and work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:

1. Institute of Electrical and Electronics Engineers (IEEE).
2. International Society of Automation (ISA).
8. Underwriters Laboratories, Inc. (UL).
   a. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.
10. Insulated Cable Engineer's Association, Inc. (ICEA).
11. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 48, Standard Test Procedures and Requirements.

1.3 SUBMITTALS
A. Shop Drawings:

1. Manufacturer's Literature:
   a. Itemized bill of materials including manufacturer, complete model number and options included.
   b. Wire and cable descriptive product information.
   c. Wire and cable accessories descriptive product information.
   d. Manufactured wiring systems descriptive product information.
   e. Manufactured wire systems rating information.
   f. Manufactured wire systems dimensional drawings.
   g. Manufactured wire systems special fittings.

2. Method and equipment for installing conductors.

B. Wire and Cable Samples:

1. A sample of each size and type of wire and cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.

C. Quality Control Submittals:

1. Itemized bill of material including manufacturer, complete model number and options included.
2. Fiber Optic Power meter test results.
3. Fiber Optic OTDR test results:
   a. Detailed map showing fiber optic network with numerical assignment to each fiber strand and termination panel.
4. O&M Manuals:
   a. Shop Drawing information.
   b. Final as-built conductor and cable tag & identification labels.
   c. Final as-built conduit/conductor schedule.
   d. Factory and field certified test reports

1.4 QUALITY ASSURANCE
A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.
B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories (UL) shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.
C. Manufacturer shall provide certificate of ISO 9002 Compliance.

1.5 PROJECT & SITE ENVIRONMENTAL CONDITIONS
A. All materials and equipment shall be designed and constructed for continuous operation, at rated current, at 6,900-feet above mean sea level, 40°C ambient and 95% relative humidity.

1.6 WARRANTY
A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.

1.7 EXTRA MATERIALS / SPARE PARTS
A. Furnish, box, tag and clearly mark on exterior, (identify each item with manufacturer’s name, description and part number), for shipment and long-term storage and deliver prior to 75% Project completion the following extra materials:
   1. Fiber Optic Test Kit. Manufacturer: Owl KIT-FO+/LOST/DOST.

1.8 UL COMPLIANCE
A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 CONDUCTORS 600 VOLTS AND BELOW
A. Conform to applicable requirements of NEMA ICEA S-95-658 / NEMA WC70. All conductors shall be rated 600 volts.
B. Conductor Type:
   1. 120-Volt Lighting, No. 10 AWG and Smaller: Solid copper.
   2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
   3. All Other Circuits: Stranded copper.
C. Insulation: Type XHHW-2 insulation.
D. Flexible Cords and Cables:

1. Used only where indicated on the Drawings and as required by the equipment furnished, unless approved by the ENGINEER.
2. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
3. Conform to physical and minimum thickness requirements of NEMA WC 8.

2.2 600-VOLT RATED CABLE

A. General:

1. All cables shall be rated 600 volts.
2. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
3. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
4. Suitable for installation in open air, in cable trays, or conduit.
5. Minimum Temperature Rating: 90°C dry locations, 75°C wet locations.

B. Type 1-Multiconductor Control and Power Cable:

1. Used only where indicated on the Drawings and as required by the equipment furnished, unless approved by the ENGINEER.
2. Conductors:
   a. Type: Power control tray cable for control applications requiring a superior construction.
   b. Sunlight resistant.
   c. Class B stranded tinned soft copper conforming to Part 2 of ICEA.
   d. Insulation: Crosslinked Polyethylene (XLP) with chlorinated polyethylene (CPE) jacket.
   e. Insulation thickness: 30-mil.
   f. Seven strand, No. 14 AWG through 10 AWG.
   g. UL 1277 listed as Type XHHW-2 rated VW-1, wet or dry locations 90°C.
   h. Conductor group bound with spiral wrap of barrier tape.
   i. Color Code: In accordance with ICEA S-95-658 / NEMA WC 70.
3. Individual conductors and complete cables shall be tested in accordance with UL requirements for TC power and control tray cables having XHHW-2, VW-1 insulated conductors, and ICEA S-73-532.
5. Manufacturers:
   a. Okonite Co.
   b. Omni Cable.

C. Type 2-Multiconductor Power Cable:

1. Used only where indicated on the Drawings and as required by the equipment furnished, unless approved by the ENGINEER.
2. Conductors:
   a. Class B stranded tinned soft copper per Part 2 of ICEA S-95-658.
   b. Insulation: flame retardant ethylene propylene rubber (EPR), meeting the requirements of UL for type XHHW-2, VW-1 with chlorinated polyethylene (CPE) jacket.
   c. Color Code: Conductors, size No.8 AWG and smaller, colored conductors, NEMA WC70 Method 1, color 5 per Item 3.2, POWER CONDUCTOR COLOR CODING. Conductors, size No.6 AWG and larger, NEMA WC70, Method 4.
3. Individual conductors and complete cables shall be tested in accordance with UL requirements for TC power and control tray cables having XHHW-2, VW-1 insulated conductors, and ICEA S-95-658.


5. Manufacturers:
   a. Omni Cable.
   b. Okonite Co.

D. Type 3-No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

   2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100% coverage.
   3. Dimension: 0.31-inch nominal OD.
   4. Conductors:
      a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B 8.
      b. 18 AWG, seven-strand tinned copper drain wire.
      c. Insulation: 15-mil nominal PVC.
      d. Jacket: 4-mil nominal nylon.
      e. Color Code: Pair conductors black and red.

   5. Cables terminated at the PLCs internal to the GCP or LCPs shall be less than 16 AWG, provided cable lengths are less than 6 feet and the size is approved by the ENGINEER.

   6. Manufacturers:
      a. Belden 1118A.

E. Type 4-No. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

   1. Outer Jacket: 45-mil nominal.
   2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100% coverage.
   3. Dimension: 0.32-inch nominal OD.
   4. Conductors:
      a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B 8.
      b. 18 AWG, seven-strand, tinned copper drain wire.
      c. Insulation: 15-mil nominal PVC.
      d. Jacket: 4-mil nylon.
      e. Color Code: Triad conductors black, red, and blue.

   5. Manufacturers:
      a. Belden 1119A.

F. Type 5—No. 16 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements.

   1. Conductors:
      a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B 8.
      b. Tinned copper drain wires.
      c. Pair drain wire size AWG 18, group drain wire size AWG 16.
      d. Insulation: 15-mil PVC.
      e. Jacket: 4-mil nylon.
f. Color Code: Pair conductors black and white with conductors numerically printed for group identification.

g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.

h. 600V, 90°C rating.

2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100% coverage.

3. Cable Sizes:

<table>
<thead>
<tr>
<th>Number of Pairs</th>
<th>Maximum Outside Diameter (inches)</th>
<th>Nominal Jacket Thickness (mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.597</td>
<td>66</td>
</tr>
<tr>
<td>12</td>
<td>0.935</td>
<td>89</td>
</tr>
<tr>
<td>16</td>
<td>1.07</td>
<td>89</td>
</tr>
<tr>
<td>24</td>
<td>1.293</td>
<td>89</td>
</tr>
</tbody>
</table>

4. Manufacturers:
   a. Belden, Cooper Industries.
   b. Okonite Co.

G. Type 6—No. 18 AWG, Multi-Twisted, Shielded Triads with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements.

1. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B 8.
   b. Tinned copper drain wires.
   c. Pair drain wire size AWG 20, group drain wire size AWG 18.
   d. Insulation: PVC/Nylon – Polyvinyl Chloride/Nylon
   e. Jacket: PVC – Polyvinyl Chloride
   f. Color Code: Pair conductors black, white, and red with conductors numerically printed for group identification.
   g. Individual Pair Shield: 100% coverage, Aluminum foil-polyester tape.
   h. 600 Volt rating.

2. Cable Shield: 100% coverage, Aluminum foil-polyester tape.

3. Cable Sizes:

<table>
<thead>
<tr>
<th>Number of Pairs</th>
<th>Estimated Maximum Outside Diameter (inches)</th>
<th>Estimated Nominal Jacket Thickness (mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.657</td>
<td>66</td>
</tr>
<tr>
<td>12</td>
<td>0.944</td>
<td>84</td>
</tr>
<tr>
<td>24</td>
<td>1.46</td>
<td>89</td>
</tr>
</tbody>
</table>

4. Manufacturers:
   a. Belden 1095A.

2.3 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type XHHW-2, insulation.

B. Direct Buried: Bare stranded copper, minimum 4/0 AWG, unless otherwise indicated.
2.4 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:
   1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90°C minimum, meeting requirements of UL 510.
   3. Arc and Fireproofing:
      a. 30-mil, elastomer
      b. Manufacturers and Products:
         1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tapebinder.
         2) Plymount; Plyarc 30, with Plymount Plyglas glass cloth tapebinder.

B. Identification Devices:
   1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
   2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.

C. Connectors and Terminations:
   1. Nylon, Insulated, Heavy Duty, Ring Connectors:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) Burndy; Insulink.
         3) ILSCO.

D. Cable Lugs:
   1. In accordance with NEMA CC 1.
   2. Rated 600 volts of same material as conductor metal.
   3. Insulated, Locking-Fork, Compression Lugs:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) Burndy; Insulink.
         3) ILSCO.
   4. Uninsulated Crimp Connectors and Terminators:
      a. Manufacturers and Products:
         1) Square D; Versitide.
         2) Thomas & Betts; Color-Keyed.
         3) ILSCO.
   5. Uninsulated, Bolted, Two-Way Connectors and Terminators:
      a. Manufacturers and Products:
         1) Thomas & Betts; Locktite.
         2) Burndy; Quiklug.
         3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, reusable, and plenum rated.
   1. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyolefin.
   1. Manufacturer and Product: Thomas & Betts; SHRINK-KON.
2.5 COMMUNICATIONS CABLE

A. All communications fiber optic cable and cooper communications cable shall be provided, terminated and tested as required in SECTION 27 00 00 and the Drawings.

B. Communications cable shall be installed as required by the Contract Documents, manufacturer's recommendations and as approved by the ENGINEER.

2.6 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, PVC-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:
   1. Ideal Co.; Yellow 77.
   2. Polywater, Inc.

2.7 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

PART 3 EXECUTION

3.1 GENERAL

A. See Specification SECTION 27 00 00 and 26 05 10 for additional communications cable requirements.

B. Conductor installation to be in accordance with NECA 5055.

C. Conductor and cable sizing shown is based on copper conductors.

D. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

E. All parallel power conductors shall be of equal length, unless otherwise approved by the ENGINEER.

F. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.

G. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

H. Bundling: Where single conductors and cables in manholes, handholes, vaults, equipment, panels, terminal boxes, wireways, and other locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches on center.

I. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

J. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.
3.2 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:
   1. Reference Specification SECTION 40 90 00 for additional color coding requirements.
   2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
   3. No. 8 AWG and Smaller: Provide colored conductors.
   4. Colors:

<table>
<thead>
<tr>
<th>System</th>
<th>Conductor</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Systems</td>
<td>Equipment Grounding</td>
<td>Green</td>
</tr>
<tr>
<td>240/120 Volts</td>
<td>Grounded Neutral</td>
<td>White</td>
</tr>
<tr>
<td>Single-Phase, Three-Wire</td>
<td>One Hot Leg</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>Other Hot Leg</td>
<td>Red</td>
</tr>
<tr>
<td>600 Volts Single-Phase, Two-Wire</td>
<td>Phase A</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>Phase B</td>
<td>Blue</td>
</tr>
</tbody>
</table>

NOTE: Phase A, B implies direction of positive phase rotation.

   5. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.3 CIRCUIT IDENTIFICATION

A. Identify all power, instrumentation, control, communication, and fire alarm cables and conductor circuits, at each termination and in accessible locations such as manholes, handholes, panels, pull boxes, and terminal boxes.

   1. Assign a circuit name for PB, LCP and equipment interface conductors and cables, where the load end shall be originating location.
      a. Examples:
         1) PB-VH-1-11/LCP-TB1-11 Where:
            a) PB-VH-1-X1 = originating panelboard VH-1, circuit 11
            b) LCP-TB1-X1 = destination LCP, terminal board 1, terminal 11.
         2) LCP-TB1-12/GIA-40 Where:
            a) LCP-TB1-12= originating LCP, terminal board 1, terminal 12
            b) X1 = destination GIA, terminal 40.
   2. Conductors and cables which are in parallel or in series between equipment shall have the same circuit name. Terminal/conductor numbers shall be the same as the terminal to which it connects.

B. Method:

   1. Conductors No. 3 AWG and Smaller: White identification sleeves with machine printed, permanent black ink letters and numbers. The figures shall be a minimum of 1/8 inch high. Sleeves shall be sized to fit the conductor insulation and shrunk to fit the conductor with hot air.
   2. Cables, and Conductors No. 2 AWG and Larger:
      a. Identify with marker plates.
      b. Attach marker plates with nylon tie cord.
   3. Taped-on markers or tags relying on adhesives not permitted.
3.4 CONDUCTORS 600 VOLTS AND BELOW

A. Install 12 AWG minimum conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by ENGINEER.

C. Connections and Terminations:
   1. Install wire nuts only on solid conductors of 120-volt and lighting and 120-volt receptacle circuits only.
   2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.
   3. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
   4. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
   5. Install uninsulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.
   6. Tape insulate all uninsulated connections.
   7. Place no more than one conductor in any single-barrel pressure connection.
   8. Install crimp connectors with tools approved by connector manufacturer.
   9. Install terminals and connectors acceptable for type of material used.
   10. Compression Lugs:
       a. Attach with a tool specifically designed for purpose.
       b. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
       c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:
   1. Indoors: Use general purpose, flame retardant tape.
   2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors and cables with UL listed end caps.

G. Cabinets and Panels:
   1. Remove surplus wire, bridle and secure.
   2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:
   1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
   2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
   3. Locate splices in readily accessible cabinets or junction boxes using terminal strips. Splices in Panduit using wire nuts are not permitted.
   4. Where connections of cables installed under this Section are to be made under SECTION 40 90 00, leave pigtails of adequate length for bundled connections.
   5. Cable Protection:
      a. Install individual wires, pairs, or triads into bundles at least 1/2 inch in diameter.
b. Maintain integrity of shielding of instrumentation cables.

c. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.5 COMMUNICATIONS CABLE INSTALLATION

A. Do not exceed cable manufacturer’s recommendations for maximum pulling tension and minimum bending radii.

B. Install cable into wall plates and patch panels per manufacturer’s instructions, using only tools approved by the manufacturer.

C. Bundling:

1. When cables are running outside of conduit, bundle together with other cables of the same type throughout their exposed length with cable ties placed at intervals not exceeding 12 inches on center. Cable running above suspended ceilings should be fastened securely to roof joists or other locations approved by ENGINEER with J-hooks or equivalent means, at maximum spacing of 6 feet on center.

D. Cable runs from each jack to the communications distribution equipment must be pulled as one continuous piece of cable. Splicing is not permitted.

E. All Category 5e data cables shall be bundled together with tie wraps in service loops approved by the ENGINEER.

F. Labeling:

1. Cables must be labeled in visible locations at each end with pre-printed wrap-around labels.

2. Cables must be labeled in visible locations at each pull box conduit, and EHH with pre-printed wrap-around labels.

3. Wall plates shall be labeled using a label-maker (Brother brand) with 1/4 inch black letters on a white background.

4. Data patch panels shall be labeled using a label-maker (Brother brand) with 1/4 inch black letters on a white background.

5. All labeling shall be approved by the ENGINEER.

G. Pulls shall be made with no splices, unless approved by the ENGINEER.

H. All interbuilding fiber cables shall be installed in rigid galvanized steel conduit or pvc-coated rigid galvanized steel conduit.

I. All fiber optic cables shall be installed in strict accordance with the manufacturer's recommendations and requirements. The fiber optic cable minimum bending radii shall be maintained as recommended by the manufacturer. The fiber optic cable shall be installed with minimized pulling tensions.

3.6 FIELD QUALITY CONTROL

A. In accordance SECTION 26 08 00.

END OF SECTION
PART 1  GENERAL

1.1 SCOPE
A. Provide and install grounding as required by the Contract Documents.

1.2 REFERENCES
A. The equipment and Work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:

1. International Society of Automation (ISA).
4. Institute of Electrical and Electronics Engineers (IEEE):
5. National Electrical Contractor's Association, Inc. (NECA):
   a. 5055, Standard of Installation.
   a. 70, National Electrical Code (NEC).
8. Underwriters Laboratories, Inc. (UL).

1.3 SUBMITTALS
A. Shop Drawings:
   1. Product Data:
      a. Itemized bill of material including manufacturer, complete model number and options included.
      b. Exothermic weld connectors.
      c. Compression connectors.
      d. Ground rods.
      e. Conductive backfill material.

B. Quality Control Submittals:
   1. Testing Related Submittals.
   2. O&M Manuals:
      a. Refer to paragraph Shop Drawings for the following items:
         1) Itemized bill of material including manufacturer, complete model number and options included.
         2) Catalog cuts.
         3) Component data sheets.
         4) All final as-built Drawings of grounding and component locations shall be provided in electronic media, (AutoCAD version 2009 or earlier), on standard IBM computer compatible 2GB Hi-Speed Flash Drives and in hard three ring 11 x 17 inches binders in unfolded quality hard copy media.
         5) Factory and field certified test reports
1.4 QUALITY ASSURANCE
   A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.
   B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories (UL) shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.
   C. Manufacturer shall provide certificate of ISO 9002 Compliance.

1.5 PROJECT & SITE ENVIRONMENTAL CONDITIONS
   A. All materials and equipment shall be designed and constructed for continuous operation, at rated current, at 6,900-feet above mean sea level, 40°C ambient and 95% relative humidity.

1.6 WARRANTY
   A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.

1.7 UL COMPLIANCE
   A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 GROUND ROD
   A. Material: Copper-clad steel.
   B. Diameter: Minimum 3/4-inch.
   C. Length: 10 feet.

2.2 GROUND CONDUCTORS
   A. As specified in SECTION 26 05 19.

2.3 CONNECTORS
   A. Exothermic Weld Type:
      1. Outdoor Weld: Suitable for exposure to elements or direct burial.
      2. Indoor Weld: Utilize low-smoke, low-emission process.
      3. Manufacturers:
         a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
   B. Compression Type:
      1. Compress-deforming type; wrought copper extrusion material.
      2. Single indentation for conductors 6 AWG and smaller.
      3. Double indentation with extended barrel for conductors 4 AWG and larger.
      5. Manufacturers:
         a. Burndy Corp.
2.4 CONDUCTIVE BACKFILL, GROUND ENHANCEMENT MATERIAL

A. Metallurgical coke breeze:
   1. Composition shall be approved by the Environmental Protection Agency.
   2. Slaked with lime to reduce moisture loss.
   3. Composition:
      a. Moisture 10% max.
      b. Fixed Carbon 85 to 92%
      c. Ash 12% max
      d. Volatiles 1.5% max
      e. Sulphur 1.5% max
      f. Phosphorous 0.03% max
   4. Physical Characteristics:
      a. Particle size 0-10mm (max)
      b. Bulk density 750kg/m³
      c. Resistivity 50-ohms/cm (max)

PART 3 EXECUTION

3.1 GENERAL

A. Grounding shall be in compliance with NFPA 70 and ANSI C2.

B. Provide and extend existing grounding grid as indicated on the Drawings. Provide individual ground pigtales for equipment and bonding as indicated on the Drawings.

C. Ground cable shall have a minimum cover of 3 feet below finished grade, unless otherwise shown on the Drawings or approved by the ENGINEER.

D. Ground cable near the base of a structure shall be installed no closer than 24 inches to the structure.

E. Buried horizontal ground cable and ground rods shall be installed using a conductive backfill material as indicated on the drawings.

F. Ground cable through exterior walls shall be prepared with a water stop that shall include filling the space between the strands with solder and as shown in drawings.

G. Connect the Valve House, Manway, and Control Building via a 4/0 AWG bare copper conductor to the electrical service grounded conductor.

H. Ground separately derived system neutrals to the ground grid and building steel.

I. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

J. Shielded Instrumentation Cables:
   1. Ground shield to ground bus at power supply for analog signal, unless indicated otherwise.
   2. Expose shield minimum one inch at termination to field instrument and apply heat shrink tube.
   3. Do not ground instrumentation cable shield at more than one point.

K. Notify ENGINEER prior to backfilling ground rods, horizontal ground conductors, and all ground connections.
3.2 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits.

B. Connect ground conductors to raceway grounding bushings.

C. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

D. Connect enclosure of equipment containing ground bus to that bus.

E. Bolt connections to equipment ground bus. Cable connections to bus bars shall be made with compression one-hole or two-hole lugs.

F. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

G. Junction Boxes: Furnish materials and connect to equipment grounding system.

H. Ground conductors on equipment shall be formed to the contour of the equipment and firmly supported.

I. All ground connection hardware, bolts, and nuts shall be high strength, high conductivity copper alloy.

3.3 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

3.4 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point a minimum of 30 inches below finished grade, unless otherwise shown.

C. Install each ground rod in a 4-inch bored hole with conductive backfill material.

D. Conductor connection shall be exothermic weld, unless otherwise approved.

3.5 CONNECTIONS

A. General:

1. Abovegrade Connections: Use either exothermic weld, unless otherwise approved by the ENGINEER.

2. Belowgrade Connections, Splices, and Joints: Install exothermic weld.

3. Connections, Splices, and Joints Which Will Be Inaccessible Upon Completion of Construction: Install exothermic weld.

4. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.

5. Notify ENGINEER prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.

2. Use welding cartridges and molds in accordance with manufacturer's recommendations.

3. Avoid using badly worn molds.

4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:
   1. Install in accordance with connector manufacturer's recommendations.
   2. Install connectors of proper size for grounding conductors and ground rods specified.
   3. Install using connector manufacturer's compression tool having proper sized dies.

3.6 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms. Bond metal platforms or steps to the grounding system.

C. Provide electrical contact between metal frames and railings supporting push button stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.7 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.8 FIELD QUALITY CONTROL

A. As specified in SECTION 26 08 00.

B. Test each grounding system, Valve House, Control Building, Stream Gauge as required in SECTION 26 08 00.

END OF SECTION
SECTION 26 05 33
RACEWAYS

PART 1  GENERAL

1.1   SCOPE
A. Provide and install raceways as specified herein and as shown on the Contract Drawings. All raceways installed in this Contract shall be installed by the Electrical Contractor and Colorado Licensed Electricians.

1.2   REFERENCES
A. The equipment and work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:
   1. Institute of Electrical and Electronics Engineers (IEEE).
   2. International Society of Automation (ISA).
   8. Underwriters Laboratories, Inc. (UL).

1.3   SUBMITTALS
A. Shop Drawings:
   1. Itemized bill of materials including manufacturer, complete model number and options included.
   2. Manufacturer's Literature:
      a. Rigid galvanized steel conduit.
      b. PVC-coated rigid galvanized steel conduit.
      c. Electrical Metallic Tubing.
      d. PVC Schedule 40 conduit.
      e. Flexible metal, liquid-tight conduit.
      f. Conduit fittings.
      g. Wireways.
      h. Accessories, including all products to be used in construction.
   3. Conduit and Ductbank Layout:
      a. Plan and section type, showing arrangement and location of conduits.
      b. Layout drawings shall be provided in electronic media, (AutoCAD version 2009 or earlier), on standard IBM computer compatible 2GB Hi-Speed USB Flash Drives and in hard three ring 11" x 17” binders in unfolded quality hard copy media. The AutoCAD Drawings shall follow Denver Water Design Drafting Standards as indicated in Quality Control Submittals.
      c. Conduit racking system to be used in the manway. The racking system shall maximize the horizontal space remaining for future use in the manway.
   4. Ductbank mix design.
   5. Equipment and machinery proposed for bending, threading, and handling metal conduit.
   6. Method for bending PVC conduit less than 30 degrees.
7. PVC-coated RGS manufacturer’s Certificate of Completion from the manufacturer’s conduit training course for all personnel who will be installing PVC-coated conduit.
8. Method and equipment for cleaning existing conduits.
9. Methods and tools to be used to assemble and install PVC-coated rigid galvanized steel conduit.
10. Electrical Handholes (EHH), including complete dimensioned drawings, calculations, concrete mix design, component cut-sheets & information.
11. Concrete Encased, Steel Reinforced Ductbank, including complete dimensioned drawings, steel data and configuration, concrete mix design, component cut-sheets & information.

B. Quality Control Submittals:

1. Testing Related Submittals: For each existing conduit provide information including:
   a. Condition of removed conductors or cables.
   b. Materials removed from existing conduit when cleaned.

2. O&M Manuals:
   a. Legends Abbreviation Lists.
   b. Refer to paragraph Shop Drawings for the following items:
      1) Itemized bill of material including manufacturer, complete model number and options included.
      2) Catalog cuts.
      3) Component data sheets.
      4) Final as-built conduit layout drawings, including all dimensions in plan & elevation. Underground raceway systems shall include dimensions of ductbank or raceway and depth to the top of the ductbank or raceway. Final As-built Contract Drawing conduit/conductor schedules and tag numbers.
      5) All final as-built Drawings shall be provided in electronic media, (AutoCAD version 2009 or earlier), on standard IBM computer compatible 2GB Hi-Speed USB Flash Drives and in hard three ring 11” x 17” binders in unfolded quality hard copy media.
      6) Manufacturer’s Certificate of Warranty.

1.4 QUALITY ASSURANCE

A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.

B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.

C. Manufacturer shall provide certificate of ISO 9002 Compliance.

1.5 PROJECT & SITE ENVIRONMENTAL CONDITIONS

A. All materials and equipment shall be designed and constructed for continuous operation, at rated current and voltage, at 6,900-ft above mean sea level, 40°C ambient and 95% relative humidity.

1.6 WARRANTY

A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.
1.7 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories (UL) shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):
   1. Meet requirements of ANSI C80.1 and UL6.
   2. Material: Hot-dip galvanized, inside and outside, with chromated protective layer.

B. PVC-Coated Rigid Galvanized Steel Conduit:
   1. Meet requirements of NEMA RN 1.
   2. The PVC-coated rigid galvanized steel conduit must be UL listed.
   3. All factory-cut threads shall be protected with hot galvanize and a clear urethane coating.
   4. Install in accordance with manufacturer’s instructions. For all pvc-coated RGS conduits, provide and install with a sufficient amount of manufacturer’s touch-up compound to the end of the conduit in the area normally covered by the sleeve, just prior to assembling joints to create a seal between the sleeve and the conduit coating to keep moisture out.
   5. PVC-coated RGS conduit shall be resistant to UV damage and shall not deteriorate when exposed outdoors.
   6. All PVC-coated conduit, fittings, and accessories shall be supplied by the same manufacturer.
   7. All couplings and fittings shall be provided with PVC sleeves and seals, unless otherwise approved by the ENGINEER.
   8. Material:
      a. Conduit: Meet requirements of ANSI C80.1 and UL 6.
      b. PVC Coating:
         1) Minimum 40 mils nominal thickness, exterior coating bonded to metal.
         2) Minimum 2 mils nominal thickness, interior coating bonded to metal.
   9. Manufacturers:
      a. Ocal
      b. Robroy

C. Electrical Metallic Conduit (EMT):
   1. EMT shall comply with UL 797 and ANSI C80.3.
   2. Zinc-coated steel, galvanized on the outside and coated on the inside with a hard smooth lacquer finish.

D. PVC Schedule 40 Conduit:
   1. Meet requirements of NEMA TC 2 and UL 651.
   2. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90°C insulated conductors.

E. Flexible Metal, Liquid-Tight Conduit:
   1. UL 360 listed for 105°C for dry locations.
2.2 FITTINGS

A. Rigid Galvanized Steel:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw fittings not permitted.

2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150°C.
   b. Manufacturers:
      1) Thomas & Betts; Type BIM.
      2) O.Z. Gedney; Type HB.

3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150°C, with solderless lugs.
   b. Manufacturers:
      1) Appleton; Series GIB.
      2) O.Z. Gedney; Type HBLG.

4. Conduit Hub:
   a. Material: Zinc or stainless steel with lexan insulated throat and ground screw.
   b. Manufacturer and Product:
      1) Crouse-Hinds; Type Myers SCRUTITE.

5. Conduit Bodies:
   a. Material: Malleable iron, sized as required by NFPA 70.
   b. Manufacturers (For Normal Conditions):
      1) Appleton; Form 35 threaded Unilets.
      2) Crouse-Hinds; Form 7 or 8 threaded condulets.
      3) Killark; Series O Electrolets.

6. Couplings: As supplied by conduit manufacturer.

7. Conduit Sealing Fitting Manufacturers:
   a. Appleton; Type EYF, EYM, or ESU.
   b. Crouse-Hinds; Type EYS or EZS.
   c. Killark; Type EY or EYS.

8. Drain Seal Manufacturers:
   a. Appleton; Type SF.
   b. Crouse-Hinds; Type EYD or EZD.

9. Drain/Breather Fitting Manufacturers:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.

10. Expansion Fitting Manufacturers:
    a. Deflection/Expansion Movement:
       1) Appleton; Type DF.
       2) Crouse-Hinds; Type XD.
    b. Expansion Movement Only:
       1) Appleton; Type XJ.
       2) Crouse-Hinds; Type XJ.

11. Cable Sealing Fittings:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2-inch or less: Neoprene bushing at connector entry.
    c. Manufacturers:
       1) Crouse-Hinds; CGBS.
       2) Appleton; CG-S.

B. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Type: Rigid galvanized steel, PVC coated by conduit manufacturer to same coating Specifications as the conduit.
3. Overlapping pressure sealing sleeves.
5. All PVC-coated RGS conduit shall be installed using the PVC coating manufactures recommended fittings, hangers, attachments, and accessories.

C. Electrical Metallic Conduit:
1. Steel compression type with a nylon insulated throat for rain-tight and concrete-tight applications.
2. Steel set screw type or steel compression type for all other connections.
3. Conduit ends shall be fitted with bushings – bushings shall be threaded and have a nylon insulated throat.
4. Die cast zinc fittings are prohibited.

D. PVC Conduit and Tubing
1. Meet requirements of NEMA TC-3.
2. Type: PVC, slip-on.

E. Flexible Metal, Liquid-Tight Conduit:
1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105°C.
2. Insulated throat and sealing O-rings.
3. Long design type extending outside of box or other device at least 2 inches.
4. Exterior and inside the manway: 40-Mil PVC coated steel, sealing O-rings, metal insulated throat connectors with integral nylon or plastic bushings rated for 105°C.
   a. Manufacturer:
      1) Robroy Industries; Series PR.
      2) Ocal; Series ST.
5. Building Interiors, dry locations: steel body, thermoplastic elastomer sealing gasket, sealing O-rings, metal insulated throat connectors with integral nylon or plastic bushings rated for 105°C.
   a. Manufacturer:
      1) Appleton; Series STB.
      2) Crouse-Hinds; Series LTB.
      3) Manufacturer: T & B; Series 5300.

F. Watertight Entrance Seal Device:
1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer: O.Z. Gedney, Type FSK or WSK, as required.
2. Cored-Hole Application:
   b. Manufacturers:
      1) O.Z. Gedney; Series CSM.
      2) Link Seal; type LS.
      3) Unless otherwise approved by the ENGINEER.

2.3 WIREWAYS

A. Meet requirements of UL 870.
B. Type: Steel or stainless steel as indicated on the Drawings, with removable, hinged cover.
C. Rating: NEMA 3R or NEMA 4X as indicated on the Drawings.

D. Finish:
   1. NEMA 3R - Gray, baked enamel.
   2. NEMA 4X – None.

E. Manufacturers:
   1. Square D.
   2. B-Line Systems, Inc.
   3. Hoffman.

2.4 PRECAST ELECTRICAL HANDHOLES (EHH)

A. Vault and Lid Design Loading: ASSHTO H-20-44, with impact.

B. Sump:
   1. Slope floors toward drain points, leaving no pockets or other non-draining areas.
   2. Provide sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover.

C. Raceway Entrances:
   1. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.

D. Embedded Pulling Iron:
   1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
      a. Location: Wall opposite each raceway entrance.

E. Cable Racks:
   1. Arms and Insulation: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
      a. Wall attachment:
         1) Adjustable inserts in concrete walls. Bolts or embedded studs are not permitted.
         2) Insert spacing: Maximum 3-foot on center on the entire inside perimeter.
         3) Arrange so that the spare raceway ends are clear for future cable installation.

F. Electrical Handhole Frames and Covers:
   1. Material: Steel, hot-dip galvanized.
      a. Cover type: Solid, lockable, hinged, of diamond plate pattern design.
      c. Cover Lock Assembly:
         1) Recessed lock assembly with a flush, gasketed, removable brass screw plug machine engraved with the Electric Handhole’s Drawing designation, ex. EHH-1.
         d. The Cover and lock assembly shall be provided with a Best Lock Core. All keys shall be provided to the OWNER at final completion.
         e. Cover lifting assist: the cover shall include provisions so that the weight of the cover isn’t borne by the lock assembly when opening or closing the cover.
f. Manufacturers:
   1) BILCO.

G. Hardware: Steel, hot dip galvanized.

H. Manufacturers:
   1. Oldcastle Precast; AMCOR or Utility Vault Co.
   2. Vaughn Concrete Products, Inc.

2.5 ACCESSORIES

A. Conduit Stands:
   1. Conduit support stands:
      a. Material: Stainless Steel
      b. Shape: Square
      c. Manufacturers:
         1) Unistrut, type P2072A SQ.

B. Duct Bank Spacers:
   1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
   2. Suitable for all types of conduit.
   3. Manufacturer: Underground Device, Inc., Type WUNPEECE; Carlon, Type SNAP-LOC, Snap-N-Stac.

C. Identification Devices:
   1. Raceway Tags:
      b. Shape: Round.
      c. Raceway Designation: Engraved.
      d. Tags relying on adhesives or taped-on markers not permitted.
   2. Warning Tape:
      b. Width: Minimum 2-inches.
      d. Manufacturers:
         1) Brady Catalog #91601.
   3. Wraparound Duct Band:
      b. Manufacturer: Raychem, Type TWDB.

D. Conduit cutting, threading, and installation/joining tools:
   1. Robroy Industries, Z-wrench.
   2. Ocal, J-wrench.
   3. Strap wrench.
   5. Vise clamp inserts specially made for PVC-coated conduit.

PART 3 EXECUTION

3.1 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors.

B. All installed Work shall comply with NECA 5055.
C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Two or more conduits in the same general routing shall be parallel with symmetrical bends. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps. Conduits installed horizontally shall allow headroom of at least 7 feet except in areas where headroom cannot be maintained because of other considerations, as determined by the ENGINEER.

G. Sealing Fittings: Provide drain seal in raceways where condensate may collect above sealing fitting, and as indicated on the Drawings.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes. Avoid passageway and access obstructions.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Paint threads, before assembly rigid galvanized steel conduit, with zinc-rich paint or liquid galvanizing compound.

O. All metal conduit shall be reamed, burrs removed, the thread degreased, cleaned and dried before installation.

P. Do not install raceways in concrete equipment pads, foundations, or beams, unless approved by the ENGINEER.

Q. Horizontal raceways installed under slabs shall lay a minimum of six inches below the slab, with no part embedded within slab.

R. Spare conduits shall be plugged with metal threaded plugs or capped with steel threaded caps.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

T. Conduit terminations at sheet steel boxes shall be sealed by forcing a non-hardening sealing compound into the conduit for a distance at least equal to the conduit diameter.

U. All conduits indicated on the Drawings shall be provided and installed as a minimum. Conductors and cables shall not be consolidated into conduits unless indicated on the Contract Drawings or approved by the ENGINEER.

V. All raceways 1.25-inch and larger shall use conduit bodies and condulets at least one size larger than the raceway and shall be sized to meet the requirements of NFPA 70 as a minimum.
Each conduit run shall be identified on each end and at all pull points by a permanently engraved brass tag corresponding to the identification listed in the “Raceway & Circuit Schedule”.

Conduits shall be installed in such a manner as to keep exposed threads to an absolute minimum and in no case shall more than three threads be left exposed.

In outdoor areas, all locations within the manway, indoor NEMA 4X areas, and other wet or corrosive areas, coat all threads with an approved electrically conductive corrosion-resistant compound.

Seal all raceways in all manway or exterior EHHs, panelboards, pull boxes, condulets, etc. with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.

Seal all raceways in the manway’s LCPs, panelboards, control stations, pull boxes, condulets, etc. with oakum or expandable plastic compound to prevent the entrance of liquids from one area to another.

Provide strut caps for all installed strut.

3.2 INSTALLATION IN CAST-IN-PLACE CONCRETE

Minimum cover one inch.

Provide support during placement of concrete to ensure raceways remain in position.

All rigid galvanized steel conduits embedded in duct banks, concrete encasement and concrete floor, wall and ceiling slabs shall be coated with a factory-installed PVC coating, when required by governmental agency having jurisdiction over the Work or to meet Code compliance.

1. Outside diameter of conduit not to exceed one-third of the slab thickness, unless otherwise approved by the ENGINEER.
2. Separate conduit by minimum four times conduit outside diameter, except at crossings, unless otherwise approved by the ENGINEER.

3.3 CONDUIT APPLICATION

Diameter: Minimum 3/4 inch and Minimum one inch, for underground conduits, unless otherwise approved by the ENGINEER.

Exterior, Exposed: PVC-coated rigid galvanized steel.

Interior, Exposed:

1. Rigid galvanized steel in Valve House, Control Building, Stream Gauge Building, and Headquarters Office Building Garage areas.
2. PVC-coated rigid galvanized steel in all manway areas and upper and lower manway entrances.
3. EMT in Headquarters Office Building Office and non-heated storage areas.

Interior, Concealed (Not Embedded in Concrete): PVC-coated rigid galvanized steel.

Aboveground, Embedded in Concrete Walls, Masonry Walls, Ceilings, or floors: PVC-coated rigid galvanized steel.

Direct Earth Burial: PVC-coated rigid galvanized steel.

Concrete-Encased Raceways (except in underground ductbanks): PVC-coated rigid galvanized.
H. Under Slabs-Below-Grade: PVC-coated rigid galvanized steel.

I. Concrete-Encased, Steel Reinforced Ductbanks, PVC schedule 40 when indicated on the Drawings, for straight conduit runs. Bends installed in ductbanks equaling or exceeding 45-degrees shall be made with factory-made PVC-coated RGS elbows or bends.

3.4 CONNECTIONS

A. For motors, fans, unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment, with rotating or moving parts, where flexible connection is required to minimize vibration:

3. Length: 18-inches minimum, 24-inches maximum, of sufficient length to allow movement or adjustment of equipment, unless otherwise approved by the ENGINEER.

B. Outdoor Areas, Process Areas Exposed to Moisture, and Areas required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

C. Transition From Concrete-Embedded to Exposed: PVC-coated rigid steel conduit. PVC-coated conduit shall extend at least 6 inches above and below the floor.

D. Transition from Underground to Exposed: PVC-coated rigid galvanized steel conduit. PVC conduit shall extend at least 6 inches above and below the floor.


F. In Exterior Light Pole Foundations: PVC-coated Rigid galvanized steel conduit.

3.5 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating. Fire-stops and seals shall be Dow Corning’s Fire-stop Series 2000, 3M’s Fire Barrier Composite Sheets CS195, or equal. Fire-stops shall be applied in accordance with the manufacturer’s recommendations. Products which are affected by water are not acceptable.

C. PVC-coated rigid galvanized steel conduit protruding through concrete floor slabs to a point 6-inches above and 6-inches below concrete surface.

D. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack when approved by the ENGINEER, or use watertight seal device.

E. Entering Structures:

1. Except for raceways containing fiber optic cables, all conduits entering the upper manway entrance shall be provided with C-condulets or LB-condulets immediately inside the wall. These conduit covers shall be faced down and the conduit shall be identified at the condulet. Additionally, C-condulets shall be installed in every raceway run at each manway landing and at the lower manway entrance. These C-condulets shall be installed with the condulet opening facing downwards and shall have a non-hardening ductseal installed in the downstream side of each C-condulet. These C-condulets shall have several ¼” holes drilled in them to allow the moisture to drain out of each raceway. Provide boxes as
specified, with Myers type conduit hubs on both sides of the box, instead of condulets for raceways containing fiber optic cables. Install these boxes immediately inside the upper manway entrance and at locations described above for other non-fiber optic designated raceways installed in the manway.

2. Seal raceways at first condulet, first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.

3. Heating, Ventilating, and Air Conditioning Equipment:
   a. Penetrate equipment in area established by Manufacturer.
   b. Terminate conduit with flexible metal liquid-tight conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
   c. Seal penetration with oakum or expandable plastic compound.

4. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device, unless otherwise indicated on the Drawings.

5. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   a. Provide watertight entrance seal device, unless otherwise indicated on the Drawings.

6. Manholes and Handholes:

F. Concrete equipment pads: Provide nonshrink grout dry-pack in blockout areas and around conduits.

G. Entering Structures:
   1. Existing Wall: Core drill wall and install watertight entrance seal devices, as required in the Contract Documents.

3.6 SUPPORT

A. When approved by the Engineer, provide floor support along pipes at 3 foot intervals using stainless steel Unistrut floor stands. Conduits shall be a minimum of 12 inches off finished floor. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 30% extra space for future conduit, unless otherwise approved by the ENGINEER.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as indicated in the Contract Documents and as approved by the ENGINEER. Typical methods:
   1. Hollow Masonry Units: Toggle bolts.
   2. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

E. Raceway supports and fasteners shall be stainless steel.

3.7 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance. Bends shall not exceed 270 degrees between pulling points, unless otherwise approved
by the ENGINEER. Pull boxes shall be provided for straight runs not to exceed 200 feet, unless otherwise approved by the ENGINEER.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit
   1. Bends 30-Degree: Provide factory-made.
   2. Bends larger than 30-Degree: Provide PVC-coated rigid steel.
   3. 90-Degree Bends: Provide Manufacturer PVC-coated rigid steel elbows.
   4. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

I. PVC-coated RGS conduit field bends shall only be made with the conduit manufacturers recommended bending equipment to prevent damage to the PVC coating.

3.8 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, in long tangential runs, and as indicated on the Drawings.

B. Provide expansion/deflection joints for 50°F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.9 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer's instructions. For all PVC-coated RGS conduits, provide and install with a sufficient amount of manufacturer's touch-up compound to the end of the conduit in the area normally covered by the sleeve, just prior to assembling joints to create a seal between the sleeve and the conduit coating to keep moisture out.

B. Provide PVC boot to cover all exposed threading.

3.10 PVC CONDUIT

A. Solvent Welding:
   1. Provide manufacturer recommended solvent; apply to all joints.
   2. Install such that joint is watertight.
   3. Follow the manufacturer's recommendations for making all solvent welds.

B. Adapters:
   1. PVC to Metallic Fittings: PVC terminal type.
   2. PVC to Rigid Metal Conduit: PVC female adapter.

C. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.
3.11 WIREWAYS
   A. Install in accordance with manufacturer's instructions.
   B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.12 TERMINATION AT ENCLOSURES
   A. Cast Metal Enclosure: Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.
   B. Sheet Metal Boxes, Cabinets, Disconnects, Panelboards, Valve Control Stations, Control Panels, Motor Control Centers, and Enclosures:
      1. Rigid Galvanized Steel Conduit and Liquid-Tight Flexible Metal Conduit:
         a. Interior: Provide zinc hub, for RGS conduit, and PVC-coated hub, for PVC-coated RGS conduit. Provide with and bond grounding screw. Hubs shall be Crouse-Hinds Myers Scru-Tite hubs.
         b. Exterior: Provide stainless steel hub, for RGS conduit, and PVC-coated hub, for PVC-coated RGS conduit. Provide with and bond grounding screw. Hubs shall be Crouse-Hinds Myers Scru-Tite hubs.
         c. Grounding bushings and hub grounding screws shall be installed with a bonding jumper from the bushing or screw to the equipment ground bus, ground terminal or ground pad.
         d. Install insulated bushing on ends of conduit where grounding is not required, only when approved by the ENGINEER.
         e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
      2. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
      3. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.
   C. New and Existing conduits: Terminate all existing conduits entering concrete troughs, FCCs, Communications cabinets, Communications closets, disconnects, motors, MCCs, equipment, panelboards, switchboards, LCPs, cabinets, and equipment (new and existing) with grounding bushing; provide a grounding jumper, bonding, ground bushings and extending to equipment ground bus, ground terminal or grounding pad.

3.13 UNDERGROUND RACEWAYS
   A. Grade: Maintain minimum grade of 4-inches in 100-ft, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
   B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown on the Drawings or approved by the ENGINEER.
   C. Make routing changes as necessary to avoid obstructions or conflicts.
   D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.
   E. Union type fittings, Erickson couplings and split couplings are not permitted.
   F. Spacers:
      1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
      2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:
   1. Crossings: Maintain minimum 12-inches vertical separation.
   2. Parallel Runs: Maintain minimum 12-inches separation.
   3. Installation over valves or couplings not permitted.

I. Metallic Raceway Coating: Apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

J. Concrete Encasement: As specified in SECTION 03 30 00, the following are the minimum requirements:
   1. Ductbank concrete shall be 3,000 psi minimum.
   2. Ductbank concrete shall be completely red, (minimum of 3# red oxide per sack of cement).
   3. Ductbank concrete mix design must be approved by the ENGINEER.

I. All underground conduits not indicated as otherwise on the Drawings shall be direct buried as shown on the Drawings.

J. Concrete placement and overflow outside of the approved ductbank section dimensions shall be minimized. Excessive concrete placement and overflow shall be removed, unless otherwise approved by the Engineer.

K. No underground conduit shall be smaller than one inch, unless otherwise approved by the ENGINEER.

L. Concrete-encased conduit shall have minimum concrete thicknesses of 2-inches between conduits, 1-inch between conduit and reinforcing, and 3-inches over reinforcing.

M. Concrete encasement on exposed outdoor conduit risers shall continue to 4-inches above grade, with top crowned and edges chamfered.

N. Underground conduits shall be sloped to drain from buildings to the manholes or handholes.

O. Backfill: Do not backfill until inspected by ENGINEER or ENGINEER’s representative.

3.14 EMPTY RACEWAYS

A. Provide permanent, removable RGS cap or plug over each end.

B. Provide 2 nylon pull cords in each.

C. Identify, as specified in Item 3.15, IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.15 IDENTIFICATION DEVICES

A. Raceway Tags:
   1. Identify per the Raceway & Circuit Schedule and DW Project tracker number 13529.
   2. All raceway tags shall be approved by the ENGINEER. Samples shall be provided to the ENGINEER.
   3. Install at each terminus, including, but not limited to, EHHs, MCCs, panelboards, switchboards, valve operators, FCCs pull boxes, gutters, condulets, instruments,
devices, communications closets & cabinets, etc. Provide stainless steel (noncorrosive) wire for attachment.

B. Warning Tape: Install approximately 12-inches above all underground or concrete-encased raceways. Align parallel to, and within 12-inches of, centerline of runs.

3.16 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

WELCOME END OF SECTION
PART 1

GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electrical Systems Analysis.
   2. Existing Equipment, reference Paragraph 1.5 A.

B. Related Sections:
   1. DIVISION 01: ADMINISTRATIVE AND PROCEDURAL WORK REQUIREMENTS.
   2. DIVISION 26: ELECTRICAL.
   3. DIVISION 40: PROCESS INTEGRATION.

1.2 REFERENCES

A. The Work covered in this Specification shall be performed and presented in accordance with the latest revisions of the applicable standards of:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
   7. Underwriters Laboratories, Inc. (UL).
   9. Insulated Cable Engineers Association (ICEA).

B. Specific Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
      b. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
      c. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.3 SUBMITTALS

A. Shop Drawings: Provide five copies of study in hard cover, indexed, tabbed divider, three-ring binders, including but not limited to:
   1. Resume(s) for Colorado licensed professional electrical engineer(s) preparing the Electrical Systems Analysis.
   2. One-line Drawing with complete system information.
   3. Impedance Drawing with complete system impedances, resistances, reactances, and sequence impedances.
   4. Submit two copies of the Electrical Systems Analysis to Intermountain Rural Electric Association (IREA) for approval.
5. Short circuit study: An initial study shall be submitted and approved before ENGINEER will approve Shop Drawings for Equipment with AIC rating, including but not limited to: metering equipment & enclosures, CT enclosures, switchboards, panelboards, disconnects, etc.

6. Protective Device Coordination Study: An initial study shall be submitted within 60 days after approval of initial short circuit study. Time-current curves on the same plot shall each be a different color.

7. Arc-Flash Hazard Study: An initial study shall be submitted within 90 days after approval of initial short circuit study.

8. Load Flow and Voltage Drop Study: An initial study shall be submitted within 90 days after approval of initial short circuit study.

B. Quality Control Submittals:

1. The Electrical Systems Analysis shall be updated, as-built and submitted prior to Project Substantial Completion based upon actual equipment information and conductor sizes and lengths as installed or measured. Utilize characteristics of as-installed equipment and materials. All shop drawing information shall be updated and included.

2. Hardcopy and electronic version of installed programs, settings, complete model numbers, equipment & material characteristics.

3. Provide Arc-Flash labels on all Electrical Equipment:
   a. ANSI Z535 compliant.
   b. Indicating worst case conditions.
   c. UV resistant vinyl.

4. Provide complete as-built Electrical Systems Analysis in hard copy media and in electronic format.
   a. Hard Copy Media:
      1) Provide five copies of study in hard cover, tabbed divider, three-ring binders.
   b. Electronic Format:
      1) Complete Electrical Systems Analysis in ESA Easypower version 8.2.
      2) All final as-built Drawings shall be provided in AutoCAD version 2007, on standard IBM computer compatible CDRs.
      3) Introductory Section, Description, Summary, Discussion, Recommendations, etc. in Microsoft Word.
      4) Tabulated data, equipment & material data and characteristics, settings, etc. Microsoft Excel.
      5) Complete Electrical Systems Analysis in Acrobat pdf format.

1.4 QUALITY ASSURANCE

A. The Electrical Systems Analysis shall be prepared, stamped, signed and dated by a licensed professional electrical engineer registered in the State of Colorado, in accordance with IEEE 242 and IEEE 399.

1.5 GENERAL

A. The Electrical Systems Analysis required by these Contract Documents shall include complete studies for all existing and new equipment to and in:

1. The Cheesman Headquarters facilities, including all existing residences, standby generators, the Headquarters Office, and the Bunkhouse and its respective standby generator.

2. The Cheesman Valvehouse and everything downstream of the new metering equipment and distribution system.
3. The 3rd Caretaker’s residence, including the metering and electric distribution system downstream of the utility service point.

B. The studies shall include, but not be limited to, the following:

1. Studies shall be performed in ESA EasyPower version 8.2. All studies shall be provided electronically in EasyPower dez non-protected, (capable of being modified in the future), format.
2. Notify ENGINEER in writing of any inadequacies and provide recommendations for corrections as soon as they are identified.
3. Equipment and component titles used in the studies shall be identical to the equipment and component titles shown on the Drawings or as provided by the Engineer.
4. Perform complete fault calculations for each proposed and ultimate source combination.
5. Impedances, resistances and reactances shall be at 25°C.
6. Source combination may include present and future circuits, large motors, or generators.
7. The CONTRACTOR shall be responsible for acquiring and providing tabulation for the actual, existing and proposed utility fault data, equipment, device and material information, and data for the studies, in a timely manner to allow the studies to be completed. Information and data shall be provided for equipment, electrical system, conductors, cables, conduits, overcurrent protection devices, generators, motors, protective relays, and other component and system information. The CONTRACTOR shall be responsible for verifying study information obtained from Contract Documents and/or provided by ENGINEER.
8. Existing equipment data.
10. Conduits, Conductors and Cables characteristics in the final Electrical Systems Analysis shall match the final as-built Conduit/Conductor Schedules.
11. Equipment information and data in the final Electrical Systems Analysis shall match the final equipment as-built Drawings and O&M manual information and data.

C. Tabulations:

1. Include complete:
   a. Manufacturer, model number and tag numbers.
   b. Equipment data.
   c. Overcurrent protection information, adjustable range and settings.
   d. Protective relay information, adjustable range and settings.
   e. Conduit, conductor and cable material data.
      1) Include conductor lengths, number of conductors per phase, conductor impedance (resistance and reactance) values, insulation types, conduit size and type.
   f. Bus data (materials, plating, ratings, size).
   g. Transformer data, nameplate information, impedances, X/R ratios, etc.
   h. Generator and motor data, nameplate information, reactances, resistances, etc.
   i. Utility data:
      1) All Utility data shall be updated. The previous Electrical Systems Analysis Utility data shall not be used.
      2) Utility personnel that provided data (name, title, phone number).
      3) Utility source data: SCamps, SCkVA, X/R, kV.
      4) System Impedance.
      5) Symmetrical Fault Currents.
      6) Asymmetrical Fault Currents.
      7) Utility line data: conductor size, Neutral size, configuration, distance, positive sequence impedance per distance, positive ...
sequence impedance P.U. in ohms, zero sequence impedance per distance, zero impedance P.U. in ohms.

D. Study Analyses:

1. Written Summary:
   a. Scope of studies performed.
   b. Explanation of bus and branch numbering system.
   c. Prevailing conditions.
   d. Selected equipment deficiencies.
   e. Results of studies.
   f. Comments or suggestions.
   g. Suggest changes and additions to equipment rating and/or characteristics.

1.6 SHORT CIRCUIT STUDY

A. Motor short-circuit contributions shall be included.

B. Tabulation shall be included which lists the calculated short-circuit currents, Fault Impedances, X/R ratios, Asymmetry factors, motor contributions, short circuit kVA, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.

C. Symmetrical and asymmetrical fault currents. Include the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.

D. The system one-line drawing shall clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the study.

E. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

F. Provide:

1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagrams.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Impedance diagrams.
7. Typical calculation.
8. Tabulations of calculated quantities.
9. Results, conclusions, and recommendations.

G. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed single-phase bolted fault at each:

1. Each Electric Utility’s supply termination point and metering equipment as identified on the one-line diagrams.
2. Each Transformer primary and secondary.
3. Generators, new and existing.
4. Switchboards.
5. All facility panelboards.
6. Automatic Transfer Switch.
7. Motor (5HP and larger).
8. Other significant locations throughout the system.

H. Provide bolted line-to-ground fault current study for areas as defined for single-phase bolted fault short circuit study.

I. Verify:
1. Equipment and protective devices are applied within their ratings.
2. Adequacy of all bus bars to withstand short circuit stresses.
3. Adequacy of transformer windings to withstand short circuit stresses.
4. Conductor and Cable sizes for ability to withstand short circuit heating, besides normal load currents.

1.7 PROTECTIVE DEVICE COORDINATION STUDY

A. Where necessary and approved by the ENGINEER, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.

B. The study shall include a separate, tabulation containing the recommended device sizes and settings of all overcurrent protective devices, protective relays, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram. Device information shall include type, manufacturer, model number, tap range, time range, trip sequence, alarms, annunciation, input and output devices and ratings.

C. Provide all calculations to determine settings.

D. System one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus.

E. Provide a discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

F. Provide Current Transformer (CT) and Potential Transformer (PT) information (model number, ratio, rating factor, relay class, ANSI metering accuracy, BIL, excitation curves, VA, etc. Provide complete burden calculations including all devices and conductors. Indicate the linear region of operation on the excitation curves. Provide discussion and recommendations for correcting saturation.

G. Provide a complete coordination study of relays, fuses, circuit breakers, and all other protective devices. The coordination study shall include the entire system including Electric Utility protective devices.

H. All protective devices shall be adjusted, tested, set, and calibrated in the field, prior to energizing the equipment, per the settings in the Study, the Study shall be resubmitted with all field changes. This work shall be done by a qualified factory service representative prior to final acceptance. Protective device settings and sizes shall be approved by the ENGINEER and IREA.

I. Proposed protective device coordination time-current curves, graphically displayed on conventional log-log curve sheets.

J. Each curve sheet to have title and one-line diagram with identification that applies to specific portion of system associated with time-current curves on that sheet.

K. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
L. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

1. The plots in the paragraph below should be modified for the project requirements.

M. Plot Characteristics on Curve Sheets, as a minimum:

1. Electric utility's equipment, fuses, reclosers, cables, including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
2. Protective relays.
3. Generator Decrement Curve.
4. Motor curves (including reduced voltage starting if applicable).
5. All overcurrent devices, (fuses & circuit breakers).
6. Low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
7. Low voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
8. Conductor and cable damage curves.
9. Pertinent transformer full-load currents at 100% and 600%.
10. Transformer magnetizing inrush currents.
11. Transformer damage curves.
12. ANSI transformer withstand parameters.
15. Protective devices for largest branch circuit and feeder circuit breaker in each panelboards.

1.8 ARC-FLASH HAZARD ANALYSIS

A. The Arc-Flash Hazard Analysis shall include Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

B. The Arc-Flash Hazard Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.

C. Results of the Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.

D. The analysis shall be performed under worst-case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

E. The Arc-Flash Hazard Analysis shall be performed in compliance with the latest version of IEEE Standard 1584, the IEEE Guide for Performing Arc-Flash Calculations.

F. The Arc-Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety.

G. The proposed vendor shall demonstrate experience with Arc-Flash Hazard Analysis by submitting names of at least ten actual Arc-Flash Hazard Analyses it has performed in the past year.

H. The proposed vendor shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.

I. Provide Arc-Flash labels on all Electrical Equipment:
1. ANSI Z535 compliant.
2. Indicating worst case conditions.
3. UV resistant vinyl.

1.9 LOAD FLOW AND VOLTAGE DROP ANALYSIS

A. The Load Flow and Voltage Drop Analysis shall include calculations of power flow in all single-phase feeder circuits, calculated voltages at each bus and voltage drops of each feeder.

B. The analysis shall provide the calculated maximum values of kVA, kW, kVAR, power factor, and amperes for each power circuit.

C. The calculated power losses in each branch and total system losses shall be provided.

D. The analysis shall include one-line diagram clearly identifying individual equipment buses, bus numbers, cable and bus connections, power flow throughout the system, and other information related to the analysis.

E. A discussion section evaluating the loading and voltage levels for the system shall be provided and recommendations included as appropriate to improve system operation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General Electric Company Engineering Services.

B. Emerson Engineering.

C. Eaton-Cutler Hammer Engineering Services.

D. Wunderlich-Malec.

E. Unless otherwise approved by the ENGINEER.

PART 3 EXECUTION

3.1 GENERAL

A. Adjust relay and protective device settings according to values established by Protective Device Coordination Study.

B. Make modifications to equipment as required to accomplish conformance with the approved Electrical Systems Analysis Studies.

C. Provide and install ENGINEER approved Arc-Flash labels on all Electrical Equipment, in ENGINEER approved locations.

D. Notify ENGINEER in writing of any inadequacies and provide recommendations for corrections as soon as they are identified.

END OF SECTION
SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

B. Related Sections:
   1. DIVISION 01: ADMINISTRATIVE AND PROCEDURAL WORK REQUIREMENTS.
   2. DIVISION 26: ELECTRICAL.
   3. DIVISION 40: PROCESS INTEGRATION.

1.2 SCOPE

A. Perform testing as specified in the Contract Documents.

B. Scope of work shall include new and existing material and equipment, that is reworked as part of these Contract Documents. This includes all materials and equipment indicated in this Specification Section including, but is not limited to, conductors, cables, circuit breakers, motor controls, transformers, disconnects, motors, grounding systems, instrument transformers, instrumentation etc. Existing electrical and I&C materials and equipment that is reworked, reused, reconnected and/or reinstalled as part of this project shall conform to the same commissioning standards as new equipment identified hereafter.

1.3 REFERENCES

A. The equipment and Work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:
   1. International Society of Automation (ISA).
   7. Underwriters Laboratories, Inc. (UL).

1.4 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:
   1. Schedule for performing inspection and tests.
   2. List of references to be used for each test.
   3. Sample copy of equipment and materials inspection form(s).
   4. Sample copy of individual device test form.
   5. Sample copy of individual system test form.

B. Quality Control Submittals: Submit within 30 days after completion of test:
   1. Test or inspection reports and certificates for each electrical item tested.
C. Contract Closeout Submittals:

1. Operation and Maintenance Data:
   a. In accordance with SECTION 01 78 23.
   b. After test or inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.5 QUALITY ASSURANCE

A. Testing Firm Qualifications:

   1. Corporately and financially independent organization functioning as an unbiased testing authority.
   2. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.
   3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
   4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.
   5. Technicians certified by NICET or NETA.
   6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
   7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
   8. In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories or a full Member Company of International Electrical Testing Association.

B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by 2007 ©NETA Acceptance Testing Specifications.

C. Test instrument calibration shall be in accordance with 2007 ©NETA Acceptance Testing Specifications.

1.6 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been reworked, reused, reconnected, reinstalled and/or installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

   1. Scheduled with ENGINEER prior to de-energization.
   2. Minimized to avoid extended period of interruption to the operating facilities and equipment.

D. Notify ENGINEER at least 24 hours prior to performing tests on energized electrical equipment.
PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Tests and inspection shall establish that:
   1. Electrical equipment is operational within industry and manufacturer's tolerances.
   2. Installation allows for proper equipment operation.
   3. Equipment is suitable for energization.
   4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.
   5. Installation conforms to 2007 ©NETA Acceptance Testing Specifications where referenced hereinafter. Conformity shall include the following sections from the 2007 ©NETA Acceptance Testing Specifications: 3, 3.1, 3.2, 4, 4.1, 4.2, 5, 5.1, 5.2, 5.3, and 5.4. These ancillary sections are to be considered congruent requirements with any references to section 7 and any other NETA reference.

B. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

C. Set, test, and calibrate protective relays, circuit breakers, fuses, and other applicable devices in accordance with values established by the ENGINEER.

D. Adjust mechanisms and moving parts for free mechanical movement.

E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents. Where any deviations are found, provide written documentation of findings to the ENGINEER.

G. Realign and level equipment not properly aligned and level.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Verify and inform ENGINEER of working clearances and spaces about electrical equipment which are not in accordance with NFPA 70.

M. Investigate and repair or replace:
   1. Electrical items that fail tests.
   2. Active components not operating in accordance with manufacturer's instructions.
   3. Damaged electrical equipment.

N. Electrical Enclosures:
   1. Remove foreign material and moisture from enclosure interior.
   2. Vacuum and wipe clean enclosure interior.
   3. Remove corrosion found on metal surfaces.
   4. Repair or replace, as determined by ENGINEER, door and panel sections having dented surfaces.
5. Repair or replace, as determined by ENGINEER, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required due to extensive damage, as determined by ENGINEER, refinish the entire assembly.

O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

3.2 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable For:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with Specifications.
   e. Proper circuit identification.

2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with 2007 ©NETA Acceptance Testing Specifications, Table 10.1, unless otherwise specified by manufacturer.

3. Shielded Instrumentation Cables For:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.

4. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.

5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for one minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.

2. Continuity test by ohmmeter method to ensure proper cable connections.

3.3 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify that fuse sizes and types correspond to one-line diagram.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with 2007 ©NETA Acceptance Testing Specifications, Table 100.1.
   b. Phase-to-phase and phase-to-ground for one minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50% or more from adjacent poles or similar switches.

3.4 MOLDED AND INSULATED CASECIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with 2007 ©NETA ATS, Table 100.12.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75°C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480 and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for one minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for one minute.
   d. Test values to comply with 2007 ©NETA Acceptance Testing Specifications, Table 100.1.

2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50% or more from adjacent poles and similar breakers.

3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
f. Trip times shall be within limits established by NEMA AB 4, Table 5-3.
g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

3.5 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:
   1. Equipment and circuit grounds in motor control centers and panelboards assemblies for proper connection and tightness.
   2. Ground bus connections in motor control centers and panelboards assemblies for proper termination and tightness.
   3. Effective transformer core and equipment grounding.
   4. Accessible connections to grounding electrodes for proper fit and tightness.
   5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:
   1. Fall-Of-Potential Test:
      a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
      b. Main ground electrode system resistance to ground to be no greater than one ohm.
   2. Two-Point Direct Method Test:
      a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
      b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.6 MOTORS

A. Perform on all existing and new motors, including but not limited to, air compressors, exhaust fans, and oil pumps.

B. Visual and Mechanical Inspection:
   1. Proper electrical and grounding connections.
   2. Blockage of ventilating air passageways.
   3. Operate Motor and Check For:
      a. Excessive mechanical and electrical noise.
      b. Overheating.
      c. Correct rotation.
      d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionality and proper operation.
      e. Excessive vibration.
   4. Check operation of space heaters.

C. Each new and existing motor shall be given a megger test between motor leads and motor frame. Test voltage and acceptable results shall be as follows:

<table>
<thead>
<tr>
<th>Motor</th>
<th>Megger Voltage</th>
<th>Minimum Megohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>460 Volts</td>
<td>500 VDC</td>
<td>10</td>
</tr>
<tr>
<td>230 &amp; 208 Volts</td>
<td>500 VDC</td>
<td>10</td>
</tr>
<tr>
<td>120 Volts</td>
<td>500 VDC</td>
<td>3</td>
</tr>
</tbody>
</table>

D. Determine that all accessories are properly connected and functioning.
E. Electrical Tests:

1. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

F. All data shall be recorded for each motor.

3.7 LOW VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check Door and Device Interlocking System By:
   a. Closure attempt of device when door is in OPEN position.
   b. Opening attempt of door when device is in ON position.
8. Check Nameplates for Proper Identification of:
   a. Equipment title and tag number with latest one-line diagram.
   b. Pushbuttons.
   c. Control switches.
   d. Pilot lights.
   e. Control relays.
   f. Circuit breakers.
   g. Indicating meters.
9. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify that current and potential transformer ratios conform to Contract Documents.
11. Check Bus Connections for High Resistance by thermographic survey and Low Resistance Ohmmeter and Calibrated Torque Wrench Applied to Bolted Joints:
   a. Ohmic value to be zero.
   b. Bolt torque level in accordance with 2007 ©NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:
   a. Closure attempt for locked open devices.
   b. Opening attempt for locked closed devices.
   c. Key exchange to operate devices in OFF-NORMAL positions.
13. Verify performance of each control device and feature furnished as part of the motor control center.
14. Control Wiring:
   a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
   b. Check for proper conductor lacing and bundling.
   c. Check for proper conductor identification.
   d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect Contactors For:
   a. Correct mechanical operations.
   b. Correct contact gap, wipe, alignment, and pressure.
   c. Correct torque of all connections.
17. Compare solid state overload setting with full-load current for proper size and setting.
18. Compare overload heater rating with full-load current for proper size.
19. Compare motor protector and circuit breaker with motor characteristics for proper size.
20. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with 2007 ©NETA ATS, Table 10.2.
   b. Bus section phase-to-phase and phase-to-ground for one minute on each phase.
   c. Contactor phase-to-ground and across open contacts for one minute on each phase.
   d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
   e. Test values to comply with 2007 ©NETA ATS, Table 10.2.

2. Overpotential Tests:
   a. Maximum applied ac or dc voltage in accordance with 2007 ©NETA ATS, Table 7.1.2.
   b. Phase-to-phase and phase-to-ground for one minute for each phase of each bus section.
   c. Test results evaluated on pass/fail basis.

3. Current Injection Through Overload Unit at 300% of Motor Full-Load Current and Monitor Trip Time:
   a. Trip time in accordance with manufacturer's published data.
   b. Investigate values in excess of 120 seconds.

4. Control Wiring Tests:
   a. Apply secondary voltage to control power and potential circuits.
   b. Check voltage levels at each point on terminal boards and each device terminal.
   c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.
      1) Insulation resistance to be one megohm minimum.

5. Operational test by initiating control devices to affect proper operation.

3.8 INSTRUMENTATION AND COMMUNICATION CIRCUITS

A. All instrumentation and communication conductors shall be tested for continuity, polarity and complete loop checks.

B. All conductors shall be disconnected from all instruments and control boards while being tested.

3.9 AUTOMATIC TRANSFER SWITCHES

A. Visual and Mechanical Inspection:
   1. Check doors and panels for proper interlocking.
   2. Check positive mechanical and electrical interlock between normal and alternate sources.
   3. Check for Proper Operation:
      b. Generator under load and nonload conditions.
      c. Auto-exerciser of generator under load and no-load conditions.
   4. Verify settings and operation of control devices.
   5. Inspect bolted electrical connections for high resistance using the following methods:
b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data or 2007 ©NETA Acceptance Testing Specifications.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with 2007 ©NETA ATS, Table 10.2 for each phase with switch CLOSED in both source positions.
   b. Phase-to-phase and phase-to-ground for one minute.
   c. Test values in accordance with manufacturer’s published data.

2. Contact Resistance Test:
   a. Contact resistance in microhms across each switch blade for both source positions.
   b. Investigate values exceeding 500 micro-ohms.
   c. Investigate values deviating from adjacent pole by more than 50%.

3. Set and Calibrate in Accordance with Specifications:
   a. Voltage and frequency sensing relays.
   b. Time delay relays.
   c. Engine start and shutdown relays.

4. Perform Automatic Transfer Tests By:
   a. Simulating loss of normal power.
   b. Return to normal power.
   c. Simulating loss of alternate power.
   d. Simulating single-phase conditions for normal and alternate sources.

5. Monitor and Verify Operation and Timing of:
   a. Normal and alternate voltage sensing relays.
   b. Engine start sequence.
   c. Timing delay upon transfer and retransfer.
   d. Engine cool down and shutdown.
   e. Interlocks and limit switch functions.
   f. Engine cool down and shutdown feature.

3.10 ENGINE GENERATOR

A. Visual and Mechanical Inspection:

1. Compare equipment nameplate data with drawings and Specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Verify the unit is clean.

B. Electrical and Mechanical Tests:

   a. Machines larger than 200 horsepower (150 kilowatts): Test duration shall be ten minutes. Calculate polarization index.
   b. Machines 200 horsepower (150 kilowatts) and less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.


3. Verify phase rotation, phasing, and synchronized operation as required by the application.

4. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
Perform vibration test for each main bearing cap.
Conduct performance test in accordance with ANSI/NFPA 110.
Verify correct functioning of the governor and regulator.

C. Test Values – Visual and Mechanical:
1. Anchorage, alignment, and grounding should be in accordance with manufacturer’s published data and system design.

D. Test Values – Electrical:
1. The dielectric absorption ratio or polarization shall be compared to previously obtained results and should not be less than 1.0. The recommended minimum insulation resistance ($IR_{1\text{ min}}$) test results in megohms shall be corrected to 40°C and read as follows:
   a. $IR_{1\text{ min}} = 100$ megohms for most dc armature and ac windings built after 1970 (form-wound coils).
   b. $IR_{1\text{ min}} = 5$ megohms for most machines and random-wound stator coils and form-wound coils rated below 1 kV.

   NOTE: Dielectric withstand voltage and surge comparison tests shall not be performed on machines having values lower than those indicated above.

2. Protective relay device test results shall be in accordance with 2007 ©NETA Acceptance Testing Specifications.
3. Phase rotation, phasing, and synchronizing shall be in accordance with system design requirements.
4. Low oil pressure, overtemperature, overspeed, and other protection features shall operate in accordance with manufacturer’s published data and system design requirements.
5. Vibration levels shall be in accordance with manufacturer’s published data and shall be compared to baseline data.
6. Performance tests shall conform to manufacturer’s published data and ANSI/NFPA Standard 110.
7. Governor and regulator shall operate in accordance with manufacturer’s published data and system design requirements.

3.11 MISCELLANEOUS CONTROL CIRCUITS
A. All control circuits shall be tested for point to point continuity.
B. All terminations shall be inspected for proper connections and labels.
C. Proper tests shall be performed to assure that no unintentional grounds or shorts exist in the circuitry.
D. Verify proper operation of all auxiliary relays.
E. All time-delay relays shall be checked for correct time settings and time delay response in accordance with data furnished by the OWNER.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. This Section covers the furnishing, installing, and testing of one diesel-fueled, engine-driven electric generator unit. The engine-generator shall be installed within an insulated, heated/ventilated building as indicated on the Drawings.
   2. The engine-generator unit shall be a skid-mounted package unit consisting of an engine, an alternator, auxiliary systems, controls, double-wall sub-base fuel tank, fuel system, and accessories as specified and as required for a complete operating system.

B. Related Sections:
   1. DIVISION 01: ADMINISTRATIVE AND PROCEDURAL WORK REQUIREMENTS.
   2. DIVISION 26: ELECTRICAL, INCLUDING BUT NOT LIMITED TOO:
      a. SECTION 26 05 10 - BASIC ELECTRICAL MATERIALS AND METHODS
      b. SECTION 26 05 19 - LOW VOLTAGE CONDUCTORS
      c. SECTION 26 05 26 - GROUNDING AND BONDING
      d. SECTION 26 05 34 - RACEWAYS
      e. SECTION 26 05 70 - ELECTRICAL SYSTEMS ANALYSIS
      f. SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS
   3. DIVISION 40: PROCESS INTEGRATION.

1.2 GENERAL

A. Equipment furnished under this Section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by ENGINEER. The engine-generator unit shall be standard product of the manufacturer and shall be a packaged type unit, fully shop assembled, wired, and tested; requiring no field assembly of critical moving parts.

B. The engine-generator unit shall be manufactured by Cummins/Onan or Caterpillar, without exception.

1. Coordination:
   a. All equipment specified in this Section shall be furnished through a single engine-generator manufacturer who shall be responsible for the design, manufacture, and coordination of the system components.

2. General Equipment Stipulations:
   a. SECTION 01 60 00 shall apply to all equipment furnished under this Section.

3. Power Supply:
   a. Site power supply provided will be 120/240 volt, 1 phase, 3 wire, for operation of the equipment and accessories. Engine-generator controls and alarms shall be dc powered from the battery pack specified herein.

4. Spare Parts:
   a. The following spare parts shall be furnished for the engine-generator unit:
<table>
<thead>
<tr>
<th>Part Description</th>
<th>Number Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air filters</td>
<td>2 sets</td>
</tr>
<tr>
<td>Oil filters</td>
<td>4 sets</td>
</tr>
<tr>
<td>Fuel filters</td>
<td>4 sets</td>
</tr>
<tr>
<td>V or Serpentine drive-belts</td>
<td>1 matched set</td>
</tr>
<tr>
<td>Fuses</td>
<td>2 sets of each size and type</td>
</tr>
<tr>
<td>Block Heater</td>
<td>2 each size and type</td>
</tr>
<tr>
<td>LEDs</td>
<td>1 box of each size, type, and color used</td>
</tr>
</tbody>
</table>

b. Spare parts shall be suitably packaged in accordance with SECTION 01 66 00 with labels indicating the contents of each package. Spare parts shall be delivered to OWNER as directed by ENGINEER.

5. Shop Painting:
   a. Outdoor equipment shall be thoroughly cleaned after fabrication and assembly and a rust-resisting primer coat applied to both interior and exterior surfaces. The engine-generator finish shall consist of at least one coat of enamel (manufacturer’s standard color).

6. Shop Tests:
   a. After the equipment has been completely assembled, it shall be shop tested for general operating conditions, circuit continuity, high potential, and other standard tests for the particular class of equipment.

7. Training of OWNER's Personnel:
   a. Following completion of installation and field testing work, eight employees of OWNER shall be trained in the proper operation, troubleshooting, and maintenance of the equipment provided. Training shall be conducted by a qualified representative of the equipment manufacturer and shall consist of at least 4 hours of hands-on instruction. Training shall be conducted at a place and time mutually agreeable to OWNER and the equipment manufacturer in accordance with SECTION 01 44 33.

1.3 SERVICE CONDITIONS

A. The engine-generator will be used as an emergency power unit and shall be suitable for standby power.

B. The engine-generator shall be suitable for "black start" conditions and shall automatically start by a start signal from the automatic transfer switch.

1.4 STANDARDS AND CODE REQUIREMENTS

A. Except where modified or supplemented by these Specifications, all equipment and materials shall be designed and constructed in accordance with the latest applicable requirements of the standard Specifications and codes of ANSI, ASTM, NEMA IEEE, DEMA, EEI, HEI, NFPA, SAE, and other such regularly published and accepted standards, as well as state and local codes.
1.5 IDENTIFICATION

A. Each control switch, indicating light, and instrument on each control panel shall be provided with a suitable engraved nameplate or legend. Standard engraved nameplates with 3/16-inch high letters may be used on push-button type units. Other nameplates shall be laminated plastic engraved through the black surface to form white letters. Relays, terminals, and special devices inside the unit shall have permanent markings to match identification used on manufacturer’s wiring diagrams.

1.6 SUBMITTALS

A. Drawings and Data:

1. Complete Bill of Material detailing all parts, assemblies and sub-assemblies, Drawings, details, data sheets, Specifications, and descriptive and engineering data for each unit shall be submitted in accordance with SECTION 01 33 00. This data shall consist of drawings and photographs in sufficient detail such that the construction of the equipment is indicated, together with details, connection and installation instructions, Specifications, and performance curves. Data submitted shall include the following:

a. Manufacturer, model, and type:
   1) Engine.
      a) Date of manufacture.
      b) Length of continuous design.
      c) EPA Tier level.
      d) Manufacturing location.
   2) Alternator, including:
      a) Rated kVA at 6,900-feet msl elevation.
      b) Rated kW at 6,900-feet msl elevation.
      c) Voltage.
      d) Temperature rise above 40°C ambient.
      e) Stator by thermometer [____]°C.
      f) Field by resistance [____]°C.
      g) Class of insulation [____].
      h) Impedance data including:
         (1) Alternator impedance information.
         (2) All resistances, reactances, time constants and losses.
         (3) X/R ratio
      i) Current transformers used for protective relaying applications and other generator needs.
   3) Radiator, including:
      a) Provide cooling calculations, all product literature, and a report from the manufacturer to substantiate the engine generator when under full rated loading conditions will not overheat under the most severe specified operating conditions. A safety factor shall be included in the cooling system design to prevent any pre-alarm conditions for high coolant temperature from occurring under the most severe loading and operating condition.
      b) Air side including:
         (1) Total air flow in cubic feet per minute at altitude of 6,900 ft. above MSL moving through the enclosure. Account for any combustion air flows. Include the individual pressure drops of all components (louvers dampers, radiator, fan shroud, ductwork and fittings). Include the design conditions for the entering air temperature and the leaving air temperature. Provide
the radiator cooling fan curves with the operating point based on the pressure drop and air flow conditions. Include the fan HP needed to provide the air flow.

(2) Provide the calculations to show the total heat being rejected by the engine and generator. The heat rejection shall include the radiation, conduction and convection forms of heat transfer to the surrounding air and engine cooling fluid.

(3) Provide calculations and information on the radiator make, model number and heat rejection capability using the specific heat for the glycol solution specified, the flow rate of the coolant, and the temperature of the entering and leaving fluid at the radiator and aftercoolers. Provide the expected radiator coolant temperatures for 25%, 50%, 75% and full load at the most severe operating conditions. Establish the pre-alarm temperature limit and the alarm limit for overheating for the cooling system. Provide at least 5 deg. F separation between each of the following: the actual coolant temperature, the pre-alarm limit temperature and the alarm limit temperature for overheating of the cooling system.

(4) Demonstrate to the satisfaction of the ENGINEER through this submittal that the equipment being provided will not overheat under the most severe operating and loading conditions.

4) Battery charger and battery.
5) Fuel oil cooler (if required by engine design).
6) Silencer.
7) Sub-base fuel storage tank.
8) Generator output breakers, including:
   a) Manufacturer.
   b) Rating and verification of 100% output rating.
   c) Trip characteristics and trip curves.
   d) Overcurrent trip plug selection and recommendation.
   e) Frame size.
   
   b. Engine output horsepower and efficiency curves at specified conditions.
   c. Fuel consumption at rated continuous duty conditions and at specified conditions.
   d. Continuous duty ratings at specified conditions:
      1) Engine (net horsepower).
      2) Engine (maximum performance horsepower bare engine).
      3) Generator kW at specified power factor.
      4) Volts.
      5) Amperes.
   
   e. Overall dimensions and weight of engine-generator and sub-base fuel tank.
      1) Length.
      2) Width.
      3) Height.
      4) Net weight.
      5) Center of gravity, wet and dry.
      6) Manufacturer’s recommended skid-to-concrete pad connection fastener size, grade, and locations.
   
   f. Descriptive product bulletins, wiring diagrams and schematics, including the engine control panel, generator breaker, battery charger, battery pad.
heater, jacket water heater, and other accessories and components, including voltage, phase, and wattage ratings for all accessory items. Diagrams shall clearly show the termination points for all field wiring for power and control circuits.
g. Alternator insulation class and temperature ratings.
h. Calculations or test results showing compliance with specified motor starting and voltage dip requirements.
i. Line circuit breaker manufacturer, model, 100% or 80% rating, frame, trip, and interrupting ratings and settings, data sheets, and time-current curves.
j. Control panel layout, identifying location of all instrumentation being supplied.
k. Engine drawings and sub-base fuel tank drawings indicating locations of all piping and accessory connections.
l. Operation instructions.
m. Letter from the engine-generator manufacturer confirming that the unit will provide the specified minimum kW rating at the specified design conditions, altitude, maximum temperature, and time duration.
n. Battery sizing calculations.
o. Battery charger sizing calculations.
p. Maximum output short circuit kVA available.
q. Exhaust gas emission data, maximum values at loads of 1/4, 1/2, 3/4, and full:
   1) Carbon Monoxide (CO), lb/hr.
   2) Nitrogen Oxides (NOx), lb/hr.
   3) Temperature, °F.
   4) Flow, acfm.
r. A certificate of emissions compliance.
s. Fuel tank, including all piping connections and certification of UL listing.
t. Silencer.
u. Installation instructions, including external connections for exhaust, fuel lines, and power and control circuits.
v. The manufacturer shall furnish complete and accurate drawings of the equipment, including plan, front, and sectional or side views; base plans showing anchor bolt locations and base details; piping connections and diagrams; raceway stub-up locations; and schematic and wiring interconnection diagrams. Wiring diagrams shall be revised as marked by ENGINEER to show external circuit conduit and cable identification for interconnecting the associated equipment.
w. Complete electrical circuit schematics, including all generator control, accessories, instruments, etc. Schematics shall include all termination points in each control panel. All wiring shall be identified by numbers and every termination point shall be assigned a number. Termination point number (including wire number) shall appear on the schematics for each wiring termination shown.
x. Automatic Transfer Switch.
   1) Manufacturer.
   2) Breaker information including:
      a) Manufacturer.
      b) Rating and verification of 100% output rating.
      c) Trip characteristics and trip curves.
      d) Overcurrent trip plug selection and recommendation.
      e) Frame size.
      f) Manufacturer’s information table corresponding to the respective short-term, long-term, and instantaneous trip dial settings.
g) Breaker output lug layout and pattern.

3) Equipment layout drawings of all equipment and wiring diagrams provided.
   a) Equipment layouts, both internal and external to the equipment.
   b) Terminal strip layouts.
   c) Breaker layout and arrangement.
   d) Dimensions, installation recommendations, including recommended mounting height.

B. Operation and Maintenance Manuals:

1. Operation and maintenance information shall be provided both in paper and electronic format. Electronic format shall include all manuals provided in a formatted, tabbed, Adobe PDF format. Operation and maintenance manuals shall be submitted in accordance with SECTION 01 78 23. Operation and Maintenance Manuals shall be the equivalent to the manuals used by factory authorized shop repair personnel and shall describe all system and sub-system removal and disassembly.

2. O&M Manuals shall include all Shop Drawing information, data and calculations.

3. The shop operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. The shop maintenance manuals shall include the following equipment:
   a. Engine.
   b. Radiator.
   c. Generator.
   d. Engine Generator Control Panel.
   e. MSDS manual with all MSDS forms for all substances provided.
   h. Repair Parts Manual available from the equipment manufacturer detailing all parts and sub-assemblies which are available as replacement parts.
   j. The O&M Manual shall include all information for the battery charger and all other equipment exterior to the engine/generator.

4. Equipment elevations, plan views, conduit entrance spaces and requirements, and dimensions shall be provided in hard copy and electronic version (AutoCAD 2007). The Drawings shall be reduced to 11” x 17” format and shall be fully legible at this Drawing size and shall include all schematic, wiring and external diagrams. Also, internal device wiring and schematic diagrams for all sub assemblies used in the equipment shall be provided.

1.7 WARRANTY

A. All materials and equipment shall be guaranteed against defective material, design, and workmanship. During the warranty period, CONTRACTOR or his authorized dealer will be required to make the necessary repairs or replacements onsite. Without additional charge, replace any material provided which develops defects within five years or 1,500 engine hours, whichever occurs first, from the date of acceptance of the entire project. Warranties requiring parts to be returned to the factory will not be accepted. The warranty shall list any and all items excluded.

B. The warranty is not to exclude items such as:

1. The engine coolant heater.
PART 2  PRODUCTS

2.1  SERVICE CONDITIONS

A. The engine-generator unit will be used as a standby power source for selected electrical loads when the utility-supplied power fails.

B. The unit shall be furnished with all equipment required to allow it to operate as a stand-alone unit.

C. Fuel for the engine-generator will be furnished from a double-wall, sub-base fuel storage tank with interstitial leak detection. The engine-generator supplier shall provide the correct amount and grade of crankcase oil, coolant, and other fluids necessary for initial testing and operations. The OWNER shall provide all fuel for initial startup and testing operations.

2.2  DESIGN CONDITIONS

A. The equipment shall be designed to operate under the following conditions:

Ambient temperature, °F

Summer, maximum 110
Winter, minimum -30

Elevation, feet above sea level 6,900

Fuel supply Type Type 2 diesel fuel suitable for the ambient conditions

Cooling system Unit-mounted, air-cooled radiator

Fluid 50% ethylene glycol solution

2.3  PERFORMANCE REQUIREMENTS

A. The equipment shall be capable of the following performance under the design conditions above:

Standby rating capacity with deratings and with accessories*, minimum kW 150

*For the following conditions and rated site conditions:

Frequency, Hz 60

Power factor 0.8

2. The engine start batteries.

C. During the warranty period, OWNER will not accept charges for:

1. Travel time.
2. Mileage.
3. On-site repair labor.
Terminal voltage: 120/240 volts, 1 phase, 3 wire

Maximum engine speed, rpm: 1,800

Minimum duration of run at full load, hours: 24

Maximum voltage drop, %: 10

B. The generating unit shall satisfactorily start and maintain the following loads when separately started in any sequence without exceeding allowable voltage drop:

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Quantity</th>
<th>Voltage</th>
<th>Load&lt;sup&gt;(1)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bubbler System Air Compressor</td>
<td>2</td>
<td>240VAC</td>
<td>5hp each, FVNR</td>
</tr>
<tr>
<td>HPU tank heater</td>
<td>1</td>
<td>120VAC</td>
<td>1.5kW heating element</td>
</tr>
<tr>
<td>Stream Gauge building load</td>
<td>1</td>
<td>240VAC</td>
<td>2.5kW electric heater</td>
</tr>
<tr>
<td>Valvewhouse heating</td>
<td>3</td>
<td>240VAC</td>
<td>13.5kW each, electric heaters</td>
</tr>
<tr>
<td>Ventilation fans EF-2, EF-3</td>
<td>2</td>
<td>240VAC</td>
<td>1.5hp each, FVNR</td>
</tr>
<tr>
<td>Damper motors, D-2, D-3, D-5, D-6, D-7</td>
<td>5</td>
<td>120VAC</td>
<td>0.1hp hp each (motor size assumed), FVNR</td>
</tr>
<tr>
<td>Control Building Lighting</td>
<td>1</td>
<td>120VAC</td>
<td>1.78kW, Fluorescent lighting</td>
</tr>
<tr>
<td>Valvewhouse Lighting</td>
<td>1</td>
<td>120VAC</td>
<td>5.24kW, Fluorescent lighting</td>
</tr>
<tr>
<td>Valvewhouse rooftop heaters</td>
<td>4</td>
<td>240VAC</td>
<td>2kW each, electric radiant heaters</td>
</tr>
<tr>
<td>Valvewhouse heating cables</td>
<td>2</td>
<td>120VAC</td>
<td>2.5kW each, electric heat tape</td>
</tr>
<tr>
<td>Valvewhouse heating cable</td>
<td>1</td>
<td>120VAC</td>
<td>1.5kW, electric heat tape</td>
</tr>
<tr>
<td>Valvewhouse heating cables</td>
<td>3</td>
<td>120VAC</td>
<td>0.75kW each, electric heat tape</td>
</tr>
<tr>
<td>Valvewhouse hot water tank</td>
<td>1</td>
<td>120VAC</td>
<td>1kW, estimated load</td>
</tr>
<tr>
<td>Step 2:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valvewhouse valve operator</td>
<td>1</td>
<td>240VAC</td>
<td>1hp, FVR</td>
</tr>
<tr>
<td>Control building heaters</td>
<td>2</td>
<td>240VAC</td>
<td>7.5kW each, electric heaters</td>
</tr>
<tr>
<td>HPU pump motor</td>
<td>1</td>
<td>240VAC</td>
<td>7.56hp, FVNR</td>
</tr>
<tr>
<td>Step 3:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>User defined miscellaneous load</td>
<td>1</td>
<td>120VAC</td>
<td>10kW assumed: mixed use load of receptacles, lights, UPS, etc.</td>
</tr>
<tr>
<td>Step 4:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control building receptacle load</td>
<td>1</td>
<td>120VAC</td>
<td>1kW</td>
</tr>
<tr>
<td>Step 5:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caretaker's house</td>
<td>1</td>
<td>240VAC</td>
<td>5kW</td>
</tr>
</tbody>
</table>

<sup>(1)</sup>Legend:
<table>
<thead>
<tr>
<th>Load Type</th>
<th>Quantity</th>
<th>Voltage</th>
<th>Load(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVNR</td>
<td>=</td>
<td>Full Voltage Non-reversing</td>
<td></td>
</tr>
<tr>
<td>FVR</td>
<td>=</td>
<td>Full Voltage Reversing</td>
<td></td>
</tr>
<tr>
<td>VFD</td>
<td>=</td>
<td>Adjustable (Variable) Frequency Drive</td>
<td></td>
</tr>
</tbody>
</table>

2.4 ENGINE-GENERATOR UNIT AND TRANSFER SWITCH

A. Acceptable Manufacturers:

1. The engine-generator shall be a current production model. Without exception, the engine-generator unit shall be manufactured by Cummins/Onan or Caterpillar/Olympian.
2. The manufacturer of the engine-generator unit shall have a full-time, fully factory-trained technical staff and an equipped 24-hour service facility having all personnel and all equipment required to maintain, repair, or overhaul the engine-generator unit and associated equipment.
3. Automatic Transfer Switch:

B. Engine:

1. Engine shall be an in-line, six-cylinder configuration.
2. The generator engine shall be turbo-charged and after-cooled.
3. The engine shall have a net horsepower rating at least equal to actual requirements at specified continuous power rating and at the specified conditions. The engine shall be equipped with the following:
   a. Engine speed shall be governed by an electronic microprocessor based governor for isochronous regulation from no load to full load alternator output. Belt-driven or velocity governors are not acceptable.
   b. Fuel system suitable for operation with specified fuel, including dual replaceable element filters, fuel pump, solenoid shutoff valve, and fuel system as hereinafter specified. All fuel hoses shall incorporate braided-steel breakage protection.
   c. Oil and coolant drains extended to edge of skid with lockable valves and caps. Drain hose shall comply with DOT FMVSS 106-74, Type A1; SAE J1402, Table A1 (previous Type E), and shall be Gates Strandoflex® 213 hose, Parker 231 PKR® hose, or equal.
   d. Pressure lubrication system, including a positive-displacement oil pump, pressure regulating valve, full flow filter, oil cooler, and level indicator or dipstick.
   e. Dry type air cleaner with replaceable elements.
   f. Fiber braid and high tensile steel braid reinforced flexible connections for all fuel oil and lube oil connections to the unit. Hose shall comply with DOT FMVSS 106-74, Type A1; SAE J1402, Table A1 (previous Type E), and shall be Gates Strandoflex® 213 hose, Parker 231 PKR® hose, or equal. Coolant connection shall be Gates GreenStripe®, Dayco Gold®, or approved substitute.
   g. Exhaust system as hereinafter specified.
   h. Cooling system as hereinafter specified.
   i. Starting system as hereinafter specified.
j. Correct amount and grade of crankcase oil, coolant, and any other fluids (except fuel) necessary for initial testing and operation.

k. All fuel, block heater, oil, and other supply lines to or for removable or replaceable filter, heating elements, etc. shall incorporate ball valves on both sides of the equipment so the equipment can be removed with only a negligible liquid spill.

C. Alternator:

1. The engine-generator unit alternator shall be 120/240 volt, 1 phase, 3 wire system with a 4 pole, revolving field design with temperature compensated solid-state voltage regulator, brushless rotating rectifier exciter system, and dripproof construction with amortisseur windings. The stator shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a semiflexible driving flange to ensure permanent alignment.

2. Frequency regulation shall be isochronous ±0.25% from no load to rated load. Voltage regulation shall be within ±0.5% of rated voltage, steady-state, from no load to full load. The momentary voltage drop shall not exceed the previously specified amount or stall the engine at any time when applying or starting the specified loads. Recovery to stable operation shall occur within 2 seconds.

3. The alternator shall have Class F insulation as defined by NEMA MG1-1.65, and temperature rise shall be within NEMA MG1-32.6 definition at rated conditions.

4. Additionally, the alternator shall have the following features:
   a. Self-ventilated.
   b. Skewed for smooth voltage waveform.
   c. With permanent magnet generator pilot exciter.
      1) Or with any other field forcing system which will provide 300% of full load current until the generator output breaker opens under overload or short circuit conditions.
   d. Protected against corrosion.
   e. Single bearing design.
   f. Insulated for continuous operation at 40°C ambient temperature.
   g. Temperature rise shall not exceed 105 °C by resistance, consistent with a Class F rise (the winding insulation shall be Class H [125°C rise by resistance]).
   h. Capable of operating at 110% full load for two out of any 24 hours without damage.
   i. The alternator power leads when used with ring terminals must be terminated using compression lugs.
   j. Alternator is to have a maximum balanced telephone interference factor (TIF) not to exceed 50 (to insure that harmonics developed by the generator do not affect the other electrical equipment in the system).
   k. Shall be designed to supply power to the non-linear loads as identified in this Specification.

D. Fuel System:

1. The engine-generator shall be supplied with a complete fuel system, including engine-driven fuel pump, double-wall sub-base fuel tank, fuel filter/separator, engine supply and return line, manual fire-safe shutoff valve, and all equipment and appurtenances necessary for a complete system. All items shall be suitable for the specified fuel, located inside the enclosure above the base plate, and shall be serviceable from inside the enclosure. The fuel tank shall incorporate an interstitial leak detection system that shall be connected into the controls and alarmed with the common alarms, but individually addressable in the generator's analog communications.
2. The filter/separator shall be located inside the generator frame assembly and shall be provided on the fuel supply line between the fuel storage tank and upstream from the flexible connectors.

3. Manual fire-safe fuel shutoff valves shall be provided for all supply and return lines. The manual fire-safe shutoff valves shall be of three piece design ball valves with carbon steel body and end caps, stainless steel or hard chrome plated ball and stem, reinforced Teflon seats and seals, and socket welding ends. Valves shall be of fire-safe design and shall utilize secondary metal seating surfaces to ensure shutoff if the primary seats are destroyed by fire. Fire-safe ball valves shall be Contromatics or Jamesbury.

4. The combination fuel strainer/separator shall be a manifold unit with isolation shutoff valves, shall be provided on the fuel supply line between the fuel source and the engine-driven pump and shall be sized as recommended by engine-generator manufacturer or approved substitute.

5. The fuel tank shall be a dual-wall, base-mounted fuel tank located underneath the generator. The tank shall include a fuel gauge and interstitial leak detector. The fuel tank shall be sized to run the generator for 24 hours at full load. The fuel tank shall be constructed with a minimum of 10 gauge steel. The fuel tank shall meet the requirements of NFPA 30 and be UL 142 listed.

6. The fuel storage tank shall be provided with the following items:
   a. Vent cap.
   b. Primary tank emergency vent if required by the local Authority Having Jurisdiction (AHJ).
   c. Secondary tank emergency vent.

7. The fuel storage tank shall be provided with the following connections:
   a. Fuel supply.
   b. Fuel return.
   c. Remote fill with dry-type coupling.
   d. Level gauge.
   e. Vent.
   f. Primary tank emergency vent.
   g. Secondary tank emergency vent.
   h. Low level switch.
   i. Interstitial leak detection.
   j. Low temperature switch.
   k. Pump out ports.
   l. Tank ports for future tank heater. Ports shall be plugged.

8. The fuel storage tank shall have controls that include, but not limited to, the following:
   a. Level switch with electrically isolated dry contacts for remote low level annunciation on the engine control panel. The Low Fuel alarm shall be set to annunciate when 25% or less (adjustable) of the tank's capacity is remaining in the tank above the engine supply connection.
   b. Float switch with electrically isolated dry contacts for remote leak detection of the primary tank on the engine control panel.
   c. Level switch to control operation of the solenoid valve in the fill line.
   d. Level gauge, capable of measuring the fuel level without the engine running.
   e. A means for annunciating low fuel temperature on the engine control panel and communicating this via individually addressable means in the generator’s analog communications signal.

9. The secondary tank shall be closed top, encircle the tank, prevent the containment area from being contaminated, and be sized to contain a minimum of 110% of the tank's capacity. All connections required for field-testing the secondary tank shall be furnished.
10. The fuel storage tank fill line shall include an electrically operated solenoid valve for shutoff of the fill line when 95% of the tank capacity has been reached. The valve shall be ac powered and be controlled from the level switch. An audible alarm shall sound at 85% of the tank capacity. The remote fill connection shall include a dry type quick disconnect coupling and be of size and type to accommodate the local fuel distributor. Quick disconnect coupling type and model shall be as approved by OWNER and the local fuel distributor.

11. Tank fill connection and level gauge shall be accessible at finished floor level. A fill spill containment box with lockable door shall be provided for containment of spillage during tank fill.

12. A suitably sized vent connection and vent cover shall be provided for the storage tank vent. The vent cover shall be installed outside of the building. The cover shall have an aluminum body, screen over the outlet, and shall prevent rain from entering the vent line.

13. Suitably sized emergency vent connections for the primary and secondary tank and emergency vents shall be provided for the fuel storage tank. Each emergency relief vent shall be installed outside the generator skid, located outside if required by the AHJ, and shall be designed as required to relieve excessive internal pressure caused by fire exposure.

14. The vent line and each emergency relief vent line shall terminate at a height as required by the AHJ and extend above the building if required by the AHJ.

15. The leak detection system shall have an isolated spdt contact, rated 120 volts ac, 10 ampere, for remote indication of fuel leak.

16. Fuel oil coolers shall be provided if the engine fuel system absorbs heat from the unit injectors and surrounding jacket water. The fuel cooler shall be a radiator mounted, air cooled unit adequately sized to cool the return fuel to prevent overheating of the fuel in the fuel storage tank. The cooler shall utilize the air flow from the radiator fan for cooling air flow.

17. Fuel coolers shall utilize ball valves on each side of the devices for maintenance purposes.

E. Exhaust System:

1. The engine-generator installation shall include a critical-grade exhaust silencer, exhaust piping, exhaust piping expansion joints, rain cap, and accessories as required for a complete operating system.

2. A single exhaust silencer shall be used. The silencer shall be 100% aluminized steel chamber type, all welded construction, with suitable saddle support brackets for horizontal mounting which bolt to the interior of the enclosure roof. The silencer shall be horizontally mounted on the exterior surface of the southern building wall and utilize inlet and outlet flanged connections. The silencer shall be suitable for super-critical type silencing.

3. Bellows type schedule 40 carbon steel expansion joints shall be furnished between the engine exhaust and the wall-mounted silencer or exhaust piping. All exhaust piping and flex connections shall be stainless steel and shall be sized according to the engine-generator recommendations.

4. The rain cap for the engine exhaust shall be stainless steel, counterbalancing, vertical opening type. The rain cap shall open from exhaust pressure from the engine and shall close when exhaust flow stops. The rain cap shall prevent rain from entering the exhaust pipe and in the event the generator is not running, shall be weighted so that a 15MPH wind cannot lift the cap. This weighting of the cap shall not exceed the back pressure requirements detailed below.

5. The complete exhaust system shall not exceed the engine manufacturers' recommended back pressure.

6. Provide and ENGINEER approved wall thimble for the exhaust piping for the south generator room wall.
F. Starting System:

1. The engine-generator unit shall include an electric motor start system, including starting motor, 24 volt battery pack with rack and cables, and battery charger.

2. Battery:
   a. The equipment supplier will supply a 24V lead acid engine start battery system.
   b. Battery shall be a lead-acid type battery.
      1) As manufactured by Interstate or ENGINEER approved equal.
      2) The battery is to be rated capable of delivering the manufacturer's recommended minimum cold cranking Amps required at -20°F, as required by the engine manufacturer to start the generator. As a minimum, the starting system shall be sized for three 15-second crank episodes, with a 15-second rest between cranks for 75 seconds.
   c. Truck type batteries or batteries with float voltage requirements above 2.27 volts per cell will not be acceptable.
   d. Battery to be supplied shall not require any additional air handling equipment to remove gases caused by constant battery charging.

3. The battery charger shall be suitable for the specified voltage lead-acid battery pack, shall have a DC output suitable to supply power for all continuous loads and to recharge the batteries from a full discharge state to normal operating voltage within 8 hours. The battery charger shall be provided with the following: NEMA 2 corrosion resistant enclosure, trickle charge feature, On/Off switch, dc ammeter, dc voltmeter, ac input and dc output circuit breakers or fuses, floating voltage equalization, equalizing timer, and relays with Form C contacts for remote annunciation of loss of ac power, low battery voltage, and high battery voltage. The battery charger shall be "Model FCA" as manufactured by Stored Energy Systems or equal.

4. The batteries shall be wrapped with thermostatically controlled battery blankets, with a thermostat range as recommended by the equipment supplier for operation at site conditions.

5. The batteries, battery rack, and battery charger shall be located inside a separate vented enclosure inside the engine-generator enclosure. The battery rack frame shall be constructed of corrosion-resistant material.

6. Separate of the emergency-stop system, the engine start circuit shall incorporate provisions for an OWNER pad-lockable, safety lock-out provision which shall open the engine's start circuit when a the lock-out mechanism is engaged.

G. Cooling System:

1. The engine shall be cooled with a unit-mounted radiator cooling system complete with radiator, water pump, belt-driven fan, fan guard, thermostatic temperature control, and high water temperature cutout, and all accessories as required for proper operation. The radiator shall be sized to handle the cooling of the engine and all other accessories required for proper operation. The fan shall draw air over the engine and discharge through the radiator. The cooling system shall be sufficient to overcome all pressure and airflow losses associated with the engine generator enclosure and the generator and support equipment. If the equipment manufacturer offers a higher capacity radiator option instead of the standard radiator product in their written literature, this option shall be provide and installed as a part of the Contract Price.

2. The cooling system shall be filled with permanent antifreeze of the ethylene glycol type with rust inhibitor.

3. The engine shall be equipped with an electric jacket water heater(s). The jacket water heater shall be sized to maintain jacket water at 90°F with a winter ambient temperature as specified. The jacket water heater shall be thermostatically
controlled. Ball valves shall be installed on each side of the water jacket heaters for maintenance purposes.

**H. Control Panel:**

1. The engine-generator unit shall have a vibration isolated, generator-mounted control panel which shall include at least, but not be limited to, the following:
   a. Engine oil pressure gauge.
   b. Engine water temperature gauge.
   c. ac ammeter.
   d. Running time meter.
   e. Voltmeter-ammeter selector switch with Off position.
   f. ac voltmeter.
   g. Frequency meter.
   h. Voltage adjustment rheostat (+5%).
   i. Safety shutdown and separate indicating lights for the following conditions:
      1) Low engine lube oil pressure.
      2) High water temperature.
      3) Overspeed.
      4) Other alarms and warnings as shown on the Drawings.
   5) Indicating lights with a common alarm for the following condition:
      a) Generator not in automatic.
      b) Emergency stop activated.
      c) Overcrank.
      d) Prealarm low engine oil pressure.
      e) Prealarm high water temperature.
      f) Low coolant level.
      g) Low water temperature.
      h) Battery charger fail.
      i) Low battery voltage.
      j) High battery voltage.
      k) Fuel leak.
      l) Low fuel temperature.
      m) Low fuel (adjustable and initially set at 25% of usable fuel remaining).
   6) Switch off flashing red light (without alarm) warns that engine start control selector switch has been left in Off position.
   7) Individual Form C contacts rated 10 amperes at 120 volts ac and 2 amperes at 30 volts dc shall be provided for each of the listed alarm conditions for remote monitoring.
   8) Dry contacts shall be included for a remote common annunciation of above conditions. The contacts shall be dpdt, and contact ratings shall be 10 amperes at 120 volts ac and 2 amperes at 30 volts dc.
   j. Alarm silence switch.
   k. Cranking system controls with solid-state cranking panel with fixed cranking cycle at 15 seconds crank, 15 seconds rest for 75 seconds. Overcranking protection designed to open the cranking circuit if the engine does not start after 75 seconds, with a cranking reset button.
   l. Three-position selector switch with positions Hand-Off-Auto. In the Auto position, a remote signal shall operate the unit.
   m. Two current transformers for electrical metering.
   n. Suitable nameplates to identify each item on the panel.
   o. Two sets of normally open dry contacts that will close when the engine is running. Two sets of normally closed dry contacts that will open when
the engine is running. Contacts shall be rated 120 volts, 10 amperes and 2 amperes at 30 volts dc.

p. Safeguard circuit breaker to protect the generator rotor and excitation system.

q. An output line current circuit breaker shall be supplied. The line current circuit breaker shall be mounted in a NEMA Type 1 enclosure to protect the generator and supply conductors from damage due to overload. Circuit breaker shall be 100% rated and sized appropriately.

r. Maintained "mushroom head" type emergency shutdown push button for immediate stopping. Provisions shall be made for the generator controller to accept two other maintained, remote, emergency stop pushbuttons as shown on the Drawings.

s. Provisions for remote emergency stop shutdown and remote annunciation connections.

t. Miscellaneous Accessories:
  1) The following items shall be provided for remote installation:
     a) Two remote two-position maintained contact "mushroom head" type emergency shutdown push button. One of these shall be mounted on the cabinet door of PLC-CHE-HPU and the other button shall be mounted on the cabinet door of the transfer switch.
     b) A remote alarm/status network annunciator panel.
     c) A network cable for connection from generator to remote annunciator panel. Belden #8471 or as required by generator manufacturer, with length as required for installation as shown on the Drawings.
  2) All items shall be included on the control panel, assembled, wired, and tested in the manufacturer's shop. All panel wiring shall have permanent typewritten wire numbers at each end of the wire.

2. The control panel shall include the features required for interfacing with PLC-CHE-HPU and the open-transition automatic transfer switch, ATS-1. The control panel shall transmit all NFPA 110 signals to the OWNER's SCADA system via PLC-CHE-HPU. The communications to the OWNER's SCADA system shall be provided by serial RS-485 with Modbus RTU protocol and by Ethernet with Open Modbus protocol. All translators and protocol converters required shall be provided. The ATS control panel will provide a start signal and emergency stop control signals as required for proper operation.

I. Generator Output Circuit Breaker:
  1. Set mounted and line side connected to alternator.
  2. Manually resettable.
  3. Line current sensing.
  4. Inverse time versus current response time.
  5. Sized and coordinated to protect the generator from damage from overload and/or short circuit.
  6. Output lug provisions to include 3-sets of parallel conductors.

J. Automatic Transfer Switch (ATS):
  1. Scope of Work: The work covered by this portion of the Specification consists of furnishing a complete microprocessor type, coordinated automatic transfer breaker switch system hereafter referred to as an automatic transfer switch. The automatic transfer switch shall be provided as a separate unit for installation by the CONTRACTOR. The automatic transfer switch frame, breaker, etc. sizes,
shall be coordinated with the engine/generator supplier’s generator breaker and approved by the ENGINEER. The automatic transfer switch manufacturer and the engine/generator manufacturer shall submit all component and enclosure sizing data to the ENGINEER for approval.

2. Characteristics of Operation: The microprocessor controlled transfer breaker system is to perform the following transfer breaker control functions:
   a. When the normal source voltage fails or when any phase voltage drops below the dropout voltage value for an adjustable time delay of 0.5 to 300 seconds, the processor is to close a set of isolated engine starting contacts which will be used to start the standby generator. When the generator has reached the desired operating voltage and frequency for the desired time period, the processor is to operate the transfer breaker system to open the normal source breaker and, after a desired open period, close the alternate source breaker. When the processor detects the return of normal source voltage for the desired time period, it is to operate the transfer breaker system to open the alternate source breaker and, after a desired open period, close the normal source breaker. After the engine has continued to run for an adjustable cool down period, the processor is to stop the engine by opening the above-mentioned isolated engine starting contacts. Should the engine fail during the operating sequence outlined above, the processor is to return the essential loads back to the normal source as soon as the normal source voltage is at an acceptable value. This immediate retransfer to normal function is also to take place if the alternate source voltage is above the pickup voltage value by 10%; is below the alternate source dropout voltage level; or is below the alternate source dropout frequency level. The control system is also to create an artificial power failure condition in response to a 24-volt DC remote start voltage pulse of 300 milliseconds in duration. Upon receipt of this remote start pulse, the transfer breaker system is to close the engine starting contacts and then operate as if a power failure condition had occurred.

3. Transfer Breaker Device: The automatic transfer breaker system shall be equipped with thermal overload protective trips in each source, shall meet UL1008 requirements; and shall transfer the essential loads from the normal source to the engine source or from the engine source to the normal source in response to signals from the microprocessor control system mentioned above. The transfer breaker system shall utilize circuit breakers as the switching elements and each breaker shall be equipped with a motor operator. A walking-beam type of mechanical interlock is not to utilize the breaker operating handles. De-ion arc quenching shall be used; magnetic blowout systems will not be acceptable; and the arc chutes and main contacts shall be fully enclosed to allow safe manual operation. Integral manual operating handles must be provided to allow emergency operation; and when manual operation is attempted, the motor operators must be de-energized automatically.

The circuit breakers in the transfer system shall include the necessary auxiliary switches to provide for transfer system indicating lamps; for interlocking purposes to prevent both breakers from attempting closure at the same time; and to provide position information to the microprocessor system. In addition, each transfer breaker element will be equipped with two 600 Volt, SPDT auxiliary switches for customer use. The transfer system will include an insulated neutral bus, and a ground bus. The normal and alternate source breaker elements shall be coordinated with the engine-generator supplier. Minimum sizes, to be approved by the ENGINEER, shall be 100%-rated breakers with 800 ampere interchangeable overcurrent trip elements. The breaker ratings of the automatic transfer switch system shall be coordinated with the engine-generator supplier.
and approved by the ENGINEER. The automatic transfer switch shall operate at 120/240 volts, 60Hz, 2-pole, 1-phase, 3 wire, and have as minimums, an 800-amp frame and 10,000 amperes interrupting capacity. All breakers provided shall include provisions for up to three sets of parallel conductor runs.

a. See submittal requirements in Paragraph 1.6 for equipment submittal requirements.

4. Adjustable Time, Voltage, and Frequency Values: The following transfer switch values shall be switch selectable, field adjustable without the use of a test or field calibration kit:

a. Normal to alternate source voltage dropout value of 80, 90, 95, 100, 102, 105, 110 or 118 volts.

b. Normal to alternate source voltage pickup value of 105, 107, 110, 112, 114, 116, 118 or 120 volts.

c. Time delay before transfer from normal source to alternate source of 0, 5, 10, or 30 seconds or 1, 5, 15 or 30 minutes.

d. Time delay before transfer from alternate source to normal source after the normal source voltage is acceptable of 0, 5, or 30 seconds or 1, 5, 35, or 60 minutes.

e. Time delay for engine cool down period of 1, 3, 5, or 10 minutes.

f. Time delay off (to provide a period during transfer when neither source is connected to the load) of 0, 2, 5, or 10 seconds.

g. Alternate source frequency dropout point of 60, 59, 57, or 56 Hz.

h. Alternate source frequency pickup point of 60, 59, 57 or 56 Hz.

i. Engine start contact delay time adjustable between 0.5 to 300 seconds.

5. An exercise timer shall be provided to simulate both a fully loaded or an unloaded station test, depending on OWNER choice, of the standby engine generator system on a weekly basis. The digital timer shall be provided and arranged so that any time-of-day or day-of-week can be programmed. The timer must display the current time of day and day of week when in normal operation. The digital timer shall be OMRON Model H5L or an Engineer approved equal.

6. With the exception of the transfer system indicating lights, digital exercise timer and power failure selector switch, all wiring is to be self-contained in a NEMA 1 enclosure. The transfer system indicating lights, power failure selector switch (test switch), and digital exercise timer shall be mounted directly on the transfer switch enclosure and shall be fully gasketed to maintain the enclosure NEMA rating.

7. The automatic transfer switch shall contain provisions to alarm either of the two breaker failure/trips or of the transfer switch’s control system failure. These alarms and faults shall be alarmed as a common alarm output via a set of Form C contacts and connected as an input to PLC-CHE-VH.

8. The automatic transfer switch enclosure shall contain provisions and terminal strip connections for a maintained, emergency stop pushbutton. The pushbutton is to be connected to a terminal strip with CONTRACTOR provided wiring and field connections to the engine-generator equipment.

9. Without exception, the transfer breaker system shall be manufactured by Electric Equipment & Engineering Company, Denver, Colorado.

K. Miscellaneous Items Engine Generator Skid:

1. The following items will also be supplied:

a. Vibration isolators as recommended by the manufacturer to properly support the engine-generator skid to its concrete pad. If vibration isolators are not utilized between the generator skid and the concrete pad, then the manufacturer shall utilize vibration isolators between the engine/generator and its steel engine-generator base.
1) Isolators are to be located for approximately equal load distribution and deflection per isolator.

2) Isolators are to be spring type designed for the load and seismic conditions as identified for the site.

PART 3   EXECUTION

3.1 INSTALLATION

A. The equipment shall be installed by CONTRACTOR in accordance with the approved Shop Drawings, manufacturers' recommendations, and all applicable codes.

3.2 OPERATION INSTRUCTION

A. Step-by-step instructions shall be furnished by the engine-generator manufacturer. The instructions shall include, but not be limited to, the following procedures or information:

1. Normal startup of the unit.
2. Normal shutdown of the unit.
3. Emergency startup and shutdown of the unit.
4. Normal operation of the unit; typical temperatures, pressures, rpm, etc., for gauges and instruments which are displayed on the panel.

B. The operation instructions shall be submitted for review by ENGINEER. Prior to startup, once the instructions are approved, the instruction sheets shall be printed on heavy paper or cardboard stock and laminated with clear plastic. Two copies of the laminated instructions shall be furnished with each unit. One copy shall be located or displayed at the control panel for each unit. The reserve copy shall be delivered to OWNER. The instructions specified here are in addition to the operation and maintenance manuals required by SECTION 01 78 23.

3.3 FIELD SUPERVISION AND TESTS

A. Arrange for an authorized representative of the manufacturer to furnish installation recommendations to OWNER, furnish an installation inspection prior to system startup, furnish the services of factory certified technicians during the startup and adjustment period to ensure that all items furnished are in proper condition, and perform inspection and testing as indicated in this Section.

B. Fuel needed for the initial fill and for testing will be provided by OWNER and filling operations shall be coordinated with and supervised by the CONTRACTOR and the engine-generator provider. The engine-generator manufacturer shall furnish lubricants and all other fluids needed for the tests. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations under the environmental conditions present.

C. Accessories that normally function while the equipment is in standby mode shall be checked for proper operation, prior to cranking the engine. These functions shall include, but not be limited to, the battery charger and engine starting system and engine starter lock-out system, block heater, fuel system heaters, and fuel gauge.

D. A visual and mechanical inspection shall be performed and shall include the following:

1. Proper grounding.
2. Blockage of ventilating passageways.
3. Proper operation of jacket water heaters.
4. Integrity of engine cooling systems.
5. Overheating of engine or generator.
6. Proper installation of vibration isolators.
7. Proper cooling liquid type and level.
8. Proper lubrication oil type and level.
9. Proper fuel type and level.
10. Proper installation, support, and insulation of the complete engine exhaust system.

E. The engine-generator shall be started in the "Test" mode and checked for the following items:

1. Excessive mechanical and electrical noise.
2. Exhaust leaks.
3. External path for exhaust gases.
5. Check resistance temperature detectors or embedded generator-alternator winding temperature detectors.
6. Movement during starting and stopping.
8. Normal and emergency line-to-line voltages and phase rotation.
9. Verify that voltage regulator and governor operation will cause unit speed and output voltage to stabilize at proper values within a reasonable length of time.
10. Compare generator nameplate rating and connection with one-line diagram.
11. Proper operation of meters and instruments.

F. Additional electrical and mechanical tests shall be performed as follows:

1. Perform a minimum of three cold-start and three black-start tests by interrupting normal power source with test load consisting of the connected system loads to verify transfer switch operation, automatic starting operation, operating ability of the engine generator, overcurrent devices ability to withstand in-rush currents, and automatic shutdown. Continuously monitor and record the data as listed on the OWNER’s standard Generator Load-bank Test Form available from the OWNER.
   a. Receive a start signal from the Automatic Transfer Switch equipment.
   b. Start the generator and come up to speed and frequency.
   c. Perform these tests with the combination resistive & reactive load bank test load and also perform these tests with the facility loads.
   d. Verify the following:
      1) Automatic Transfer Switch operation.
      2) Automatic starting operation.
      3) Operating ability of the engine generator.
      4) Overcurrent devices ability to withstand in-rush currents.
      5) Automatic shutdown.
   e. Continuously monitor and record the data as listed on the OWNER’s standard Generator Load-bank Test Form available from the OWNER.
   f. Initiate a cool-down sequence of the generator on a loss of the start signal from the transfer switch equipment.

2. Test and demonstrate the engine protective shutdown features and alarm features for all warning and shutdown alarms.

G. Arrange for and make all adjustments both mechanically and electrically as needed and/or as directed by ENGINEER to ensure a complete and operable system. Demonstrate that all control devices/alarms features operate properly and start, stop, etc. the engine generator as shown on the Drawings and as intended.
H. Provide a combination resistive and reactive load bank test at the fully rated kW/KVA of the standby generator system and shall test the generator at 25%, 50%, 75% and at full capacity with the load bank power factor at 0.8. The testing shall be for 30 minutes duration at each incremental step and the full load testing shall be for a minimum of 4 hours at 100% load. The equipment supplier shall follow the manufacturer's written recommendations for "breaking in" the engine prior to operating the engine at rated capacity. Fill out the OWNER's standard Generator Load-bank Test Form available from the OWNER and as listed as a supplement to this Section. This load bank testing shall occur at a time and date convenient to the OWNER during the months of July or August when the ambient temperature is above 90°F.

I. Provide a load bank test of the standby generator system with the facility loads and shall test the generator at the facility's demands. The facility load testing shall be for a minimum of 4 hours. Fill out the OWNER's standard Generator Load-bank Test Form available from the OWNER and as listed as a supplement to this Section.

J. Assist the OWNER with the register mapping and verification of all discrete and analog control and alarm signals available to the OWNER. The acceptance testing of the control systems shall demonstrate, signal by signal and register by register, the verification and functionality of all hardwired discrete and analog signals and alarms to the OWNER's communication/SCADA equipment.

3.4 TRAINING

A. Engine-generator and automatic transfer switch training shall not occur until all generator testing is completed and all communication and alarm interfaces are established, proven, and accepted by the ENGINEER.

B. Arrange for the manufacturer's technicians to provide all training. Technicians shall instruct OWNER's personnel regarding the operation and maintenance of all items supplied.

C. Mechanical maintenance training shall cover all preventive maintenance and normal operational condition, including mechanical operations, day-to-day maintenance, periodic maintenance, and detailed and overhaul maintenance of the engine and generator.

D. Electrical maintenance training shall cover all preventive maintenance, normal operational condition, settings, and adjustments, and duration in accordance with Paragraph 1.7 – Warranty of this Specification. Training shall include the control systems, operations, maintenance, and adjustments of the complete electrical and control system for the engine-generator.

E. Comply with requirements of SECTION 01 44 33.

END OF SECTION
SECTION 26 43 00
TRANSIENT VOLTAGE SURGE SUPPRESSORS (TVSS)

PART 1 GENERAL

1.1 SCOPE
A. Furnish and install the Transient Voltage Surge Suppressors (TVSS) having the ratings, features/accessories and enclosures as specified in the Contract Documents.
B. The TVSS shall include all equipment and devices necessary for a complete TVSS system as indicated in the Contract Documents.

1.2 REFERENCES
A. The equipment and Work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:
   1. Institute of Electrical and Electronics Engineers (IEEE).
   2. International Society of Automation (ISA).
   8. Underwriters Laboratories, Inc. (UL).
   9. UL Compliance and Labeling:
      a. For power and signal circuits, TVSS devices shall comply with UL 1449 and UL 1283 as an electromagnetic interference filter. Provide units which are listed and labeled by UL.
      b. For telephone circuit protection, TVSS devices shall comply with UL 497A.

1.3 SUBMITTALS
A. Shop Drawings:
   1. Itemized bill of material including manufacturer, complete model number and options included.
   2. Descriptive information, manufacturer’s descriptive and technical literature.
   3. Catalog Cuts: components, electrical devices, and mechanical devices:
      a. Catalog information.
      b. Descriptive literature.
      c. External power and signal connections.
      d. Scaled drawings showing exterior dimensions and locations of all electrical and mechanical interfaces.
   4. Submit product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
   5. Submit manufacturer’s UL certified test data and nameplate data for each TVSS.
   6. Submit electrical single-line diagram showing location of each TVSS.
   7. Dimensional drawings.
   8. Anchoring instructions and details.
   9. Schematic (elementary) diagrams.
10. Outline diagrams.
11. Interconnection diagrams.
12. Installation Details: Include all mounting methods, size and detail of supports, channels and steel; provide weight(s) from which supports, channels and steel are to carry. Include all modifications, branch circuit breaker ampacity recommendations and additional details required.

B. Quality Control Submittals:

1. Testing Related Submittals.
2. O&M Manuals:
   a. Legends Abbreviation Lists.
   b. Refer to paragraph Shop Drawings for the following items:
      1) Itemized bill of material including manufacturer, complete model number and options included.
      2) Catalog cuts.
      3) Component data sheets.
      4) All final as-built Drawings shall be provided in electronic media, (AutoCAD version 2009 or earlier), on standard IBM computer compatible 2GB Hi-Speed Flash Drives and in hard three ring 11 x 17 inches binders in unfolded quality hard copy media.
      5) Factory and field certified test reports
   c. Device O&M manuals for components, electrical devices, and mechanical devices shall include:
      1) Operations procedures.
      2) Installation requirements and procedures.
      3) Maintenance requirements and procedures.
      4) Troubleshooting procedures.
      5) Internal schematic and wiring diagrams.
   d. List of spares and expendables required and recommended.

1.4 QUALITY ASSURANCE

A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.

B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.

C. Manufacturer shall provide certificate of ISO 9002 Compliance.

1.5 PROJECT & SITE ENVIRONMENTAL CONDITIONS

A. All materials and equipment shall be designed and constructed for continuous operation, at rated current, at 6,900-ft above mean sea level, 40°C ambient and 95% relative humidity.

1.6 WARRANTY

A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.
1.7 EXTRA MATERIALS

A. Furnish, box, tag and clearly mark on exterior, (identify each item with manufacturer’s name, description and part number), for shipment and long-term storage and deliver prior to 75% Project completion the following extra materials:

1. Fuses: A minimum of ten of each type and each current rating installed.
2. Provide spare TVSS components as follows:
   a. A minimum of six suppression modules of each type & size.
   b. Ten indicators light lamps of each color installed.

PART 2 PRODUCTS

2.1 GENERAL

A. All TVSS devices for power circuits, provided under this Section, shall be the product of a single manufacturer and shall be of modular construction designed for field replacement.

B. TVSS devices shall be capable of performance at ambient temperatures between 40°C and 60°C, at relative humidity ranging from 0% to 95%, and at altitudes ranging from sea level to 6,900 feet.

C. TVSS devices shall be fused to disconnect the suppressor from the electrical source should the suppressor fail. The fusing shall allow full surge handling capabilities and to afford safety protection from thermal overloads and short circuits.

D. Design TVSS devices for the specific type and voltage of the electrical service. Single-phase and 3-phase wye-configured systems shall have L-N, L-G, and N-G protection. Grounded delta-configured systems shall have L-L and L-G protection.

E. Power Filter: The TVSS shall include a high frequency extended range power filter and shall be UL 1283 listed as an electromagnetic interference filter. The filter shall provide minimum noise attenuation as follows:

<table>
<thead>
<tr>
<th>Attenuation Frequency</th>
<th>100 KHz</th>
<th>1 MHz</th>
<th>10 MHz</th>
<th>100 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion loss (ratio)</td>
<td>50-1</td>
<td>350-1</td>
<td>500-1</td>
<td>250-1</td>
</tr>
<tr>
<td>Insertion loss (dB)</td>
<td>34</td>
<td>51</td>
<td>54</td>
<td>48</td>
</tr>
</tbody>
</table>

2.2 MANUFACTURER

A. TVSS devices shall be products of the following manufacturer:

1. National Lightning Protection Corp. of Denver, CO.

2.3 PANELBOARD TVSS

A. Provide TVSS meeting ANSI/IEEE C62.41 Location Category B.

B. Maximum single impulse current rating shall be not less than the following:

1. L-L Capacity: 160 kA.
2. L-N Capacity: 160 kA.
3. L-G Capacity: 160 kA.
4. N-G Capacity: 80 kA.

C. Suppressor shall be in an enclosure that has the same NEMA rating as the panel it protects or the TVSS may be integral to a panelboard.

D. UL 1449 maximum clamp voltage shall not be more than:
2.4 ANNUNCIATION
   A. Provide unit or separately mounted LED-type indication lights to show the normal and failed status of each module. Provide one normally open and one normally closed contact which operate when the unit fails.

2.5 PAIRED CABLE DATALINE INTERIOR SUPPRESSORS
   A. Provide units meeting ANSI/IEEE C62.41, Location Category A.
   B. Use bi-polar 1,500-watt silicon avalanche diodes between the protected conductor and earth ground.
   C. Provide units with a maximum single impulse current rating of 80 amperes (10x1,000 microsecond--waveform).
   D. Breakdown voltage shall not exceed 36 volts.

2.6 PAIRED CABLE DATALINE EXTERIOR SUPPRESSORS
   A. Provide units meeting ANSI/IEEE C62.41, Location Category A.
   B. Suppressors shall be a hybrid design with a minimum of three stages, utilizing solid-state components and operating bi-directionally.
   C. Suppressors shall meet or exceed the following criteria:
      1. Maximum single impulse current rating of 10,000 amperes (8x20 microsecond--waveform).
      2. Pulse Life Rating: 3,000 amperes (8x20 microsecond--waveform): 2,000 occurrences.
      3. Maximum clamping voltage at 10,000 amperes (8x20 microsecond current waveform), shall not exceed the peak of the normal applied signal voltage by 200%.

PART 3 EXECUTION
3.1 APPLICATION REQUIREMENTS
   A. Install TVSS as indicated on the Drawings and on:
      1. Power supply to instrumentation and control system cabinets.
   B. Electronic Equipment Paired Cable Conductors: Install dataline suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.
      1. Use secondary protectors on lines that do not exit the structure at the Control Building.
      2. Use primary protectors on lines that exit and enter the structure at the Office headquarter’s building.

3.2 GENERAL INSTALLATION REQUIREMENTS
   A. Install suppressors according to manufacturer's recommendations.
   B. Ground in accordance with NFPA 70.
C. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with all conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.

D. Provide at least 3 inches of separation between line-side and load-side connecting wires. Do not bundle line-side and load-side conductors together, nor run them in the same raceway.

E. Field installed conductors shall be the same as specified for building wire, not smaller than No. 8 AWG and not larger than No. 4 AWG. Device leads shall not be longer than the length recommended by the manufacturer, unless specifically reviewed and approved by the manufacturer.

F. Provide dedicated disconnecting means for TVSS devices installed at generator terminals, panelboards and switchboards. The interrupting capacity of the circuit breakers shall be that specified for the other breakers at that location.
PART 1 GENERAL

1.1 SCOPE

A. Provide lighting and accessories as specified herein and as shown on the Contract Drawings.

1.2 REFERENCES

A. The equipment, materials and work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:

1. Institute of Electrical and Electronics Engineers (IEEE).
2. International Society of Automation (ISA).
8. Underwriters Laboratories, Inc. (UL).
   a. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.3 SUBMITTALS

A. Shop Drawings:

1. Itemized bill of material including manufacturer, complete model number and options included.
2. Interior Luminaires:
   a. Catalog data sheets and pictures.
   b. Luminaire finish and metal gauge.
   c. Lens material, pattern, and thickness.
   d. Candle power distribution curves in two or more planes.
   e. Candle power chart 0 to 90 degrees.
   f. Lumen output chart.
   g. Average maximum brightness data in foot lamberts.
   h. Coefficients of utilization for zonal cavity calculations.
   i. Mounting or suspension details.
3. Exterior Luminaires:
   a. Catalog data sheets and pictures.
   b. Luminaire finish and metal gauge.
   c. Lens material, pattern, and thickness.
   d. IES lighting classification and isolux diagram.
   e. Fastening details to wall or pole.
   f. Ballast type, location, and method of fastening.
4. Lamps:
   a. Voltages.
   b. Colors.
   c. Approximate life (in hours).
   d. Approximate initial lumens.
   e. Lumen maintenance curve.
f. Lamp type and base.
g. Copy of lamp order, including individual quantities, for Project.

5. Ballasts:
a. Type.
b. Wiring diagram.
c. Nominal watts and input watts.
d. Input voltage and power factor.
e. Starting current, line current, and re-strike current values.
f. Sound rating.
g. Temperature rating.
h. Efficiency ratings.
i. Low temperature characteristics.
j. Emergency ballasts rating and capacity data.

6. Descriptive information on all accessories including, but not limited to, photocells, poles, etc.

B. Quality Control Submittals:

1. O&M Manuals:
a. Legends Abbreviations Lists.
b. Refer to paragraph Shop Drawings for the following items:
   1) Itemized bill of material including manufacturer, complete model number and options included.
   2) Catalog cuts.
   3) Component data sheets.
   4) All final as-built Drawings shall be provided in electronic media, (AutoCAD version 2009 or earlier), on standard IBM computer compatible 2GB Hi-Speed Flash Drives and in hard three ring 11 x 17 inches binders in unfolded quality hard copy media.
   5) Factory and field certified test reports.
c. List of spare and expendables required and recommended.

1.4 QUALITY ASSURANCE

A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.

B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.

C. Manufacturer shall provide certificate of ISO 9002 Compliance.

1.5 PROJECT & SITE ENVIRONMENTAL CONDITIONS

A. All materials and equipment shall be designed and constructed for continuous operation, at rated current, at 6,900-feet above mean sea level, 40°C ambient and 95% relative humidity.

1.6 WARRANTY

A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.
1.7 EXTRA MATERIALS

A. Furnish, box, tag and clearly mark on exterior, (identify each item with manufacturer’s name, description and part number), for shipment and long-term storage and deliver prior to 80% Project completion the following extra materials:

1. One spare ballast of each type.
2. One case spare lamps of each type.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Specific requirements relative to execution of Work of this Section is located in the Lighting Schedule on Drawings.

B. Feed-through type, or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Tandem wired for three-lamp, fluorescent fixtures.

E. Wire Leads: Minimum 18 AWG.

F. Component Access: Accessible and replaceable without removing luminaire from ceiling.

G. Interior Wet Installations:
   1. UL Labeled: SUITABLE FOR WET LOCATIONS.

H. Exterior Installations:
   1. UL Labeled: SUITABLE FOR WET LOCATIONS.
   3. When factory-installed photocells are provided, entire assembly shall have UL label.

2.2 LAMPS

A. General: All lamps shall meet or exceed the requirements of the “Energy Policy Act of 1992.”

B. Fluorescent Lamps: F32T8 rapid-start type, cool white, or as indicated on the Drawings.

C. Pulse Start Metal Halide: Suitable for burning position as required for the light fixture, conforming to ANSI C78.388. Average rated life in the vertical burning position shall be 10,000 hours minimum for 250-watt and smaller lamps and 20,000 hours minimum for 400-watt and larger lamps. Mean lumens shall be 75% of initial lumens minimum, color temperatures shall be 3600K minimum, re-strike time after momentary interruption shall not be more than 4 minutes, and warm-up time to full brightness shall be within 15 minutes.

D. Manufacturers:
   1. Sylvania.
   2. General Electric.

2.3 BALLASTS

A. General:
1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
2. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's Specifications.
3. For use in exterior located ballasts to produce reliable starting of lamps at -20°F at 90% of nominal line voltage.

B. Fluorescent:

1. Type: High power factor, premium low heat high frequency electronic ballast with a maximum THD of 10%
2. Manufacturers and Products:
   a. Advance; Mark V.
   b. Motorola.
   c. MagneTek.
3. Class: P, certified CBM.

C. Pulse Start Metal Halide:

1. Ballasts shall be single lamp, volts and watts as indicated. At any lamp voltage, from nominal through life, lamp wattage regulation spread at that lamp voltage shall not exceed 5% for ±10% line voltage variation. Ballasts shall have a minimum power factor of 90% and shall be suitable for low-temperature operation.

D. Manufacturers:

1. Sylvania.
3. Advance Transformer.
4. Universal.

PART 3 EXECUTION

3.1 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
4. Install plumb and level.
5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
6. Install each luminaire outlet box with galvanized stud.
7. Pendant fixtures shall have swivel type box covers and threaded conduit pendants unless otherwise indicated.
8. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise indicated.
9. The Drawings indicate the general location and arrangement of the fixtures desired. The actual location and arrangement of the fixtures shall be clear of pipes, mechanical equipment, structural openings, and other obstructions. The actual location and arrangement of the fixtures shall be approved by the ENGINEER.

B. Pendant Mounted:
1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48-inches apart.
3. Provide twin-stem hangers on single luminaires.

C. Swinging Type: Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

D. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: As shown on the Drawings.

3.2 LAMPS
A. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

3.3 BALLASTS
A. Install in accordance with manufacturer's recommendations.
B. Utilize all ballast mounting holes to fasten securely within luminaire.
C. Replace noisy or defective ballasts.

3.4 CLEANING FOLLOWING CONSTRUCTION
A. Remove all labels and other markings, except UL listing mark.
B. Wipe luminaires inside and out to remove construction dust.
C. Clean luminaire plastic lenses with antistatic cleaners only.
D. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
E. Replace all defective lamps at time of Substantial Completion.

END OF SECTION
PART 1  GENERAL

1.1 SCOPE

A. Installation of telephone and network systems will be the responsibility of the CONTRACTOR. Coordinate work with the OWNER and Qwest Communications.

B. Provide as noted, install, and be responsible for all communications between equipment, the Headquarters Office and other areas of the facility including the Valve House, Control Building, and Stream Gauge Building.

C. Install all equipment and materials required by the Contract Documents, including but not limited to:

1. Communications racks, patch panels, switches, routers, hubs, transceivers, converters, conduits, cables, connectors, wall plates, etc.
2. Category 5 (CAT-5) cable from each telephone and data jack indicated on the Drawings to the communications equipment (example: a location that contains one phone, one fax and two data jacks will require four CAT-5 cables to be run to the communications distribution equipment).
3. Fiber Optic Cables: the Communications Subcontractor shall provide, install, and terminate all fiber optic cables as part of the Contract.

1.2 REFERENCES

A. The equipment and work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:

1. Institute of Electrical and Electronics Engineers (IEEE).
2. Instrument Society of America (ISA).
8. Underwriters Laboratories, Inc. (UL).

1.3 SUBMITTALS

A. Submit a complete list of equipment and materials and any details required to demonstrate that the equipment will function properly as a unit. This material shall include:

1. Itemized bill of material including manufacturer, complete model number and options included.
2. Manufacturer’s descriptive and technical literature.
3. Detailed descriptions of equipment, including weights, dimensions and installation requirements.
4. Complete dimensional plan views indicating sizes and clearances required for all equipment.
5. Manufacturer's fiber optic system cut sheets, manuals, and schematics.

B. Quality Control Submittals:

1. Testing Related Submittals.
2. **O&M Manuals:**
   a. Manufacturer’s installation instructions.
   b. Refer to paragraph Shop Drawings for the following items:
      1) Itemized bill of material including manufacturer, complete model number and options included.
      2) Catalog cuts.
      3) Component data sheets.
      4) All final as-built Drawings, fiber and copper cable mapping, devices and tag numbers shall be provided in electronic media, (AutoCAD version 2009 or earlier), on standard IBM computer compatible 2GB Hi-Speed Flash Drives and in hard three ring 11 inch x 17 inch binders in unfolded quality hard copy media.
      5) Factory and field certified test reports

3. Operating instructions and start-up procedures including receiving and installation requirements.

4. Maintenance instructions listing preventive and corrective maintenance procedures. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Reference test measurement levels to specific test points on the installed equipment.

5. Provide spare parts data for each item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply. Provide a list and itemized price breakdown of spare parts recommended for stocking. The parts selected shall be those which, in the manufacturer’s judgment, will be involved in the majority of maintenance problems.

6. Copy of guarantees and warranties issued for the various items of equipment, showing all dates of expiration.

1.4 **QUALITY ASSURANCE**

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Communications System equipment, materials, terminations and testing shall be provided and performed by:

1. American Datapath, 2345 S. Platte River Dr. W., 1-800-821-4131.
3. Unless otherwise approved by the ENGINEER.

1.5 **PROJECT & SITE ENVIRONMENTAL CONDITIONS**

A. All materials and equipment shall be designed and constructed for continuous operation, at rated current, at 6,900-ft above mean sea level, 40°C ambient and 95% relative humidity.

1.6 **WARRANTY**

A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.

1.7 **PACKING AND SHIPPING**

A. Established by CONTRACTOR to facilitate ingress of equipment to final installation location.
1.8 SPARE PARTS

A. Furnish to the ENGINEER's office the following spare equipment, a maximum of 20 weeks after the notice of award, of the Contract:

1. Four Fiber Optic to 10/100 base T media converter / Transceiver, Allied Telesyn AT-FS201-10.
2. Two Ethernet SCADA hubs: Ethernet switch with six RJ-45 ports and two 100BASE-FX ports with ST type connectors, Phoenix Contact FL Switch SFN 6TX/2FX ST.
3. Provide the following spare patch cords:
   a. (10) GB ST2-D2-01
   b. (10) GB ST2-D2-03
   c. (10) GB ST2-D2-05

PART 2 PRODUCTS

2.1 COMMUNICATIONS RACKS

A. Miscellaneous Racks features:

1. Wall mount type
2. 19 inch EIA 310-D compliant rail.
3. Front swing gate.
4. Hook and loop type straps.
5. Manufacturer: Great lakes, Ortronics, Hoffman.

2.2 FIBER OPTIC PATCH PANELS

A. At each fiber optic cable termination, the connectorized fibers shall be integrated into a fiber optic patch panel. The panel shall be of metallic construction, with lockable cover, totally enclosing the connectors. The panel shall accept "ST" type bulkhead connectors.

B. Fiber optic patch panels shall be enclosed within the PLC cabinets, and Communications Racks, as noted on the Drawings.

1. Manufacturer and Product: as approved by the ENGINEER.

2.3 FIBER OPTIC PATCH CORDS

A. Patch cords shall be utilized to connect the fibers within the fiber optic patch panel to the fiber optic transmitter and receiver modules. All patch cables shall be 62.5 microns and possess the attenuation and bandwidth parameters as specified for fiber optic cable plant. Fibers shall be placed in individual tight thermoplastic buffer tubes and protected with kevlar-strength members and enclosed with a thermoplastic jacket. The patch cords shall be terminated with "ST" type connectors.

1. Manufacturer and Product:
   a. Fiber optic patch cords with "ST" type connector shall be GB ST2-D2-XX

2.4 FIBER OPTIC SPLICE ENCLOSURE

A. Fiber optic splice enclosures shall not be used unless approved by the ENGINEER.

B. Splice enclosures shall protect the spliced fibers from moisture and damage, and provide strain relief for the fiber optic cable and the fibers. At each splicing location, sufficient cable shall be provided to properly rack and splice the cables, and allow for additional future splices.

C. Fiber optic splices shall be fusion-type only.
2.5 FIBER OPTIC ELECTRONIC UNITS

A. General - The fiber optic transceiver units shall be located within the specified control panels. The units shall be compatible with the fiber optic cable, panels, cords, and connectors as specified.

B. Fiber Optic to 10/100 Base T media converters/transceivers.
   1. All fiber optic Ethernet transceivers shall be IEEE 802.3 compliant. Conversion from the fiber optic media to the media required by the communications equipment shall be accomplished through the use of one device; multiple transceivers/converters to perform a single media conversion shall not be acceptable. The converter/transceiver shall be capable of detecting and reporting all link failures at the transceiver. The transceiver shall be supplied with LED indicators for displaying Transmit, Receive, and Collision status. The Fiber Optic Ethernet Converters/Transceivers shall be Allied Telesyn Media Converters AT-FS201-90 unless otherwise approved by the ENGINEER.

C. Fiber-Optic Repeaters: It is the responsibility of the CONTRACTOR to provide power for repeaters if their use is required to meet the requirements of this Specification. At a minimum, the repeater must regenerate the optical signal at the required transmission rate and be mechanically and optically compatible with the entire fiber-optic subsystem. Repeaters location and installation shall be approved by the ENGINEER.

2.6 ETHERNET SCADA HUB/SWITCH:

A. Ethernet switch with six RJ-45 ports and two 100BASE-FX ports with ST type connectors.

B. Transmission speed 10/100 Mbps on RJ-45 ports.

C. DIN rail mounted.

D. 24VDC power.

E. Manufacturer: Phoenix Contact FL Switch SFN 6TX/2FX ST.

2.7 TELEPHONE/DATA WALL JACK PLATE

A. Wall jack plate must be capable of being wired for 4 jacks and shall match nearby electrical cover plates in color and style.

B. Unused jack openings shall be covered with a flush plug made by the same manufacturer as the wall plate and that is the same color as the plate.

C. Shield and drain wires shall be grounded at the patch panel only. Only ground shield and drain wires at one end.

D. Female telephone jacks on the wall plates shall be ivory in color.

E. Female data jacks on the wall plates shall be orange in color.

F. Female fax jacks on the wall plates shall be ivory in color.

G. Female SCADA jacks on the wall plates shall be red in color.

H. All jacks shall be compatible with Category 5e cable and connectors, using 568B pinouts.

I. Each wall plate must be labeled using nomenclature specified in Item 3.2, LABELING.

J. Manufacturer: LEVITON Quickport unless otherwise approved by the ENGINEER.
K. All wall plate jacks, except in the powerhouse office, shall be provided with in-use type covers. In-use covers shall be approved by the ENGINEER.

2.8 COMMUNICATIONS CABLE

A. Fiber Optic Cables:

1. Cables and connectors shall be provided and installed by the installation CONTRACTOR. Supplier shall design and specify these components.
   a. Each link shall consist of two separate fiber optic cables.
   b. Each cable shall contain the number of strands indicated on the Drawings. If the number of strands is not indicated on the Drawings, the cable shall contain twice the number of strands required to handle all the specified communications functions. A minimum of eight strands shall be in any cable, unless otherwise approved by the ENGINEER.
   c. Optical fiber shall be coated with a suitable material to preserve the intrinsic strength of the glass. Fiber shall be protected by a protective tube, a jacketed strength member, and an exterior jacket.
   d. Conductors shall be multimode, graded index, solid glass waveguides with the following characteristics:
      1) Nominal Core Diameter: 62.5 microns.
      2) Minimum Ellipticity: 2.0 percent.
      3) Outside Clad Diameter: 125 microns.
      4) Minimum Numerical Aperture (NA): 0.275.
      5) Maximum Attenuation (850 nm): 3.75 dB/Km.
      6) Minimum Bandwidth (850 nm): 160 MHz/Km.
      7) Maximum Attenuation (1300 nm): 1.5 dB/Km.
      8) Minimum Bandwidth (1300 nm): 500 MHz/Km.
   e. Glass cladding shall be nominally concentric with the fiber core.
   f. Each fiber shall be continuous with no factory splices.
   g. Mechanical stress present in the cable shall not be transmitted to the optical fibers. The fiber optic cable shall use loose tube construction allowing for thermal expansions and free movement of the fiber within the protective container.
   h. All protective coatings in any single length of cable shall be continuous and be of the same material. The protective coverings shall be free from holes, splices, blisters, and other imperfections. A flooding compound shall be applied into the interior of the fiber buffer tubes.
   i. Strength members shall be an integral part of the cable construction. The combined strength of all the strength members shall be sufficient to support the stress of installation and to protect the cable in service.
   j. The outer cable jacket shall be made of high-density polyethylene (HDPE).
   k. Manufacturer and Product
      1) Superior Essex Series 1G.

B. Fiber optic cable accessories

1. Fiber Optic Cable Terminations: All fiber optic cable shall be "fanned out" to allow direct connectorization of the fiber optic cable. Each individual fiber shall be sleeved over with a kevlar-reinforced furcation tube. At the convergence point of all furcation tubes, provide strain relief with a high-density plastic fan-out collar. Fiber optic cable shall be supported on EHH walls by an ENGINEER approved method. An additional ten foot loop of spare fiber optic cable shall be installed in the EHH, unless otherwise approved by the ENGINEER.

2. Fiber Optic Connectors:
   a. All fibers shall be terminated with an "ST" type stainless steel or ferrule bayonet, keyed connector. Fiber optic equipment and cable shall use
the same type connectors. All connectors shall be installed using a 24-hour curable epoxy. The connector shall conform to the following:

1) Attenuation (Typical/Maximum): 0.3 dB/0.4 dB.
2) Fiber Nominal Outside Diameter: 125 microns.
3) Cable Nominal Outside Diameter: 2.4 mm, 3.0 mm.
4) Loss Repeat: <0.2 dB per 1,000 reconnects.

b. Manufacturer and Product: Fiber optic "ST" type connector shall be Systimax.

C. Data/telephone cable (Category 5e):

1. All telephone and data cable shall be industrial Ethernet cable with the following features:
   a. Four twisted pairs shielded, 24 AWG solid bare copper conductors.
   b. Suitable applications: Industrial Ethernet cable, harsh environments, 100MHz Category 5e, RJ-45 compatible, noisy environments, 100BaseTX.
   c. Each cable must be labeled in visible locations at both ends using the materials and nomenclature specified.

2. Manufacturer: Belden 7919A, unless otherwise approved by the ENGINEER.

D. Data cable (RS-485):

1. Data cable shall have the following features:
   a. Two twisted pairs, overall 100% shielded, 22 AWG stranded tinned copper conductors.
   b. Each cable must be labeled in visible locations at both ends using the materials and nomenclature specified.

2. Manufacturer: Belden 3107A, unless otherwise approved by the ENGINEER.

PART 3 EXECUTION

3.1 COMMUNICATIONS CABLE INSTALLATION

A. All communications fiber optic cable and copper communications cable shall be installed as required by the Specification Section 26 05 19, the Contract Documents, and manufacturer’s recommendations and as approved by the ENGINEER.

B. Do not exceed cable manufacturer’s recommendations for maximum pulling tension and minimum bending radii.

C. Install cable into wall plates and patch panels per manufacturer’s instructions, using only tools approved by the manufacturer.

D. Bundling:

1. When cables are running outside of conduit, bundle together with other cables of the same type throughout their exposed length with cable ties placed at intervals not exceeding 12 inches on center. Cable running above suspended ceilings should be fastened securely to roof joists or other locations approved by ENGINEER with J-hooks or equivalent means, at maximum spacing of 6 feet on center.

E. Cable runs from each jack to the communications distribution equipment must be pulled as one continuous piece of cable. Splicing is not permitted.

F. All data cables shall be bundled together with plenum rated tie wraps in service loops approved by the ENGINEER.
3.2 LABELING

A. CONTRACTOR must provide and install labels for each cable, wall plate, and patch panel.
   1. Cables must be labeled in visible locations at each end with pre-printed wrap-around labels.
   2. Cables must be labeled in visible locations at each pull box conduit, and EHH with pre-printed wrap-around labels.
   3. Wall plates shall be labeled using a label-maker (Brother brand) with 1/4 inch black letters on a white background.
   4. Data patch panels shall be labeled using a label-maker (Brother brand) with 1/4 inch black letters on a white background.
   5. All labeling shall be approved by the ENGINEER.

3.3 FIELD QUALITY CONTROL

A. An Optical Time Domain Reflectometer (OTDR) shall be used to map all fiber runs, including spare fibers, from start to finish to provide a warning of any microbending or other signal loss. The OTDR shall be Tektronix OTDR Fiber Master at 1300 nm with hard copy printout. A hard copy map of all fiber runs shall be submitted to the ENGINEER.

B. All fiber connections shall be checked under a video microscope for optical clarity and tested for insertion loss via a power meter connected on the opposite end to a laser source. All measurements shall be documented.

C. Telephone cables must be tested by after they have been installed and terminated. Test must be conducted using a tone device to make sure that cable and jacks have been properly installed. Any deficiencies shall be repaired. A summary report listing the test result for each phone line shall be submitted to OWNER upon completion.

D. Data cables must be tested after they have been terminated. A test report must be submitted for each data cable and must contain the following minimum information:
   1. Cable Identification Number
   2. Test Summary (Pass or Fail)
   3. Project Name
   4. Cable Location
   5. Date and Time of Cable Test
   6. Name of Person Conducting the test
   7. Test Standard
   8. Cable Type
   9. Test Instrument Used
   10. Length of cable tested
   11. Prop. Delay (ns)
   12. Delay Skew (ns)
   13. Impedance (ohms)
   14. Attenuation (dB)
   15. Frequency (MHz)
   16. Limit (dB)

END OF SECTION
SECTION 28 10 00
SECURITY SYSTEM

PART 1 GENERAL

1.1 SCOPE

A. The CONTRACTOR shall furnish and install the security system having the ratings, features/accessories and enclosures as specified in the Contract Documents. The CONTRACTOR shall be responsible for a complete, full functioning security system.

B. The security system shall communicate via TCP/IP Ethernet network. Provide Ethernet fiber optic converters, RJ-45 cable, and Serial to Ethernet converter (Lantronix UDS-10) to be connected and interfaced with the security control panel(s) SNIBs.

C. The Security System shall include all equipment and devices necessary for a complete security system as indicated in the Contract Documents. The security system shall include, but not be limited to, control panels, scramble keypads, miniature line modules, door hardware, security gate components, etc.

D. The Security Control Panel (SCP) shall be meet the requirements of Specification Section 40 90 00 Instrumentation & Control System (I&C). The SCP indicated is the minimum acceptable size, the Contractor shall be responsible for providing a SCP sized to house the Security Panel and equipment required while leaving 50% spare back panel space for future equipment.

E. All raceways and wiring external to the security devices and panels shall be provided and installed by the Electrical Subcontractor.

1.2 REFERENCES

A. The equipment and Work covered in this Specification, except as noted, shall be designed, manufactured, installed and tested in accordance with the latest revisions of the applicable standards of:

1. Institute of Electrical and Electronics Engineers (IEEE).
2. Instrument Society of America (ISA).
8. Underwriters Laboratories, Inc. (UL).

1.3 SUBMITTALS

A. Shop Drawings:

1. Itemized bill of material including manufacturer, complete model number and options included.
2. Descriptive information.
3. Catalog Cuts: components, electrical devices, and mechanical devices:
   a. Catalog information.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled drawings showing exterior dimensions and locations of all electrical and mechanical interfaces.
4. The Drawings indicate locations of the door interlocks, keypad, and security control panel. The Drawings provide a one-line diagram to indicate the intended interconnection of the system devices.

5. Dimensional drawings.

6. Anchoring instructions and details.

7. One-line diagrams of the new and existing systems.

8. Schematic (elementary) diagrams of the new and existing systems.


10. Interconnection diagrams.

11. Installation Details: Include all modifications or further details required.

12. Spares, expendables, and test equipment.

B. Quality Control Submittals:

1. Testing Related Submittals.

2. O&M Manuals:
   a. Legends Abbreviation Lists.
   b. Refer to Paragraph A. Shop Drawings, above, for the following items:
      1) Bill of materials.
      2) Catalog cuts.
      3) Component data sheets.
      4) Final as-built drawings and wiring diagrams
      5) Factory and field certified test reports
   c. Device O&M manuals for components, electrical devices, and mechanical devices shall include:
      1) Operations procedures.
      2) Installation requirements and procedures.
      3) Maintenance requirements and procedures.
      4) Troubleshooting procedures.
      5) Internal schematic and wiring diagrams.
   d. List of spares and expendables required and recommended.

1.4 QUALITY ASSURANCE

A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.

B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.

C. Manufacturer shall provide certificate of ISO 9002 Compliance.

D. Installation shall be supervised and tested by the manufacturer of the system equipment. The supervisory and testing work shall be performed by skilled technicians under the direction of experienced engineers, all of who shall be properly trained and qualified for the work.

1.5 PROJECT & SITE ENVIRONMENTAL CONDITIONS

A. All materials and equipment shall be designed and constructed for continuous operation, at rated current and voltage, at 6,900-ft above mean sea level, 40°C ambient and 95% relative humidity.

1.6 WARRANTY

A. The Manufacturer shall warrant all equipment to be free from defects in materials and workmanship for one year from the date of installation or 18 months from the date of purchase, whichever occurs first.
1.7 EXTRA MATERIALS

A. Furnish, box, tag and clearly mark on exterior, (identify each item with manufacturer’s name, description and part number), for shipment and long-term storage and deliver prior to 75% Project completion the following extra materials:

1. Fuses: A minimum of ten of each type and each voltage & current rating installed.
2. Lamps & LEDs: A minimum of ten of each type and each voltage & current rating installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The security system shall be manufactured by Hirsch Electronics Corporation. The system shall be designed, coordinated and supplied by the system manufacturer or its authorized agent who is regularly engaged in the business of designing and installing security systems.

2.2 INDIVIDUAL DEVICE SPECIFICATIONS

A. The following Specifications shall apply to the equipment furnished as part of the security system.

1. Door Locks, hinges, line modules, and contacts:
   a. The door locks shall be provided and installed as indicated on the Drawings and as recommended by the Manufacturer. The door locks shall be provided by Best Access Systems; Model 35HW-EWEU-RQE electrified mortise lock, (core housing, lever style, trim style, finishes & handing shall be coordinated with Specification Division 08 to provide complete & functional security system doors).
   b. The electric hinges shall be provided and installed as indicated on the Drawings and as recommended by the Manufacturer; ACS #1104 electric hinge.
   c. The miniature line modules shall be provided and installed as indicated on the Drawings and as recommended by the Manufacturer; HIRSCH MELM3.
   d. The door contacts shall be provided and installed as indicated on the Drawings and as recommended by the Manufacturer; Sentrol 1078C for new door installations, and Sentrol 2505A for existing door installations.

2. Security Keypads: Security high intensity door keypads shall have an alphanumeric display capable of providing complete messages during all stages of operation and programming of the system and display all relevant operating and test data. Keypad shall be capable of arming and disarming any portion of the security system based on P.I.N. authorization. The security keypad shall be Hirsch Electronics Corporation Model DS47L-SPX-HI-MR2B.

3. Security Panel: The security panel shall be capable of monitoring a minimum of eight zones.
   a. All interface cables between the panel, keypads, door contacts, and door locks shall be provided and installed as indicated on the Drawings, recommended by the Manufacturer and as approved by the ENGINEER.
   b. The panel shall have a minimum of 2 spdt, 5 ampere rated output relays. One alarm relay contact shall provide an alarm input to the control system when any zone is alarmed.
   c. The security panel shall allow authorized users to enter, change, or delete the daily on and off schedules for the output relays and to establish permanent opening and closing schedules for each day of the week.
d. Keypad in the security door system shall be provided with entry and exit delay, adjustable from 0 to 250 seconds.

e. When a zone is entered, its associated keypad shall sound a prewarn tone and shall display an "Enter Code" message on its alphanumeric display. If a valid code is not entered prior to the expiration of the entry delay, an alarm shall be transmitted to the plant control system. When the above zone is exited, and exit delay shall be displayed and counted down on its associated keypad alphanumeric display. If the zone is in an alarm condition at the expiration of the exit delay, the entry delay sequence shall commence immediately.

f. The security panels shall be Hirsch Electronics Corporation M8N Model 2 or Model 8 Control Panels as shown on the Drawings, with a 24 VDC Power Supply.

PART 3 EXECUTION

3.1 INSTALLATION

A. The system shall be installed with all conduits, conductors, outlet boxes, fittings, connectors and accessories necessary to ensure a complete, operable system in compliance with all applicable codes and regulations.

B. All wiring shall be installed in RGS conduit or within equipment, unless otherwise approved by the ENGINEER. Conductor within equipment enclosures shall be carefully cabled and laced. Individual conductors shall be tagged indicating circuit number and type. Markers shall be used on all equipment at each outlet or pull box and at each equipment enclosure.

C. Install equipment in accordance with NEMA ICS 2.3, Submittal Drawings, and Manufacturer's Instructions and Recommendations.

D. Interface new security system equipment, devices and network with the existing security system located in the Valvehouse and the Caretaker's Headquarters.

E. Install equipment plumb and in longitudinal alignment with pad or wall.

F. Coordinate terminal connections with installation of cables.

3.2 FIELD QUALITY CONTROL

A. Testing as required in Specification Section 26 08 00 Commissioning of Electrical Systems.

B. Verify wiring, installation and identification.

C. Inspect support and grounding connection.

D. Verify proper system operation.

E. Provide installation Certification.

3.3 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative in accordance with SECTION 01 43 00 of Contract 11577A, for the following services at jobsite or classroom as designated by OWNER, for minimum person-days listed below, travel time excluded:

1. One person-day for installation assistance, inspection of installation, and system programming with the Owner after the system has been installed.
2. One person-day for functional and performance testing.
END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Drilling holes for hydraulic and electrical conduits extending from the new control building foundation to one each: the auxiliary level gate, the mid/low level gate, and manway house downstream of dam.

1.2 SUBMITTALS

A. At least 15 calendar days prior to drilling, furnish the following submittals for ENGINEER’s review and acceptance.

1. Drilling Plan: The drilling plan shall include a schedule, planned equipment, drilling method, and containment plan.
2. Bore hole alignment and setup, plan and internal inspection plan, including means and methods to keep bore hole on the design alignment, and inspection method to evaluate condition of the hole.
3. Bore hole casing material, coupling mechanism, cementing mix, and backfill grouting mix, including means and methods to install, cement, clean, and backfill grout the holes in place.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Become familiar with all details of the Work and verify all dimensions in the field. Advise the ENGINEER of any discrepancy before performing the work.

3.2 DRILLING

A. The inclined holes are designed to convey either hydraulic and air lines or electrical conduit from the control building foundation to the auxiliary gate, low/mid level gate, and manway house.

B. The inclined holes shall be drilled at the locations shown on the drawings.

C. The method of drilling shall be at CONTRACTOR’s option, and subject to the requirements in these Specifications. The drilling method shall be capable of drilling a minimum 16-inch diameter hole at 10 to 45 degree angle from horizontal.

D. A pilot hole, with a maximum diameter of 3 inches, shall be drilled from the control building foundation to one each: the auxiliary level gate, mid/low level gate, and the manway house. The pilot hole shall be in place prior to the drilling of the 16-inch diameter hole. The location of the pilot hole shall be accepted by the OWNER prior to the start of drilling the 16-inch diameter hole.

E. Submit to the OWNER the methods of drilling, plans to evacuate the cutting from the hole and handling any waste products (i.e. drilling mud, etc.) produced during drilling.

F. If a drilling method is proposed which requires drilling mud, only a degradable polymer shall be allowed as a drill mud, and bentonite mud shall not be allowed. Full containment on the dam crest is required. Offsite disposal of drilling mud is the CONTRACTOR’s responsibility.
G. Drilling fluids used shall be composed of new materials including use of potable water. It is expressly understood that toxic and/or dangerous substances will not be added to the drilling fluid. Maintain the quality of the drilling fluid to assure protection of the water-bearing zone or potential water bearing zone(s) exposed in the formation materials. A drilling fluid containment plan shall be included within the drilling plan submittal. No potable water is available at the site.

H. Measure the hole inclination at a minimum of 25 foot intervals as the drilling of the pilot and bore hole is proceeding. A maximum hole deflection of 1.5 degrees will be allowed. Any deviation observed by the CONTRACTOR will be corrected as needed to ensure the boreholes and pilot hole exit at the specified locations.

I. Any hole drilled for the inclined bore holes and pilot holes that do not encounter the reservoir within 10 feet of the specified location will be backfilled with a sand/cement/bentonite mix approved by the ENGINEER. The backfill of any hole and subsequent redrilling of a new pilot hole and/or indirect overflow hole will be done at the CONTRACTOR’s expense and will not be reimbursed by the OWNER.

J. The inclined hole to the Manway House shall be cased, cemented, and finished to be permanently sealed against water seepage from bottom to top, the minimum nominal casing size is 14 inches.

K. The inclined holes to the auxiliary intake and the low/mid intake shall be cased, cemented, and finished to provide a smooth bore hole interior capable of accepting the hydraulic and air line tubing assembly. The minimum nominal casing size is 14 inches.

L. The inclined holes to the auxiliary intake and the low/mid intake shall be backfill grouted upon installation completion of the hydraulic and air line tubing assembly.

END OF SECTION
PART 1 GENERAL

1.1 DESCRIPTION

A. This Section specifies procedures for and restrictions on drilling and blasting operations and the storage, handling and use of explosives for fracturing and excavating rock and concrete/rock masonry structures.

1.2 CONTRACTOR RESPONSIBILITIES

A. Evaluate all necessary data and inspecting site areas to determine where blasting is needed to facilitate rock excavation.
B. Design and implement the drilling and blasting program to achieve the desired results in a safe manner.
C. Protect all persons, animals, aquatic life, structures, facilities, property from damage caused by drilling, blasting and excavation.
D. All liabilities and damages associated with the drilling, blasting and excavation.
E. Obtaining permits, providing notifications, and fulfilling requirements for permits from all applicable agencies.
F. Coordinate all blasts with the ENGINEER and shall ensure that all applicable agencies are properly warned about all blasting activities and schedules.

1.3 WORKSITE CONDITIONS

A. The CONTRACTOR is hereby notified that rock blasting work will occur near existing valves and other critical facilities within Cheesman Dam. Blasting will also occur at locations below water with depth up to 200 feet. This Statement of Concern is expressly written to alert the CONTRACTOR (or prospective bidders) to the fact that ordinary practices customarily considered as standard for the blasting industry will not be acceptable on this project. Extra caution and skill will be required to accomplish this work in a safe and satisfactory manner. Because of these concerns, the OWNER will exercise their prerogative to examine carefully the qualifications of any persons whose knowledge and skills may bear on the outcome of the work. In addition, the OWNER will reject any persons who are deemed unqualified for any tasks that may be required.

1.4 RELATED SECTIONS

A. All sections with special reference to the following:
   1. SECTION 01 33 00

1.5 REFERENCES

A. Comply with the applicable rules, regulations and standards established by the Regulatory Agencies, codes and professional societies listed herein, including rules and regulations for storage, transportation, and use of explosives. These rules and standards include but are not limited to the following:
   2. OSHA of 1970, 29 U.S.C., Section 651 et seq., including safety and health regulations for construction.
1.6 DEFINITIONS

A. Blaster-in-Charge or Blasting Supervisor - The single designated and licensed person with complete responsibility and total authority over all decisions involving safe handling, use and on-site security of explosives.

B. Charge-per-Delay - For vibration control, any charges firing within any 8-millisecond time period are considered to have a cumulative effect on vibration and air-overpressure effects. Therefore, the maximum charge-per-delay (W) is the sum of the weight of all charges firing within any 8-millisecond time period. For example, if two 10-lb. Charges fire at 100 ms and one 15-lb charge fires at 105 ms, the maximum charge per delay would be 35 lbs.

C. Controlled Blasting – Excavation of rock using explosives, wherein the blast is carefully designed and controlled to provide a distribution of charge and confining stemming that will excavate the rock to the required limits but minimize overbreak, control rock movement, and assure that intensities of blast-induced vibration and water-overpressure do not exceed specified limits.

D. Decoupled Charges – Un-tamped explosive charges with a diameter less than the diameter of the blasthole. The degree of decoupling is expressed as the ratio of the charge and hole cross-sections.

E. Impulse – Cumulative blast-induced force created by ambient pressure changes applied over time. Impulse is expressed in units of psi-milliseconds and can have a positive or negative value.

F. Line Drilling - A method of overbreak control in which a series of very closely spaced holes is drilled at the perimeter of the excavation. These holes are not loaded with explosives.

G. Peak Particle Velocity - Peak Particle Velocity (PPV): The maximum of the three ground vibration velocities measured in the vertical, longitudinal and transverse directions. PPV measurement units are expressed in inches-per-second (ips).

H. Perimeter Holes - The blast holes drilled along the final limit of the excavation.

I. Pre-splitting - A drilling and blasting technique whereby smooth fracture planes are created by detonating decoupled explosive charges in holes drilled on closely spaced centers along final excavation lines.

J. Primary Initiation - The method used to initiate a blast(s) from a remote and safe location. Primary initiation systems use shock-tubes or electrical current to convey firing energy from the point of initiation to blast locations.

K. Production Holes - Blast holes in the main body of the rock mass being removed by drilling and blasting.

L. Prohibited Persons - Persons prohibited from handling or possessing explosive materials as defined by the seven categories described in Section 555.11 of 27 CFR (ATF Rules).
M. Scaled Distance: A calculated value describing relative vibration energy based on distance and charge-per-delay. For ground vibration control and prediction purposes, Scaled Distance (D_s) is obtained by dividing the distance of concern (D) by the square root of the charge-per-delay (W); so \( D_s = \frac{D}{W^{0.5}} \) or when a minimum defined scaled distance is defined to limit charge weight, \( W = \left(\frac{D}{D_s}\right)^2 \). For example, if a blast is designed to meet a minimum scaled distance of 60, the maximum charge-per-delay for a blast located 200 feet from the structure of concern would be \((200/60)^2\), or 11.1 pounds.

N. Seismograph -- An instrument used to record the intensity and frequency of ground vibrations measured with three mutually perpendicular geophones and a linear-scale microphone that measures air-overpressure.

O. Smooth Blasting -- A drilling and blasting technique using reduced hole-spacing similar to pre-splitting, except that the reduced charges in holes at the perimeter of the blast are detonated with adjacent mass-blast holes using the highest delay times.

P. Stemming -- Crushed stone, tamped clay or other inert earth material placed in the unloaded collar area of blastholes for the purpose of confining explosive charges and limiting rock movement and air-overpressure (noise).

Q. Subdrilling -- The portion of the blasthole that is drilled below or beyond the desired excavation depth or limit. Subdrilling is generally required to prevent the occurrence of high or tight areas of unfractured rock between blastholes.

R. Water-overpressure – absolute value of increases or reductions to ambient water pressure measured with a hydrophone and recording equipment designed for underwater blasting measurements. Overpressure is expressed in units of pounds-per-square-inch (psi).

1.7 CONTRACTOR SUBMITTALS

A. All submittals for blasting shall be provided in accordance with the requirements of this Section and SECTION 01 33 00.

B. Review or acceptance of submittals by the ENGINEER and compliance by the CONTRACTOR with provisions for protection of life and property shall not relieve the CONTRACTOR of the CONTRACTOR’s responsibility or liability for the safety of persons, property, and maintenance of the environment.

C. Blasting Licenses and Permits: At least 20 days before any blasting work occurs, submit.
   1. Copy of Colorado Type I Blasting Permits for all proposed Blasters-in-Charge.
   2. Copy of Colorado Type II Blasting Permit for the Blasting CONTRACTOR.
   3. Copy of Colorado Type III blasting permit for the Blasting CONTRACTOR if Explosives will be stored on site.
   4. Copy of Blasting CONTRACTOR’s federal ATF License.
   5. Copy of Blasting CONTRACTOR’s or Explosive Distributor’s federal DOT Hazardous Materials Transportation License.
   6. Copy of Colorado Commercial Drivers Licenses with Hazmat Endorsements for all CONTRACTOR or subcontractor employees that will transport explosives to and from the site.

D. Obtain at least two printed copies of all applicable codes, regulations, ordinances and monitoring standards. One set of these documents shall be kept in the CONTRACTOR’s office at the jobsite. A second set of these regulations and standards shall be submitted to the ENGINEER at least 20 days before and blasting work occurs.

E. At least 20 calendar days before any blasting occurs, submit the names and qualifications with written evidence of past experience and competency for all Blasters-in-Charge and the CONTRACTOR’s proposed Blasting Consultant. In the event that personnel change during the project, submit information on the newly proposed personnel at least 10 days before they
are involved with any work at the project. The qualifications and experience of these persons shall conform to the requirements of this Section.

F. At least 30 days before any drilling or blasting work has begun, submit a General Drilling and Blasting Plan that shall include the following items:

1. Material Safety Data Sheets for all explosive materials.
2. Manufacturer’s Specifications Sheets for all explosives, initiators, and blasting devices.
3. Methods used to restrict access to the blast area and assure the safety of all persons. The submittal shall include description of OSHA-compliant warning signs, procedures for clearing and checking the blast area prior to each blast, blast warning signals, post blast checks, and all-clear signals. It is understood that audible signals will be sounded by the shot-firer from a floating platform.
4. Drawings with text notes that clearly show:
   a. Details of typical blasthole layouts in plan and section views.
   b. Details of typical charges showing types and size of explosives, weight of charges, and type and amount of stemming used to confine charges.
   c. Details of initiation system hookups and planned firing times of all charges.
5. Description of the primary initiation method that will be used to initiate blasts from a safe location. Include Specification sheets for the non-electric shot-firing device.
6. Description of methods that will be applied to suspend blasting work and secure all workers and explosive materials in safe locations if a lightning hazard is detected. Include manufacturer’s Specifications for lightning detector.
7. Description of methods that will be used to implement fish-scare charges meeting the requirements of this Specification.
8. Provide manufacturer’s published Specifications for all vibration and water-overpressure monitoring equipment and software. Also submit copies of manufacturer’s calibration certificates for all recorders, sensors and hydrophones dated no earlier than six months before the time blasting work is expected to begin.
9. Include a signed letter from the CONTRACTOR’s Blasting Consultant stating that they have either authored the General Drilling and Blasting Plan, or they have reviewed it and approve it in its entirety.
10. Include signed letters from technical managers representing manufacturers of all explosives and initiation devices confirming that all products used for this work are designed to function safely and reliably in an environment under as much as 212 feet of water and with hydrostatic pressure of 92 psi.

G. At least 20 days before any blasting has begun, submit a Plan describing the temporary barriers or devices that will be used to attenuate blast-induced water-overpressure exerted toward needle and gate valves. The design of the barriers shall conform to the minimum standards of this Section and this plan shall include design calculations prepared and stamped by a qualified professional engineer licensed in the state of Colorado.

H. At least 20 days before any explosives are brought to the site, submit detailed Explosives Handling Plan with descriptions of trucks and other conveyances that will be used to transport explosives at the site; and describe day boxes and handling procedures. Also include descriptions of placards, fire extinguishers, IME 22 containers and other safety and regulatory compliance equipment used on transport vehicles and boats.

I. If the CONTRACTOR plans to store explosives and detonators on Denver Water property near the site, submit an Explosive Storage Plan to include:

1. A scaled map showing proposed locations of explosive and detonator magazines with respect to nearest occupied structures and public roadways.
2. Provide maximum storage quantities of explosives by classification and show that maximum quantities are in full compliance with the American Table of Distance requirements.
3. Describe signage that will be posted at the site to alert emergency response personnel in the event of fire or other emergency.
4. Provide a listing of emergency contact personnel including names, home and cell phone numbers.
5. Copies of letters and accompanying documents and maps notifying the applicable County Sheriff (Douglas or Jefferson) and the North Fork Volunteer Fire Department about the explosive storage facilities.

J. At least 24 hours before the planned time of a blast, submit Individual Blast Plans for each blast. All individual Blast Plans shall conform to the general blasting procedures described in the most currently approved General Drilling and Blasting Plan. Individual Blast Plans shall include:

1. Text and drawings that clearly show details of hole-charging arrangement showing types and size of explosives, weight of charges and stemming type and amount.
2. Text and drawings showing typical drilling pattern arrangement and millisecond delay timing hook-up and firing times for all individual charges.
3. Include summary of total explosive quantities, rock volume and powder factor calculation.
4. Scaled maps showing location of blast with respect to nearest structures.
5. Define maximum charge-weight-per-delay and provide calculations of expected peak intensity of vibration at the nearest valve and other identified structures of concern.
6. Signature of Blaster-in-Charge of record with a statement that the submitted plan conforms to the currently approved General Drilling and Blasting Plan. Conforming Individual Blast Plans do not require the signature of the CONTRACTOR’s Blasting Consultant.

K. Blast Reports: Within 16 hours of the time of each blast submit Individual Blast Reports and Monitoring Records. Blast reports shall include time and date of blast, blast number, charge delay timing details, summaries of all explosives and initiators used in blast, maximum charge-per-delay, hole-diameters, spacing, depths, burden, sub-drilling, and hole-charging and stemming configuration for all holes. Also include all information required by State of Colorado Division of Oil and Public Safety regulations.

L. Blast Monitoring Records: Within 16 hours after all blasts submit:

1. A copy of the instrument-software generated blast monitoring report at each instrument location where vibration or water-overpressure is measured. Reports shall include time-intensity plots of measured effect, frequencies of particle motion or pressure changes, and peak intensity of measured values such as PPV, Peak Overpressure, or Impulse. Reports shall also include date and time of event recording, and date the instrument was last calibrated.
2. Scaled map(s) showing the locations of all blast monitoring instruments and the distance to nearest charges.

1.8 QUALITY CONTROL

A. Blasters-in-charge: All proposed supervising Blasters-in-charge shall be properly licensed and have a minimum of ten years of construction blasting experience. Documented experience must include involvement as Blaster-in-charge at a minimum of two projects where controlled underwater blasting was successfully completed near sensitive structures or facilities. Divers performing drilling and blast charging work underwater can either be the licensed blaster or they can report to a blaster-in-charge supervising the work from an above-water floating platform.

B. Blasting Consultant: The independent Blasting Consultant shall have at least 20 years of documented experience in designing and overseeing the successful implementation of close-in construction rock blasting work and shall have direct experience in at least 4 underwater blasting projects. The Blasting Consultant shall not be an employee of any suppliers to the CONTRACTOR or an employee of the CONTRACTOR or any affiliated companies. The Blasting Consultant shall: visit the site to examine conditions before blasting occurs, assist the CONTRACTOR with the development of all blasting plans, be onsite to oversee results of
the first three blasts, and be on call to attend any meetings as directed by the ENGINEER. At a minimum, the Blasting Consultant shall be expected to spend at least 120 hours of time on this project, including at least 6 one-day visits to the site to attend meetings and oversee test blasts.

C. Qualified Barrier Designer:

1. The proposed barrier designer shall be a Colorado Licensed Professional Engineer and have a minimum of 10 years experience applicable to the design of blasting barriers. Documented experience must include design of tunnel or conduit plugs specific to temporary dewatering.

D. Blasting Kick-Off Meeting: At least 10 days before any holes are drilled for blasting work, a one-day meeting will be held on site to review the CONTRACTOR’s general blasting plans, structure and aquatic life protection measures, and explosive handling procedures. All of the CONTRACTOR’s blasters, divers, and supervisors involved in the blasting work shall attend this meeting with the OWNERS representatives. The CONTRACTOR’s Blasting Consultant shall also attend this meeting. No extra payments beyond items already included in the bid schedule will be made to cover any costs associated with this meeting.

1.9 NOTIFICATIONS

A. Provide notification to ENGINEER at least 24 hours in advance of each blast.

B. If explosives are stored overnight on Denver Water property, notify Bureau of Alcohol Tobacco Firearms and Explosives (ATF) within 48 hours of establishing explosive storage facilities.

C. At least seven calendar days before explosives are brought to the site, notify, as appropriate, the Douglas or Jefferson County Sheriffs and the applicable Fire and Emergency Response Agency with a written letter detailing the locations, quantities and types of explosive materials that will be stored at the site. The notification letters shall be copied to the ENGINEER and it shall also include a scaled map showing locations of explosive and detonator magazines, a summary of maximum storage amounts and United Nations (UN) hazard classifications. A second notice shall be similarly made and copied to the ENGINEER when all materials have been removed from the site when blasting work is complete.

1.10 ACCESS FOR INSPECTION AND MONITORING

A. Provide safe transportation and access to floating platforms for all OWNER’S representatives involved in water pressure monitoring and inspection of the work.

PART 2 PRODUCTS

2.1 EXPLOSIVES AND INITIATION SYSTEMS

A. Use only explosives, detonators, and accessories that are specifically designed to work in an environment with hydrostatic pressures as high as 92 psi.

PART 3 EXECUTION

3.1 BLASTING SAFETY

A. The CONTRACTOR is responsible for blasting in a safe manner. Adhere to all safety and health standards from all agencies having jurisdiction over the work.

B. Initiation System: Do not use electrical detonation systems.
C. Lightning Protection: Use a lightning detector to monitor the approach of electrical storms. When storms are detected within 2 miles of the work area, blasting operations shall be suspended and all persons and explosive materials shall be moved to safe and secured locations until the hazard has passed.

3.2 HANDLING, STORAGE AND SECURITY OF EXPLOSIVE MATERIALS

A. Unless an overnight storage plan is submitted and approved by the ENGINEER and all notifications to ATF, fire and police authorities are made as required, remove all explosives, detonators and explosive boxes from the site on a daily basis.

B. The CONTRACTOR may request permission from the ENGINEER to store blast materials on Denver Water Property near the site. If the CONTRACTOR does store blast materials onsite, obtain all necessary permits and shall arrange necessary security. The location of magazines shall be as proposed by the CONTRACTOR and accepted by the ENGINEER. No magazine shall be provided until all the permits have been obtained and the ENGINEER accepts the location.

C. Explosives Security: The responsible person holding the ATF license for this work shall ensure the security of explosive materials at all times when explosive materials are used or kept on the project site. Ensure that:

1. All persons that handle explosive materials, have control over them, or access to them, must not be prohibited persons, as defined in Section 555.11 of 27 CFR (ATF Rules).
2. All blasting work and explosive handling activities are done under the supervision of a properly licensed Blaster-in-Charge.
3. When explosives are delivered to the work site, they shall not be unloaded from delivery vehicles until a responsible Blaster-in-Charge has signed the delivery paperwork and assumes full authority and responsibility for the security of the explosive materials. Unused explosive materials must be similarly signed over to a properly licensed driver with a Commercial Drivers License with a Hazmat endorsement before explosive materials are loaded onto a fully-DOT-compliant vehicle for removal from the site.
4. Maintain copies of ATF Employee Possessor questionnaire forms (OMB No. 1140-0072) or documentation of ATF clearance on the CONTRACTOR's ATF license for all employees who will possess, handle or have access or control over explosives for this work as defined in 27 CFR Part 555. This documentation must be available upon request by the appropriate authorities or the ENGINEER. CONTRACTOR and subcontractor employees, without submitted evidence of satisfactory ATF clearance, must not handle, control or have access to explosive materials.
5. Proper storage, safety and security of the blast materials shall be the CONTRACTOR's responsibility.

3.3 WORK HOURS AND BLAST SCHEDULES

A. The OWNER imposes no limits on the hours in which blasting can occur. IF necessary, obtain a variance from daylight blasting restrictions from the State of Colorado.

3.4 TEST BLASTS

A. Conduct at least one Test Blast in the Mid Level and Low Level Outlet areas. These Test Blast(s) will be half the scale or less of the full sized blasts submitted in the CONTRACTOR's General Blast Plan.

B. The Test Blast(s) shall conform to all blast design and monitoring requirements specified for full-scale blasts. Results of the Test Blast(s) as documented by underwater cameras shall be reviewed by the CONTRACTOR and ENGINEER for effectiveness. Effectiveness will be evaluated relative to fragmentation, over-drilling, ground movement, vibration, water-overpressures. After each Test Blast, the ENGINEER will determine whether or not one or
more Test Blasts are necessary. Successive test blasts and/or production blast designs shall be revised as necessary to produce the desired results.

C. The CONTRACTOR’S Blasting Consultant shall be present to oversee hole-charging, tie-in, monitoring and execution of all test blasts.

3.5 DRILLING AND BLASTING LIMITATIONS

A. No flowable explosives shall be used for blasting. Charges comprised of cartridge-explosives and detonating cord are allowed.

B. All charges shall be double-primed with two separate detonators of the same delay.

C. Diameter of explosive charges shall not exceed 1.5 inches.

D. If dynamite is used, it shall be phlegmatized to prevent propagation. PowerDitch 1000, DGEL 1000.

E. A minimum of one feet of tamped clay stemming shall be used to confine all charges.

F. The maximum charge-per-delay for all blasts shall not exceed 10 pounds.

G. Intensity of peak ground motion at the closest access point to the nearest valve shall not exceed 4.0 in/s.

H. Intensity of peak water-overpressure measured 100 feet from the blast location shall not exceed 75 psi. If peak pressures exceed 75 psi, use air curtains supplied by oil-free air or other mechanisms as necessary to comply with water pressure limits.

3.6 FISH PROTECTION

A. Fire scare-charges in the water at the same elevation as planned production blasts one to two minutes before firing the main blast. Detonators containing no more than one gram of PETN or equivalent high explosive base charge shall be used for scare charges.

3.7 VALVE PROTECTION

A. Design temporary barriers that will be installed and secured tightly within tunnel openings between existing needle and gate valves in the dam and work area. These barriers shall be designed to absorb and attenuate water pressure pulses created by blasting. At a minimum, the barriers shall be able to withstand a peak quasi-static pressure of 40 psi and impulse of 16 psi-milliseconds.

3.8 INSTRUMENTATION AND MONITORING

A. Seismographs operated by representatives of the OWNER will be used to monitor intensity of blast-induced vibration and air-overpressure at key locations decided by the ENGINEER.

B. An underwater dynamic pressure monitoring system, operated by representatives of the OWNER will be used to measure peak water-overpressure and impulse for all blasts. The pressure sensor shall be suspended and secured in the water at the elevation of the blast, and located 100 feet laterally from the blast.

C. Coordinate their work with the ENGINEER to assure that all monitoring is done safely and as planned.

END OF SECTION
PART 1  GENERAL

1.1  GENERAL
   A. Section includes basic piping, components, and installation information.

1.2  REFERENCES
   A. The following is a list of standards which may be referenced in this Section and any supplemental Data Sheets:

1. American National Standards Institute (ANSI):
   b. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   c. B16.25, Butt Welding Ends.


3. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessels.
   b. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
   c. B 31.1, Power Piping.
   d. B 16.11, Forged Fittings, Socket Welded and Threaded
   e. B 16.22 Wrought Copper and Bronze Solder Joint Pressure Fittings

   d. B 32, Solder Metal.
   f. D 1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   k. D 1785, Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

5. American Welding Society (AWS):
   a. A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   b. QC 1, Standard for AWS Certification of Welding Construction Project Inspectors.


1.3  DEFINITIONS
   A. Submerged Piping: Piping installed underwater ranging from 0 depth to 225 feet depth.
B. Piping / Tubing: Round, hollow, fluid conveying devices.

C. Tunnel Bore: Tunnel bore through rock for the purpose of running piping to its intended destination.

D. Exposed Piping: Piping which is not buried, submerged, or concrete embedded or encased.

E. Welders: Qualified personnel who perform welding, soldering, or brazing operations as required.

1.4 DESIGN REQUIREMENTS

A. Design requirements are for Copper Tubing and Plastic Pipe as used in this project.

B. Design Pressure: 250 PSI

C. Safety Factor against bursting: 3

1.5 SUBMITTALS

A. Material Compliance:
   1. Catalog cut sheets, general drawings and Specifications to prove compliance for all specified components
   2. Tube fittings

B. Shop Drawings:
   1. Field drawings showing proposed layout, joint details, pipe installation and routing methods, etc.
   2. Pipe wall thickness
   3. Piping support methods

C. Quality Control Submittals:
   1. Qualifications:
      a. Welders:
         1) List of qualified welders and welding operators.
         2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
      2. Weld Procedures.
      3. Nondestructive inspection and testing procedures.
      4. Hydrostatic test results.

D. All submittal items approved for construction shall be included in the final O&M manual. O&M Manual will also be submitted in PDF format, see SECTION 01 33 00 for requirements.

1.6 QUALIFICATIONS

A. Welder and Welding Operator Qualifications:
   1. Qualified by accepted inspection and testing agency before starting Work in accordance with AWS D1.1 and ASME Boiler and Pressure Vessel Code.
   2. Qualified to perform groove welds in Position 6G for each welding process and pipe material specified.
   3. Qualification tests may be waived by ENGINEER based on evidence of prior qualification.
   4. Retesting: Upon ENGINEER's written request, retest qualified welder(s).
B. Plumbers (For Piping work):
   1. Licensed Master Plumber
   2. 10 Years experience working on industrial projects of a similar scope and size
   3. Resumes and compliance information is required

1.7 DELIVERY, STORAGE, AND HANDLING
A. In accordance with SECTION 01 60 00, and:
   1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
   2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
   3. Cold Weather Storage: Locate products to prevent coating from freezing to ground.

PART 2 PRODUCTS
2.1 PIPING
A. As specified on Data Sheet(s) and Piping Schedule located at the end of this Section as Supplement.
B. Emergency generator exhaust piping shall be sch 40 carbon steel piping and fittings with welded joints, and high-temperature coating.
C. Stainless Steel Tubing for Hydraulic Lines is specified in SECTION 23 11 00. Installation methods shall be common with the piping specified herein.
D. Diameters Shown:
E. Identification Marking: All piping shall be permanently and legibly marked for identification before installing. Marking material must be water resistant and compatible with Potable Water

2.2 JOINTS
A. General:
   1. Joints for piping that can be installed dry in the tunnel bores or Control Building shall be soldered or solvent welded
   2. Joints that must be installed underwater shall be mechanical joints per the Specifications
   3. The joints furnished shall have the same or higher pressure rating as the abutting pipe.
B. Threaded Joints: NPT taper pipe threads in accordance with ANSI B1.20.1.

2.3 INSULATING DIELECTRIC UNIONS AND FLANGES
A. Provide between ferrous and nonferrous piping and where otherwise required for electrically insulated connection, as shown.
B. Materials: Galvanically compatible with piping to which attached and pressure ratings suitable for system working pressures.
C. Unions 2 Inches and Smaller: Screwed or solder-joint type.
D. Unions 2-1/2 Inches and Larger: Flanged type, complete with bolt insulators, dielectric gasket, bolts, and nuts.

E. Manufacturers:
   1. Epco Sales, Inc., of Cleveland, OH.
   2. Capitol Insulation Unions.

2.4 FITTINGS AND SPECIALS

A. General:
   1. Minimum radius of elbows shall be 2.5 times pipe diameter. Maximum miter angle on each section of elbows not to exceed 11-1/4 degrees, unless shown otherwise.
   2. Equal in pressure design strength, equal or greater thickness.

B. Vibration Isolation Pads:
   1. Type: Neoprene Waffle.
   2. Manufacturers and Products:
      a. Mason Industries; Type W.
      b. Korfund; Korpad 40.

C. Modular Mechanical Seal:
   1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
   2. Fabrication: Assemble interconnected rubber links with ASTM A 276-94, Type 316 stainless steel bolts, nuts, and pressure plates.
   3. Size: According to manufacturer’s instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
   4. Manufacturer: Thunderline Link-Seal.

D. Stainless Steel Hose Flexible Pipe Connectors
   1. Corrugated stainless steel tubing
   2. Stainless steel wire braid covering and ends welded to inner tubing
   3. Pressure rating same as connecting tubing
   4. Threaded end connections

2.5 SPACER / SLIDERS, MOUNTING CHANNEL, TUBING CLAMPS

A. Reference SECTION 23 11 00.

2.6 VALVES

A. General:
   1. Valves to include those required on systems not related to the hydraulic system. Reference other Specification Sections for Hydraulic System Valves
   2. Valves shall be the same size, with the ends suiting the adjoining pipe, unless otherwise noted

B. Materials
   1. Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 16% zinc and 2% aluminum.
2. Approved alloys are of the following ASTM designations:
   a. ASTM B 61, B 62, B 98 (Alloy UNS No. C65100, C65500, or C66100),
      B 139 (Alloy UNS No. C51000), B 584 (Alloy UNS No. C90300 or
      C94700), B 164, B 194, and B 127.
3. Stainless steel Alloy 18-8 may be substituted for bronze.

C. Ball Valves:

1. Type V300 Ball Valve 2 Inches and Smaller for General Water and Air Service:
   All-bronze, end entry type, RTFE seats, Teflon packing, hand lever operator,
   rated 150-pound SWP, 600-pound WOG.
   a. Manufacturers and Products:
      1) Milwaukee; BA100, threaded end.
      2) Nibco; T-585-70, threaded end.
      3) Milwaukee; BA150, soldered ends.
      4) Nibco; S-858-70, soldered ends.

2. Type V301 Ball Valve 2 Inches and Smaller for Equipment Air System Shutoff:
   All-bronze, end entry, RTFE seat, Teflon packing, rated 600-pound WOG,
   threaded ends, safety exhaust port to exhaust the downstream side when valve
   is in closed position, locking handle.
   a. Manufacturers and Products:
      1) Milwaukee; BA100ELD.
      2) Apollo; 75-100-41.

3. Type V330 PVC Ball Valve 2 Inches and Smaller: Rated 150 psi at 73°F, with
   ASTM D 1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry,
   double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon
   O-ring stem seals.
   a. Manufacturers and Products:
      1) Nibco; True-Bloc.
      2) ASAHI-America; Duo-Bloc.

4. Type V920 Solenoid Valve 3 Inches and Smaller for Gas Shutoff Service: Two
   way normally closed, aluminum body, visual indication of open + shut position,
   proof of closure switch, 1/8 inch NPT upstream and downstream pipe taps with
   plugs for routine testing, pressure range: 0-5 psi, 120V AC coil.
   a. Manufacturers and Products:
      1) ASCO Series F214 Suffix C

D. Accessories:

1. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag for each valve
   operator, bearing the valve tag number shown on the Valve Schedule.

E. Tests and Inspection:

1. Test that valves open and close smoothly with operating pressure on one side
   and atmospheric pressure on the other, in both directions for two-way valve and
   applications.
2. Set, verify, and record set pressures for all relief and regulating valves.

2.7 MISCELLANEOUS PRODUCTS

A. All materials or products required but not specified shall be in accordance with Denver
   Water Engineering Standards.
PART 3 EXECUTION

3.1 GENERAL
A. Piping and tubing to be grouped together for a neat, workmanlike appearance
B. The entire piping system of every component shall be well thought out and approved before installation. There are many complicated construction conditions such as concealed areas and underwater construction that may require unconventional methods

3.2 PREINSTALLATION MEETING
A. To be held between OWNER and CONTRACTOR after approved submittals and before installation to discuss the proposed installation procedures.

3.3 EXAMINATION
A. Verify size, material, joint types, proper site conditions, elevation, condition of installation surface.
B. Solder and solvent weld material: Verify proper material.

3.4 PREPARATION
A. Notify ENGINEER at least 2 weeks prior to field fabrication of pipe or fittings.
B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

3.5 WELDING
A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1, B31.3, and B31.9 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.
B. Weld Identification: Mark each weld with symbol identifying welder.
C. Pipe End Preparation:
   2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
D. Surfaces:
   1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
   2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
   3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.
E. Alignment and Spacing:
   1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
   2. Root Opening of Joint: As stated in qualified welding procedure.
   3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or one inch, whichever is greater.
F. Climatic Conditions:
   1. Do not perform welding if there is impingement of any rain, snow, sleet, or high
      wind on the weld area, or if the ambient temperature is below 32°F.
   2. Stainless Steel and Alloy Piping: If the ambient is less than 32°F, local
      preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld,
   made with electrode similar or equivalent to electrode to be used for first weld pass, and
   not defective. Remove those not meeting requirements prior to commencing welding
   procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Passes: As required in welding procedure.

J. Weld Quality: Free of cracks, incomplete penetration, weld undercutting, excessive weld
   reinforcement, porosity slag inclusions, and other defects in excess of limits shown in
   applicable piping code.

3.6 INSTALLATION-GENERAL

A. Determine optimum locations for joints and space or stagger as necessary to make
   installation easier.

B. Join pipe and fittings in accordance with manufacturer’s instructions, unless otherwise
   shown or specified.

C. Remove foreign objects prior to assembly and installation.

D. Threaded and Coupled Joints:
   2. Produce sufficient thread length to ensure full engagement when screwed home
      in fittings.
   3. Countersink pipe ends, ream and clean chips, mill scale and burrs after threading
      and before making up.
   4. Make connections with not more than three threads exposed.
   5. Lubricate male threads only with thread lubricant or tape as specified on Piping
      Data Sheets.
   6. For potable water service, make joints with compound approved for potable
      water.
   7. Install unions to make removal of equipment possible without cutting.

E. Grooved-End Joints:
   1. Type: Rigid, except where joints are used to correct misalignment, to provide
      flexibility, and where shown otherwise, in which case provide flexible type.

F. Soldered Joints:
   1. Soldered joints shall be made in accordance with ASTM B 828.
   2. Use only solder specified for particular service.
   3. Cut pipe ends square and remove fins and burrs.
   4. After thoroughly cleaning pipe and fitting of oil and grease using solvent and
      emery cloth, apply noncorrosive flux to the male end only.
   5. Wipe excess solder from exterior of joint before hardened.
   6. Before soldering, remove stems and washers from solder joint valves.
   8. Mitering of joints for elbows, and notching of straight runs of pipe for tees, is not
      permitted.
G. PVC and CPVC Piping:
1. Solvent weld joints shall be made in accordance with ASTM D 2564
2. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
3. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.

3.7 INSTALLATION-EXPOSED PIPING

A. Piping Runs:
1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.

B. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

C. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

D. Piping clearance, unless otherwise shown:
1. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet 0 inches, measured from equipment extremity and extremity of piping system including flanges, valve bodies, mechanisms, or hanger/support systems.
2. From Adjacent Work: Minimum one inch from nearest extremity of completed piping system including flanges, valve bodies, mechanisms, insulation, or hanger/support systems.
3. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
4. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.8 INSTALLATION OF SUBMERGED PIPE

A. General:
1. Lay out and group piping to provide ease of transition from concealed to surface mount and transition to connecting to the final destination
2. Surface mount to solid, rock surface per details in the Contract Drawings
3. Protect with protective covering per Contract Drawings

B. Joints:
1. Mechanical:
   a. Mechanically reshape tubing and install mechanical fittings per manufacturer’s per manufacturer’s instructions

C. Routing methods:
1. Preference is for straight runs
2. Bolt support assemblies into competent rock
3. Avoid boulder fields or areas with loose debris
4. Do not fasten to trashracks, gate cylinder, or any other ancillary support material

3.9 INSTALLATION-CONCEALED PIPE

A. General:
1. All piping shall be dielectrically insulated. In no circumstances can dissimilar metals be in contact with each other.
2. Installation method shall be proposed by the CONTRACTOR and approved by the ENGINEER.

B. Placement:
1. Piping shall be placed in the dry from the surface through the tunnel bore or other concealed area to the point at which the bore exits into the reservoir.
2. Placement shall occur segmentally, with sections installed and the assembly moved through the concealed area.
3. Commercially available pipe spacer – sliders and custom manufactured spacers shall be used to help guide and move the piping assembly.
4. Approved piping installation and restraint methods must be employed to ensure that the assembly does not become dislodged or moved out of position.

C. Testing:
1. All piping is required to pass testing as specified. Since the concealed piping has long pipe runs, and removing and correcting any leaks would be cumbersome, intermittent testing of the assembly to prove conformance is encouraged.

D. PVC or CPVC Pipe Placement:
1. Cut, make up, and install in accordance with pipe manufacturer’s recommendations and as specified herein.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40°F, or above 90°F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

3.10 RESTRAINT
A. General:
1. Design temporary restraining methods until piping assemblies can be permanently secured.

3.11 CLEANING
A. Following assembly and testing, and prior to final acceptance, remove air nozzles, and flush pipelines (except as stated below) with water at 15 fps minimum flushing velocity until foreign matter is removed. This is intended to remove any dirt, debris, solder splatter, or solvent weld residue as this could clog the small air nozzles if not thoroughly cleaned.

3.12 PNEUMATIC TESTING
A. Fluid: Oil-free, dry air.

B. Procedure:
1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to exposed joints and connections, examine for leakage. Monitor pressure for 10 minutes. If pressure falls, find the leakage path and correct.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct examination for leakage.
5. Correct leakage and retest as specified.
6. Pressure test at 200 psi for a minimum of 20 minutes. There shall be zero leakage. Correct any deficiencies.
7. Final pressure test shall be performed for the completion of each bubbler system run and before air nozzles are installed. All joints, both exposed and concealed, shall be tested.

C. Allowable Leakage: Piping system, shall show no visual or measurable evidence of leakage.

3.13 SUPPLEMENTS
A. Piping Schedule:

<table>
<thead>
<tr>
<th>Cable</th>
<th>Piping Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Copper</td>
</tr>
<tr>
<td>Grout Application Lines</td>
<td>PVC</td>
</tr>
<tr>
<td>Hyd</td>
<td>Stainless Steel Reference</td>
</tr>
<tr>
<td></td>
<td>SECTION 23 11 00</td>
</tr>
</tbody>
</table>

B. Supplemental Data Sections:

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>-07</td>
<td>Polyvinyl Chloride (PVC) Pipe and Fittings</td>
</tr>
<tr>
<td>-09</td>
<td>Copper and Copper Alloy Pipe, Tubing, and Fittings</td>
</tr>
</tbody>
</table>

END OF SECTION
### SECTION 33 11 00.07
POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe (Spec not intended for pressure piping)</td>
<td>All</td>
<td>Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D 1784 and ASTM D 1785.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>Schedule 80 PVC as Specified Under Pipe Above: ASTM D 2466 and ASTM D 2467 for socket-weld type. Threaded type not allowed.</td>
</tr>
<tr>
<td>Joints</td>
<td>All</td>
<td>Solvent socket-weld except where connection to valves and equipment that may require future disassembly. Threaded type not allowed except where specifically authorized by OWNER for connection to equipment or valves.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Flat Face Mating Flange: ASTM A 193/A 193M Rev A Type 316 stainless steel Grade B8M hex head bolts and ASTM A 194/A 194M Grade 8M hex head nuts. Provide Type 316 stainless steel washers under bolt heads and under nuts.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All</td>
<td>Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber.</td>
</tr>
<tr>
<td>Solvent Cement</td>
<td>All</td>
<td>As recommended by the pipe and fitting manufacturer conforming to ASTM D 2564.</td>
</tr>
</tbody>
</table>

END OF SECTION
### Copper and Copper Alloy Pipe, Tubing, and Fittings

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Tubing** | Seamless, conforming to ASTM B 88 Rev A-93 as follows:  
Domestic hot water ................. Type L, hard drawn  
Compressed air ....................... Type L, hard drawn |
| **Fittings** | When accessible in the dry:  
Commercially pure wrought copper, socket joint, conforming to ASTM B 75, dimensions conforming to ANSI B16.22.  
Underwater Construction:  
Brass O-Ring Face Seal with captive O-Ring. Mechanically formed and reinforced tube end. O-Lok by Parker Hydraulics.  
Copper unions, cast copper alloy, hexagonal – stock body, with ball and socket, metal to metal seating surfaces, and solder joint ends |
| **Flanges** | Commercially pure wrought copper, socket joint, conforming to ASTM B 75, faced and drilled 150-pound ANSI B16.24 standard. |
| **Bolting** | ASTM A 307, carbon steel, Grade A hex head bolts and ASTM A 563 Grade A hex head nuts. |
| **Gaskets** | 1/16-inch thick non-asbestos compression type, full face, Cranite, Johns-Manville. |
| **Solder** | J.W. Harri, bridges, lead free solder. Conforming to ASTM B 32. |

**END OF SECTION**
SECTION 35 53 00
UNDERWATER CONSTRUCTION

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to perform commercial diving services required under this Contract as specified herein.

B. The Work includes but is not necessarily limited to the following:

1. Initial underwater sire survey/inspection.
2. Demolition and removal of existing trashracks and appurtenant equipment.
3. Blasting and rock removal from tunnel portals and within the tunnels.
4. Complete in place installation of OWNER furnished slide gate assemblies.
5. Complete in place installation of OWNER furnished trashracks.
6. Installation and connection of hydraulic tubing to new slide gates.
7. All equipment and system testing.
8. Any other diving services required to execute the Work.

1.2 SUBMITTALS

A. Submit, in accordance with SECTION 01 33 00, the following certifications and documentation required to establish compliance with this Section:

1. Name, address and telephone number of the commercial Diving Contractor meeting the qualification requirements specified in below.
2. Certification by commercial Diving Contractor that all diving operations will be performed in accordance with the requirements of OSHA 29 CFR 1910, Subpart T – Commercial Diving Operations.
3. Certification that the commercial Diving Contractor’s operations will be performed in accordance with the requirements of these Contract Documents.
4. Copy of commercial Diving Contractor’s certificate of insurance.
5. Copy of commercial Diving Contractor’s confined space entry plan.
6. Copy of a diploma from a commercial diving training school for each diver performing Work under this Contract.
7. Copy of Millright Certification for at least one crew member.
8. Physician Certification for each diver performing Work under this Contract, certifying the divers meet the requirements of this Section, as a minimum.
9. Copies of current certifications showing completion of CPR and first aid training for each diver performing Work under this Contract.
10. Documentation showing each diver’s underwater construction experience.

B. Submit, in accordance with SECTION 01 33 00, the following information collected during the installation and construction project:

1. Underwater videotaping using a high quality color camera (with lighting if required) of the events detailed in this Section.
2. Submit one copy of each recorded event on DVD format media within 24 hours of videotaping.

1.3 REFERENCE STANDARDS

A. Occupational Safety and Health Administration:

B. Association of Diving Contractors International:
   1. Consensus Standards for Commercial Diving and Underwater Operations

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 QUALITY ASSURANCE

A. Safety:
   1. All safety is the responsibility of the CONTRACTOR, this Section is for information only.
   2. Safety to include general boating safety.

1.5 EXISTING UNDERWATER SURVEY DATA

A. The plan view shown of Drawing G-10.0 is a combination of original reservoir traverse done in 1899, a Northwest underwater constructors survey complete in 2006, and the OWNER’s survey performed in 2008.

The fourth survey found in Appendix E performed by Kreech Ojard & Associates in 2008 & 2009 covered only the area immediately around the three inlets.

The accuracy of the survey and other dimensions shown in the tunnels cannot be verified.

The data for each of these surveys is accurate within the tolerances of the equipment used. The accuracy of the original traverse is ± 2.5 feet vertically and as much as ± 5 feet horizontally.

The survey performed by Kreech Ojard & Associates is accurate ± 6 inches vertically and 2 feet horizontally.

Combining these surveys increase the errors because they were performed independently using different control methods. Each Survey provides relatively accurate information for comparison as long as they are not combined and relied upon for accuracy.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. All diving operations, including equipment preparation and maintenance, shall be performed in accordance with the requirements of OSHA 1910, Subpart T.

B. Surface to diver communication shall be maintained at all times.

C. Comply with all related Federal, State and local safety requirements and provide all necessary safety equipment for the Work of this Contract.

3.2 PRE-DIVE MEETINGS

A. A pre-dive meeting shall be held prior to commencing Work with OWNER, ENGINEER, and CONTRACTOR to ensure that the divers understand the configuration of the structure, time restrictions, Work to be performed, and working conditions.
3.3 INITIAL UNDERWATER SITE SURVEY/INSPECTION

A. Perform an underwater site survey/inspection at each intake level. The survey must include measurements within the tunnels at location shown on the Drawings. The survey/inspection must also include the areas to each side, above, and below the tunnel to a distance not less than 15-feet in length. Measurements of the rock removal above the auxiliary level portal, and mortar and rock removal above the low level portal shall be sufficient to estimate the required volume of rock requiring removal. The approach area in front of the mid level intake shall be inspected and surveyed to evaluate the need or quantity of leveling concrete. Any other discrepancies between the Drawings and existing conditions should be brought to the OWNER's attention. A post survey/inspection report shall be submitted to the OWNER.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A.  Section Includes:

1. Furnish instrumentation and control systems (I&C) as indicated in the Contract Documents.
2. Work Includes: Engineering, design, providing, installing, calibrating, adjusting, testing, documenting, starting up, and OWNER training for a complete Instrumentation and Control System.
3. Detailed Design: The I&C design, as indicated in the Contract Documents, includes functional, performance, and component requirements. Complete the detailed I&C design.
4. As a minimum, provide ECPs, LCPs, RTU/PLCs, instrumentation, including primary elements, transmitters, control devices, control panels, and DCS equipment.

B.  PICS Subcontractor's Work Scope:

1. For I&C equipment and ancillaries required under PICS Subsystem sections:
   a. Completing detail design.
   b. Required Submittals.
   c. Equipment and ancillaries.
   d. Instructions, details, and recommendations to, and coordination with, CONTRACTOR for Certificate of Proper Installation.
   e. Verify readiness for operation.
   f. Verify the correctness of final power and signal connections (lugging and connecting).
   g. Adjusting and calibrating.
   h. Starting up.
   i. Testing and coordination of testing.
   j. Training.
2. Verify following work not by the PICS Subcontractor is provided:
   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of PICS-related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. For equipment not provided under PICS Subsystems, but directly connected to equipment required by PICS Subsystems:
   a. Obtain from CONTRACTOR, manufacturers’ information on installation, interface, function, and adjustment.
   b. Coordinate with CONTRACTOR to allow required interface and operation with PICS.
   c. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer’s recommendations.
   d. Test to demonstrate required interface and operation with PICS.
   e. Examples of items in this category, but not limited to, the following:
      1) Existing analog equipment in the Manway and Valvehouse.
      2) Standby generator.

C.  Provide, install, and be responsible for a complete and fully operational SCADA/DCS System.
1. Coordinate all equipment provided and installed with requirements in Division 26, Electrical and Division 27, Communications.

2. Provide, configure and interface new and existing equipment and materials to provide a complete and fully operational SCADA/DCS System.
   a. OWNER will provide IP addresses.
   b. All communications, SCADA/DCS equipment and materials shall be included in ORT, PAT, and FDT testing.
   c. The SCADA/DCS System shall include, but not be limited too, fiber optic equipment, multimedia switches and servers, transceivers, generator control panels, ATS control panels, field I/O connections and terminations, RTU/PLC/DPC equipment, instrumentation primary elements, & transmitters, PID controllers, GUIs, FCCs, LCPs, etc.
   d. The fully operational system will include:
      1) Communications between all PLCs, RTUs, DPCs, GUIs, Generator Controllers, multimedia switches, etc.
      2) Communications along reconnected segments of the existing plant network, as called out in the Contract Documents.
   e. The fully operational system will include an Ethernet link between PLC-CHE-HPU and the new engine generator and ATS control package.
   f. OWNER will provide the CONTRACTOR with the fiber optic landing locations on the multimedia router for the Ethernet Process network prior to testing.
   g. The Entire SCADA/DCS system shall be tested after all equipment is installed on system.

3. Other Services:

D. Programming:

1. All PLC/RTU programming logic shall be provided by and installed by the OWNER. Demonstrate to the OWNER network communications between all RTUs, DPCs, and CSs; optimization of the communications response through the complete DCS network (Process Ethernet and RTU/DCS data highway); polling periods and network communications are fully optimized; and individual signal I/O performance for each RTU I/O point and field termination. All system demonstrations shall be to the satisfaction of the OWNER.

E. Wiring External to Equipment Provided by PICS Subsystems:

1. Fiber Communications Cable: Provided by Communication Systems Contractor installed by the Electrical Contractor.
2. Other Wiring and Cable: Provided by the Electrical Contractor as specified in SECTION 26 05 19.

F. Related Divisions:

1. DIVISION 01: GENERAL REQUIREMENTS.
2. DIVISION 26: ELECTRICAL
3. DIVISION 27: COMMUNICATIONS
4. DIVISION 40: PROCESS INTEGRATION

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. International Society of Automation (ISA):
   a. ISA S5.1 - Instrumentation Symbols and Identification (NRC ADOPTED)
   b. ISA S50.1 - Compatibility of Analog Signals for Electronic Industrial Process Instruments
   c. ISA RP55.1 - Hardware Testing of Digital Process Computers, Recommended Practice
2. National Electrical Manufacturers Association (NEMA):
   a. NEMA 250-85 - Enclosures for Electrical Equipment (1,000 Volts Maximum)
   b. Underwriters Laboratories, Inc. (UL):
   c. UL 508 - Standards for Safety, Industrial Control Equipment
   d. Deutsche Industries-Norm (DIN):
   e. DIN VDE 0611 - Specification for modular terminal blocks for connection of copper conductors up to 1,000V AC and up to 1,200V DC
   g. NFPA 820 - Fire Protection in Wastewater Treatment Plants

1.3 DEFINITIONS

A. Abbreviations:

1. CS: Computer Subsystem.
2. DPC: Distributed Process Controller. (Note: This abbreviation is also used in reference to ControlWave Process Automation Controllers, PACs.)
3. DCS: Distributed Control System.
5. I&C: Instrumentation and Control.
9. ORT: Operational Readiness Test.
10. PAT: Performance Acceptance Test.
11. PC: Personal computer.
14. PLC: Programmable Logic Controller.
15. PMCS: Process Monitoring and Control Software.
16. RAT: Reliability Acceptance Test.
17. RTU: Remote Terminal Unit. (Note: This abbreviation is also used in reference to ControlWave Process Automation Controllers, PACs.)
18. SCADA:
20. TS: Telemetry Subsystem.

B. Enclosure: Control panel, console, cabinet, instrument housing, or local control panel.

C. Instructor Day: 8 hours of actual instruction time.

D. Loop Specifications: Lists and descriptions in Article Supplements, giving additional requirements for individual control loops.

E. Software:

1. Programming of digital devices using all types of programming language.
2. Configuring of digital devices using all types of configuring process.
3. Programs or configuration data stored in read only memory, programmable read only memory, read/write memory, disk, tape, or other storage device.

F. Rising/Falling: Terms used to define action of discrete devices about their set point:

1. Rising: Contacts close or open when an increasing process variable rises through set point.
2. Falling: Contacts close or open when a decreasing process variable falls through set point.
G. Signal Types:

1. Analog Signals, Current Type:
   a. 4 to 20 mA DC signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PICS Subsystem components, use the following ISA 50.1 options:
      1) Transmitter Type: Number 2, 2-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.
2. Analog Signals, Voltage Type: 1 to 5 V DC within panels where a common high precision dropping resistor is used.
3. Discrete signals, 2-state logic signals using DC or 120V AC sources as indicated.
4. Pulse Frequency Signals:
   a. Direct current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches as indicated.
   c. Power source less than 30V DC.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

H. Instrument Tag Numbers:

1. The tag number notation corresponds to the Drawings and is used in the Loop Specifications. Example: PI 3020-01-02.

<table>
<thead>
<tr>
<th>Notation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI</td>
<td>ISA designator for Pressure Indicator</td>
</tr>
<tr>
<td>30</td>
<td>Unit process number</td>
</tr>
<tr>
<td>20</td>
<td>Loop number</td>
</tr>
<tr>
<td>01</td>
<td>First unit number</td>
</tr>
<tr>
<td>02</td>
<td>Second unit number</td>
</tr>
</tbody>
</table>

1.4 SUBMITTALS

A. In accordance with SECTION 01 33 00, unless otherwise specified in Specification Sections 40 90 00 and 40 90 10.

B. Submittal Breakdown: With ENGINEER's approval, Submittals may be broken down into smaller packages than listed in Article Sequencing and Scheduling. Show proposed breakdown in PICS Progress Schedule.

C. Administrative Submittals:

1. PICS Progress Schedule:
   a. Submit within 30 days after first Preconstruction Conference.
   b. Upon acceptance by ENGINEER, shall form basis and schedule for all Submittal reviews, test witnessing, and partial payments relating to PICS work.
   c. Prior to this acceptance, ENGINEER will not review Submittals, witness tests, or consider requests for partial payment related to PICS work.

2. OWNER Training Plan: In accordance with SECTION 01 44 33.
D. Shop Drawings:

1. General:
   a. PICS Subcontractor's Information:
      1) Organization Chart: Showing organization structure for this Project. Identify key personnel who will be assigned to do this Project. Identify separate organizations that will supply subsystems. For each subsystem, identify organization and key personnel that will supply specified maintenance.
      2) Qualification of Personnel: Provide Resumes for key personnel who will be assigned to do this project, including but not limited to: Project Manager, Project Engineer, Engineers, Site Representative, onsite startup and testing team member (engineers, technicians, and software/configuring personnel).
   b. Identify proposed items and options. Identify installed spares and other provisions for future work (e.g., reserved panel space; unused components, wiring, and terminals).
   c. Legends and Abbreviation Lists: Shall match the Contract Documents, unless otherwise approved by the ENGINEER.

2. Bill of Materials:
   a. All equipment, components, devices, and materials.
      1) Data Included:
         a) Tag number.
         b) Description.
         c) Manufacturer, complete model number and all options not defined by model number.
         d) Quantity supplied.
         e) Organize by location and enclosure (LCP, FCC, ECP, etc.)

3. Catalog Cuts for all equipment, components, devices, and materials:
   a. Catalog information.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled Drawings showing exterior dimensions and locations of all electrical interfaces, mechanical interfaces, and mounting arrangements.
   e. Specific features and configuration data:
      1) Location or service.
      2) Manufacturer and complete model number.
      3) Setpoints and scale range.
      4) Engineering Specifications.
      5) Equipment weights.
      6) Power and grounding requirements.
      7) Materials of construction.
   f. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

4. Construction Drawings:
   a. Show to scale enclosure, internal & external equipment layout, device nameplates, terminal blocks, wireways, etc.
   b. Show dimensions and locations of panel mounted devices, doors, louvers, subpanels, internal and external.
   c. Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
   d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, louvers, mounting brackets and tabs, door hinges and latches, and welding.
   e. Cable access areas and cable routing.
   f. Anchor bolt size and location.
   g. Installation and mounting detail Drawings.
   h. Process and Instrumentation Diagrams.
i. Hydraulic and Electrical Schematics
j. Equipment weights.

5. Wiring Diagrams:
   a. Ladder diagrams in a format similar to those shown on Drawings, using Drawing grid and location references indicated on Contract Drawings. All devices, contacts, connects, etc. shall include location references similar to the Drawings, i.e.[#(A1)].
   b. Diagrams shall be coordinated and show all field interfaces.
   c. Interconnection from power sources and panelboards.
   d. Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
   e. Component and panel terminal board identification numbers, and external wire and cable numbers.
   f. Circuit names, identify terminals, cable ID tags, actual cable lengths, and conduit tags.
   g. Grounding diagram, philosophy, implementation, terminations, type, and connections.
   h. Show each circuit individually.
   i. Identify each item with attributes listed.
      1) Wires, conductors, cables: type, number, size and color.
      2) Terminals: Location, terminal strip number, and terminal block number.
      3) Discrete Components:
         a) Tag number, terminal numbers, and location.
         b) Switching action (open or close on rising or falling variable), setpoint value and units, and variable description.
      4) Input/Output (I/O) Point List for All I/O Points: Information in the list shall include all the following information:
         a) RTU/PLC identification & IP address, P&ID Drawings reference.
         b) Point names and descriptions.
         c) Point addresses, tag numbers, functions, ranges, and Engineering units.
         d) Wire and cable assignments.
         e) I/O card layout, module and block number.
         f) Field wiring termination assignments.
      5) Relay Coils:
         a) Tag number and its function.
         b) On right side of run where coil is located, list contact location by ladder number and sheet number. All contacts shall be fully developed, showing terminal numbers, conductor identification and color, and spare contacts.
      6) Relay Contacts: Coil tag number, function, and coil location.

6. RTUs cabinet Power Consumption and Heat Dissipation, tabulate and summarize:
   a. Required voltages, currents, and phases(s).
   b. Maximum heat dissipations Btu per hour.
   c. Include all calculations.

7. Communications with LCP Devices, PLC Equipment: Describe configuration, operation, limitations, and diagnostics for LANs, data highway, serial links, and other communication paths. Provide sufficient documentation to allow third parties to troubleshoot communications problems with devices connected to DCS and RTUs.

8. Applications Software Documentation:
   a. Complete configuration documentation for microprocessor based configurational devices.
   b. For each device, include a program configuration listing showing:
      1) Functional blocks or modules used.
2) Configuration, calibration, and tuning parameters.
3) Descriptive annotations.

9. Shop Drawings for Changes Impacting Software Configuration:

10. Schedule:
   a. Submit first changes as part of Shop Drawings.
   b. Submit updated changes at approximately 30-day intervals.

11. Changes to Input/Output (I/O) List reflecting actual equipment and instrumentation.

12. Changes required to software configuration resulting from installation of alternative, upgraded, and modified equipment.

13. List of Spares, Expendables, and Test Equipment Proposed for Project.

E. Quality Control Submittals:

1. Certificates: For all PICS equipment, require PICS Subcontractor to provide Manufacturer's Certificate of Proper Installation and readiness for operation, using ORT forms.

2. Operation and Maintenance (O&M) Manuals:
   a. In accordance with SECTION 01 78 23, unless otherwise specified in this Section.
   b. Include Shop Drawing submittal information.
   c. Content and Format:
      1) Complete sets of separately bound O&M manuals for each PICS Subsystem.
      2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PICS component.
      3) Final versions of Legend and Abbreviation Lists.
      4) All final as-built Drawings shall be provided in electronic media, (AutoCAD version 2009 or earlier), on standard IBM computer compatible 2GB Hi-Speed USB Flash Drives and in hard 3-ring 11-inch x 17-inch binders in unfolded quality hard copy media. The AutoCAD Drawings shall follow Denver Water Design Drafting Standards and shall include, but not be limited too, the following Standards:
         a) All drawings shall be on the Standard Denver Water title block (provided electronically by Denver Water).
         b) Denver water Standard line colors and weights.
         c) Denver Water Standard text size and scale.
         d) All other Standards shall be approved by Denver Water's Design Drafting Supervisor.
   d. Manual Submission Requirements:
      1) O&M manual outline.
      2) Preliminary O&M manuals.
      3) Final O&M manuals.

3. Testing Related Submittals:
   b. Factory Demonstration Test, Staging Site Demonstration Test, and Performance Acceptance Test:
      1) Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation:
         a) Copy of signed off test procedures when tests are completed.
c. Operational Readiness Test:
   1) Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
   2) Final Test Procedures: Proposed forms and checklists.
   3) Test Documentation: Completed component calibration sheets with O&M manuals.

d. Performance Acceptance Test:
   1) Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
   2) Final Test Procedures: Proposed tests, forms, and checklists.
   3) Test Documentation: Copy of signed off test procedures when tests are completed.

F. Contract Closeout Submittals: Prior to Substantial Completion, submit service agreements signed by OWNER and maintenance provider for all work required under Article Maintenance Service.

1.5 QUALITY ASSURANCE

A. The equipment furnished under this Specification Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years, unless otherwise approved by the ENGINEER.

B. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark, unless otherwise approved by the ENGINEER.

C. Coordination Meetings:

1. General: In accordance with SECTION 01 12 16.
   a. Location: Site or ENGINEER's office, as determined by the ENGINEER.
   b. Attended by: OWNER's ENGINEER, OWNER, CONTRACTOR, and PICS Subcontractor. The meetings will be combined with the weekly progress meetings.
   c. Meeting Frequency (unless otherwise agreed upon by OWNER): Monthly in the first half of the project. Biweekly in the second half of the project. Specific dates shall be noted on Progress Schedule.
   d. First Meeting: Within 30 days after Notice to Proceed.

2. Training Coordination Meeting:
   b. Purpose:
      1) Resolve required changes to proposed training plan.
      2) Identify specific OWNER personnel to attend training.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide field and warehouse storage facilities for all PICS equipment.

B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.
1.7 ENVIRONMENTAL REQUIREMENTS

A. Environmental Design Requirements: The following defines certain types of environments. PICS Subsystems refer to these definitions by name to specify the environments requirements for individual equipment units. The dam site elevation is 6,900 feet above mean sea level.

1. Inside:
   a. Temperature: 20 to 104°F.
   b. Relative Humidity: 10 to 100%.
   c. NEC Classification: Nonhazardous.

2. Outside:
   a. Temperature: Minus 20 to 104°F.
   b. Relative Humidity: 10 to 100%, rain, snow, freezing rain.
   c. NEC Classification: Nonhazardous.

1.8 SEQUENCING AND SCHEDULING

A. PICS Progress Schedule:

1. Purpose: Supplement the overall Project Progress Schedule to:
   a. Coordinate activities between CONTRACTOR and PICS Subcontractor.
   b. Coordinate interactions with ENGINEER and OWNER for coordination meetings, testing, programming, Submittal reviews, test witnessing, and training.
   c. Clarify required work sequences and major Milestone prerequisites.

2. Format: In accordance with SECTION 01 32 16.

3. Content:
   a. Include all:
      1) Design activities.
      2) Preparation of Submittals.
      3) Submittal submission.
      4) ENGINEER reviews of Submittals.
      5) Purchasing, fabricating, and assembly activities.
      6) Shipment and delivery.
      7) Installation.
      8) Testing.
      9) Startup.
      10) Training.
      11) Coordination meetings.
      12) Substantial Completion.
      13) Acceptance.

4. Activity prerequisites (by symbol).
5. Required lead times.
6. Identify by special symbol Milestones where a request for partial payment is planned.
7. Obtain ENGINEER's approval if Submittals for a PICS Subsystem are proposed to be made in multiple packages, show each package.

B. Activity Completion: The following is a list of key activities and their completion criteria:

1. Administrative Submittals: Reviewed and accepted.
2. Shop Drawings: Review and approved.
3. Quality Control Submittals: Reviewed and accepted.
4. Tests (Except ORT): Tests have been completed and required test documentation has been accepted.
5. ORT: ORT has been completed and ENGINEER has spot-checked associated test forms and checklists in field.
6. Ready for Operation: ORT has been completed.
C. Allowance for Interruptions to CONTRACTOR's work due to applications software testing:

1. During ORT and PAT, Anticipate interruption of testing and delays to work and allow:
   a. Investigation of software problems.
   b. OWNER to make software configuration changes.
   c. Retesting.
2. Refer to paragraph Prerequisite Activities and Lead Times for specified time allowances.

D. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

1. Submittal to the ENGINEER:
   a. Prerequisite: ENGINEER acceptance of PICS Progress Schedule.
2. Hardware Purchasing, Fabrication, and Assembly: Associated Shop Drawing Submittals completed.
3. Tests: Associated test plan Submittal completed. For PAT, notice of test schedule required 4 weeks prior to start of test.
4. Training: Associated training plan Submittal, reviewed and accepted by the ENGINEER.
5. DCS applications software configuring by OWNER.
6. DCS applications software configuring and testing by OWNER.
7. Shipment to Site: Completion of PICS Shop Drawing Submittals, preliminary O&M manuals, and for PICS elements.
8. DCS installation.
9. Phase 1 ORT: DCS installation complete.
10. Phase 2 ORT: 
   a. Prerequisite: Phase 1 ORT completed.
   b. Allowance for Interruptions to CONTRACTOR's work due to applications software testing: 30 days total for Phase 2 ORT.
11. PAT: 
   a. Prerequisite: Phase 2 ORT completed and facility started up.
   b. Allowance for Interruptions to CONTRACTOR's work due to applications software testing: 30 days total for Phase 2 PAT.

E. PICS Substantial Completion:

1. Prerequisites for Substantial Completion include:
   a. PICS Submittals have been accepted or approved, as specified.
   b. PICS has successfully completed PAT.
   c. OWNER training plan is on schedule.
   d. Spares, expendables, and test equipment have been delivered to OWNER.
   e. Service and maintenance agreements submitted for work required under Article Maintenance Service.

F. PICS Acceptance: Reference the General Conditions, unless otherwise specified below for PICS:

1. When ENGINEER issues a written notice of acceptance, the following prerequisites shall have been met:
   a. PICS Certificate of Substantial Completion.
   b. Punch-list items completed.
   c. Final revisions to O&M manuals accepted.
   d. After the PICS has been completely installed and made operational, the entire system shall be subject to an operational test run before being accepted. To complete this requirement, the PICS and DCS communications shall operate properly, without significant system
malfunction, as deemed by the ENGINEER, for a continuous uninterrupted time period of 480 hours. If the DCS fails to meet this requirement, make any and all necessary repairs or adjustments as required to correct the problem, and the acceptance test shall completely restart from the beginning for a complete retest.

e. Maintenance service agreements for PICS accepted by OWNER.

1.9 MAINTENANCE SERVICE

A. Maintenance Service Agreement:

1. Duration of one year, unless otherwise noted in PICS Subsystems.
2. Start on date of Substantial Completion.
3. Performed by factory trained service engineers with experience of PICS Subsystems to be maintained.
4. PICS Subsystems Covered:
   a. IPS and DCS, except for ENGINEER-provided applications software.
5. All materials and labor for preventive maintenance and visit Site twice, as determined by the ENGINEER.
6. All materials and labor for demand maintenance and coverage shall be 8:00 a.m. to 5:00 p.m., Monday through Saturday.
7. Response Time: Service ENGINEERs shall be onsite within 24 hours of request by OWNER.
8. Spare Parts: If not stocked on-site, delivered to Site within 24 hours from time of request.
9. Repair or replace all components or software found to be faulty.
10. Replace and restock within one month, onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.
11. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each visit to Site.

PART 2 PRODUCTS

2.1 GENERAL

A. DCS diagrams as shown on Drawings are diagrammatic and supplement PICS performance requirements.

B. PICS functions as shown on Drawings and as required in PICS Subsystems for each subsystem and loop. Furnish equipment items as required in PICS Subsystems. Furnish all materials, equipment, and software (except for ENGINEER provided applications software), whether indicated or not, necessary to effect required subsystem and loop performance.

2.2 COMPONENTS

A. Component Specifications: Component Specifications are in Supplement A of SECTION 40 90 10.

B. First Named Manufacturer: PICS design is based on first named manufacturers of equipment, materials, and software required in PICS Subsystems:

1. If an item is proposed from other than first named manufacturer, obtain approval from ENGINEER for such changes in accordance with Article Submittals.
2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:
1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer’s services.

2. Implement all same or similar functions in same or similar manner. For example, but not limited to, control logic, sequence controls and display layouts.

2.3 SYSTEM PERFORMANCE

A. For facility discrete and continuous process and process equipment variables:
   1. Measure and monitor.
   2. Present to plant operators for monitoring of plant status.
   3. Provide historical data acquisition storage, retrieval, and processing.

B. Provide means for plant operators to control plant processes, both automatically and manually.

C. End-to-end response time.

2.4 SPARE PARTS

A. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

2.5 SOURCE QUALITY CONTROL

A. General:
   1. Test PICS elements, both hardware and software, to demonstrate that PICS satisfies requirements.
   2. Factory tests described under this article:
      a. Unwitnessed Factory Test (UFT).
   3. On-Site Tests Described Under PART 3, Execution:
      a. Operational Readiness Tests (ORT).
   4. Test Format: Cause and effect:
      a. Person conducting test initiates an input (cause).
      b. Specific test requirement is satisfied if correct result (effect), occurs.
   5. Procedures, Forms, and Checklists:
      a. Except for UFT, conduct tests in accordance with, and documented on, ENGINEER-accepted procedures, forms, and checklists.
      b. Describe each test item to be performed.
      c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
   6. Required Test Documentation: Test procedures, forms, and checklists. Signed by ENGINEER and CONTRACTOR, except for ORT items signed only by CONTRACTOR.
   7. Conducting Tests:
      a. Special testing materials and equipment.
      b. Wherever possible, perform tests using actual process variables, equipment, and data.
      c. If not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
      d. Define simulation techniques in test procedures.
      e. For PICS Subsystems for which ENGINEER provides applications software, provide sufficient temporary software configuring to allow FDT and SDT testing of these subsystems.
   8. Coordinate PICS testing with OWNER and affected Subcontractors.
   9. ENGINEER will actively participate in many of the tests.
10. ENGINEER reserves right to test or retest all specified functions whether or not explicitly stated test procedures.
11. ENGINEER's decision will be final regarding acceptability and completeness of all testing.
12. Excessive Test Witnessing:
   a. OWNER will recover costs for witnessing retesting of corrected or replaced defective work, and for return visits to manufacturing facilities to witness factory testing or retesting as set forth in the Supplementary Conditions.
   b. Refer to Article Submittals, paragraph Excessive Submittal Reviews for rates.

B. Unwitnessed Factory Test (UFT):
   1. Scope: Inspect and test PICS to ensure it is operational, ready for FDT.
   2. Location: PICS Subcontractor's factory.
   3. Integrated Test:
      a. Interconnect and test PICS, except for primary elements.
      b. Exercise and test all functions.
      c. Simulate inputs and outputs for primary elements and final control elements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Equipment furnished by PICS Subcontractor and installed by CONTRACTOR, requires PICS Subcontractor to observe and advise on installation to extent required to certify with ORT that equipment has been properly installed and will perform as required.

B. For equipment not provided by PICS Subcontractor, but that directly interfaces with the PICS, verify the following conditions:
   1. Proper installation.
   2. Calibration and adjustment of all positioners and I/P transducers.
   3. Correct control action.
   4. Switch settings and dead bands.
   5. Opening and closing speeds and travel stops.
   6. Input and output signals.

3.2 INSTALLATION

A. Material and Equipment Installation:
   1. Follow manufacturers' installation instructions, unless otherwise indicated or directed by the ENGINEER.
   2. Retain a copy of manufacturers' instructions at Site, available for review at all times.

B. Wiring connected to PICS components and assemblies, including power wiring in accordance with requirements in SECTION 26 05 16.

C. The Contractor shall allow a minimum of 40 hours of time to assist the ENGINEER or ENGINEER's represent in PLC/RTU programming issues related to I/O interface and communications.

D. Removal or Relocation of Materials and Equipment: In accordance with SECTION 01 12 16
3.3 FIELD QUALITY CONTROL

A. General: All requirements listed in paragraph General under Article Source Quality Control, also applies to this article.

B. On-Site Supervision:
1. PICS site representative to supervise and coordinate onsite PICS activities.
2. PICS site representative shall be onsite during total period required to complete onsite PICS activities.

C. Startup and Testing Team:
1. Thoroughly check installation, termination, and adjustment for PICS Subsystems.
2. Complete on-site tests.
3. Complete onsite training.
4. Provide startup assistance to OWNER.

D. Operational Readiness Test (ORT): Prior to startup test period and PAT, inspect, test, and document that entire PICS is ready for operation:

1. Phase 1 ORT: Performed by PICS Subcontractor to test and document that PICS, excluding OWNER provided DCS applications software, is ready for operation. For PICS Subsystems for which OWNER provides applications software, provide sufficient temporary software configuring (testing software) to allow testing of these subsystems:
   a. Loop/Component Inspections and Tests:
      1) Check PICS for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.
      2) Provide space on forms for signoff by PICS Subcontractor.
      3) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
         a) Project name.
         b) Loop number.
         c) Tag number for each component.
         d) Checkoffs/Signoffs for each component:
            (1) Tag/identification.
            (2) Installation.
            (3) Termination wiring.
            (4) Termination tubing.
            (5) Calibration/adjustment.
         e) Checkoffs/Signoffs for the Loop:
            (1) Panel interface terminations.
            (2) I/O interface terminations with DPCs and RTUs.
         f) I/O Signals for DPCs and RTUs are Operational: Received/sent, processed, adjusted.
         g) Total loop operational.
         h) Space for comments.
      4) Component calibration sheet for each active IPS component (except simple handswitches, lights, gauges, and similar items) and each DPCs and RTUs I/O module and include the following:
         a) Project name.
         b) Loop number.
         c) Component tag number or I/O module number.
         d) Component code number for IPS elements.
         e) Manufacturer for IPS elements.
         f) Model number/serial number for IPS elements.
         g) Summary of functional requirements, for example:
(1) Indicators and recorders, scale and chart ranges.
(2) Transmitters/converters, input and output ranges.
(3) Computing elements' function.
(4) Controllers, action (direct/reverse) and control modes (P&ID).
(5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
(6) I/O Modules: Input or output.

h) Calibrations, for example, but not limited to:
(1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100% of span, rising and falling.
(2) Discrete Devices: Actual trip points and reset points.
(3) Controllers: Mode settings (P&ID).
(4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100% of span, rising and falling.

i) Space for comments.

5) Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site and make them available to ENGINEER at all time.

6) These inspections and tests will be spot checked by ENGINEER.

7) ENGINEER reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of ORT. Correct deficiencies found.

b. ORT Forms: Example ORT forms referenced in Article Supplements.

2. Phase 2 ORT: Combined effort between PICS Subcontractor and ENGINEER to confirm that PICS, including applications software, is ready for operation:

a. Prerequisite: Completion of Phase 1 ORT.

b. Joint test with ENGINEER. Repeat of ENGINEER's FDT application software tests, except using real field sensors and equipment. Plant interlocking and communications with DPCs, RTUs, and CS tested on loop-by-loop basis.

c. Test procedures provided by ENGINEER based on Phase 1 ORT and on FDT application software tests.

E. Performance Acceptance Tests (PAT): These are the activities that SECTION 01 75 16 refers to as performance testing:

1. Once ORT has been completed and facility has been started up, perform jointly with OWNER a PAT on complete PICS to demonstrate that it is operating as required by the Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.

2. Loop-specific and non-loop-specific tests same as required for FDT except that entire installed PICS tested using actual process variables and all functions demonstrated.

3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.

4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

5. Make updated versions of documentation required for PAT available to ENGINEER/OWNER at Site, both before and during tests.

6. Make one copy of all O&M manuals available to ENGINEER/OWNER at the Site both before and during testing.

7. Follow daily schedule required for FDT.
8. Refer to referenced examples of PAT procedures and forms in Article Supplements.

F. Specialty Equipment: For certain components or systems provided under this Section but not manufactured by PICS Subcontractor, provide services of qualified manufacturer's representative during installation, startup, demonstration testing, and OWNER training. Refer to Article On-Site Services in PICS Subsystems for specific requirements.

3.4 TRAINING

A. General:

1. Provide an integrated training program for OWNER's personnel.
2. Perform training to meet specific needs of OWNER's personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on all working shift(s) as needed to accommodate the OWNER's personnel schedule.
5. OWNER reserves the right to make and reuse video tapes of all training sessions.

B. Operations and Maintenance Training:

1. Refer to specific requirements specified in PICS Subsystems.
2. Include a review of O&M manuals and survey of spares, expendables, and test equipment.
3. Use equipment similar to that provided or currently owned by OWNER.
4. Unless otherwise specified in PICS Subsystems, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.

3.5 PROTECTION

A. Protect all enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. Periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace all capsules just prior to Final Payment and Acceptance.

3.6 SUPPLEMENTS

A. Unit process and control loop description.

B. Test and Report, Forms, and Examples:

1. System Problem Report Form: Use this form to record information about problems that are found during the testing of Computer Subsystems, Distributed Control Subsystems, and Telemetry Subsystems.
2. Operational Readiness Test (ORT) Forms:
   a. Loop Status Report: Each sheet shows the status of all instruments on a given loop. Also gives functional description for the loop.
   b. Instrument Calibration Sheet: Provides detailed information on each instrument (except simple handswitches, lights, and similar items).
   c. I&C Valve Adjustment Sheet: Each sheet shows detailed information for installation, adjustment, and calibration of a given valve.
3. Performance Acceptance Test (PAT) Sheet: Describes the PAT for a given loop. The format is mostly free form:
   a. Lists the requirements of the loop.
   b. Briefly describes the test.
   c. Cites expedited results.
   d. Provides space for check-off by witness.

END OF SECTION
A. Carbon Monoxide and Natural Gas Monitoring System:

1. General: The carbon monoxide and natural gas monitoring systems shall measure and provide the controlling in the event that the gas level exceeds the limit setpoints. Relay outputs shall be provided.

2. Solid state sensors:
   a. Sensors shall utilize state-of-the-art enhanced MOS sensor technology. Sensor element is to be microprocessor-controlled and compensated for humidity and temperature. Sensor shall not require the addition of reagents.
   b. All sensor transmitters shall have a minimum useful life of 3 years. The supplier shall provide replacement sensors at no charge for any sensor that does not meet the minimum requirements.
   c. The interconnecting wiring from the sensor to the central panel shall be three-conductor shielded cable for the 4 to 20mA sensors.
   d. The voltage supplied to the sensor shall be a minimum of 21V dc and a maximum of 30V dc.
   e. The sensor units shall be capable of being located remote from the central panel by up to 2,000 feet. Sensor units shall receive power from and send signals corresponding to the central panel.

3. Central Panel Requirements:
   a. The system shall be a 4-point wall mountable monitor with external solid state sensors.
      1) The enclosure shall be of general purpose metal NEMA 12.
      2) Enclosure shall not exceed 2.5 cubic feet in volume.
   b. System Power Requirements: The system shall operate on 110V ac, 50 to 60 Hz.
   c. Monitor Unit Requirements:
      1) Discrete LEDs shall indicate Warning, Alarm, and Sensor status. 3.5 digit LCD scanning display for direct reading of the full scale gas concentrations shall be available.
      2) Alarm Setpoint Levels: Two separate field-adjustable setpoints for warning and alarm. One nonadjustable setpoint for system fault.
      3) Relay Outputs: Each setpoint shall have an SPDT relay with dry contacts rated at 10 amps, 110V ac resistive. Alarm relay to have field optional 60-minute on delay to reduce nuisance activation and shall be selectable as latching or nonlatching. All relays shall be capable of being normally energized for fail-safe operation. Four discrete warning relays with adjustable (off delay) shall be provided.
      4) Audible Alarm: The audible alarm shall have a solid on sound pulse.
      5) Sensor Inputs: Shall be capable of receiving a 4-20mA sensor signal.
      6) Approvals: Must be CSA or NRTL approved.
   d. Maximum Maintenance Requirements: The system shall be factory tested and calibrated. System shall be automatically zero compensated and not require any field calibration.
   e. Manufacturer's Capability: As a minimum, the manufacturer must meet the following requirements:
      1) Shall be capable of providing toll-free factory assistance.
      2) Shall be capable of providing onsite service and training with factory-trained personnel.
      3) Shall be capable of providing in-house repairs.
4. The carbon monoxide and natural gas detection system shall be a Mine Safety Appliance MSA Toxgard II gas monitor as indicated in the Contract Documents or ENGINEER-approved equal.

B. Indicator, Digital Meters:

1. General:
   a. Function: Display analog signal.
   b. Type: 7-segment digital, horizontal edgewise.

2. Performance:
   a. Range and engineering units as required, indicated, and approved by the ENGINEER.
   b. Accuracy: Maximum of ±0.1% full scale.
   c. Temperature, Operating: 32°F to 120°F.

3. Features:
   a. Digits: 5; 0.56-inch high minimum; red sunlight readable 7-segment LED.
   b. Decimal Point: Field selectable.
   c. Input Impedance: 100 ohms maximum.
   d. Service Legend: Permanent, display of engineering units and nameplate without manufacturer’s logo, unless otherwise approved by the ENGINEER.
   e. Response Time: One second maximum to 0.1% accuracy.
   f. One control relay output with adjustable set points, unless indicated otherwise.
   g. Submit certified factory calibration.

4. EMI suppression devices shall be provided and installed as approved by the digital meter manufacturer, suppression device manufacturer, and ENGINEER. Ferrite suppression cores for signal and control cables. Line filters for input power cables.

5. Signal Interface: 4 to 20 mA DC.

6. Enclosure:
   a. Type: NEMA 4X.
   b. Mounting: Panel; approximately 1.95-inch high, 3.8-inch wide, 4.1-inch deep.

7. Power: 120 VAC unless otherwise noted.

8. Manufacturer:
   a. Red Lion PAX, unless otherwise approved by the ENGINEER.

C. Level Switch, Float Type, Water on Floor:

1. General:
   a. Function: Actuate contact at preset liquid level.
   b. Type: Float-actuated mounted directly to wall.

2. Service:
   a. Liquid: Water, unless otherwise noted.
   b. Pressure: Atmospheric.
   c. Temperature: 0°F to 120°F (50°C).

3. Performance:
   a. Setpoint: As indicated or required.
   b. Deadband: 1/16 inch maximum.

4. Features:
   a. Entire Assembly: Watertight and impact-resistant.
   b. Cable: length as noted or as necessary per mounting requirements.
   c. Materials:
      1) Float, stem, and guide connected to a switch enclosure.
      2) Insertion Length: As required to achieve the noted set point.
4) Float Size: 2 inch maximum, unless otherwise indicated or required by the ENGINEER.

5. Signal Interface:
   a. Switch: SPST snap action rated 50VA continuous at 120VAC.
   b. Provide a resistor and capacitor type surge suppressor in parallel with the switch as recommended by the Manufacturer.

6. Manufacturer:
   a. GEMS; Series LS-270.

D. Isolator, Current-to-Current:

1. General:
   b. Type: Electronic, back of panel.

2. Performance:
   a. Range: As required and approved by the ENGINEER.
   b. Accuracy: ±0.1% of span.
   c. Temperature, Operation: 0°F to 150°F.

3. Features:
   a. Adjustments: Span and zero; external, front, multi-turn potentiometers.
   b. Isolation: Input, output and power.
   c. Provides 24VDC power to 2-wire output-loop powered instruments, unless otherwise required by the instrument and approved by the ENGINEER.
   d. Input Impedance: 50 ohms maximum.

4. Signal Interface:
   a. Input: 4 to 20 mA DC.
   b. Output: 4 to 20 mA DC for load impedance 0 to 1200 ohms. Dual 4 to 20 mA DC for load impedance 0 to 1200 ohms, where indicated.

5. Enclosure: Metallic case with dust cover and integral bracket for rear of panel mounting.

6. Power: 24 VDC, unless otherwise noted.

7. Manufacturers:
   a. Moore Industries; Model ECT/4-20MA/4-20MA/24DC/-TX [DIN], unless otherwise approved by the ENGINEER.

E. Converter, Resistance-to-Current:

1. General:
   a. Function: Convert resistance signal to a current signal.
   b. Type: Solid State, back of panel.

2. Performance:
   a. Potentiometer Resistance: 0-1000 ohms, unless otherwise indicated or required.
   b. Accuracy: ±0.03% of output span.
   c. Temperature, Operating: -13°F to 149°F, minimum.
   d. Isolation: 1,000 V RMS between case, input, output, and power terminals.
   e. Noise rejection: Common mode, 120 dB at 60 Hz.
   f. Output Ripple: 10-mV peak to peak maximum when measured across a 250-ohm resistor for current output.
   g. RMI/EMI Protection: 30 V/M – ABC ≤ 0.5% of reading when tested according to SAMA PMC 33.1 standard.
   h. Response time:
      1) Output response: 800-milliseconds maximum for an output to reach full-scale response to a full-scale input change.
      2) Alarm Response: 700-milliseconds maximum for step change in input and alarm point at midpoint of full-scale.
3. Features:
   a. Display: 2x4 character backlit, alphanumeric LCD.
   b. LEDs: Trip, Input, Ready.
   c. Isolation: Power supply isolation.
   d. Adjustments: Four front-panel push buttons control settings for span, zero, alarm trip point, etc.
   e. Onsite programming in plain English of inputs, outputs, alarms, ranging.

4. Signal Interface:
   a. Input: Three-wire potentiometer.
   b. Output: 4 to 20 mA dc for load impedance 0 to 1200 ohms when configured as internally powered.

5. Enclosure: Metallic case with dust cover and integral bracket for rear of panel mounting.

6. Power: 24 VDC, unless otherwise noted.

7. Manufacturer and Product:
   a. Moore Industries; Model SPT/TPRG/PRG/U/[DIN], unless otherwise approved by the ENGINEER.

F. Hand Switches, Pushbuttons and indicating Lights:

1. General:
   a. Function: Select, initiate, and display discrete control functions.
   b. Type: Heavy-duty, watertight, oiltight, industrial.
   c. Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.
   d. Legend Plate: Large size square style aluminum field and black markings, unless otherwise noted. Minimum letter and number height: 7/64-inch. Markings as indicated on the Drawings and as approved by the ENGINEER.
   e. Configuration: Light, pushbutton, or switch as indicated.

2. Light Features:
   a. Lights: Full voltage 120V AC high-visibility LED, push-to-test type, unless otherwise approved by the ENGINEER.
   b. Lens Color, unless otherwise indicated on the Drawings.

<table>
<thead>
<tr>
<th>Tag Function</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER ON</td>
<td>POWER ON</td>
<td>Green</td>
</tr>
<tr>
<td>ON</td>
<td>ON</td>
<td>Red</td>
</tr>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>Green</td>
</tr>
<tr>
<td>OPEN</td>
<td>OPEN</td>
<td>Red</td>
</tr>
<tr>
<td>CLOSED</td>
<td>CLOSED</td>
<td>Green</td>
</tr>
<tr>
<td>LOW</td>
<td>LOW</td>
<td>Amber</td>
</tr>
<tr>
<td>FAIL</td>
<td>FAIL</td>
<td>Amber</td>
</tr>
<tr>
<td>HIGH</td>
<td>HIGH</td>
<td>Amber</td>
</tr>
<tr>
<td>AUTO</td>
<td>AUTO</td>
<td>White</td>
</tr>
<tr>
<td>HAND OR MANUAL</td>
<td>HAND OR MANUAL</td>
<td>Yellow</td>
</tr>
<tr>
<td>LOCAL</td>
<td>LOCAL</td>
<td>White</td>
</tr>
<tr>
<td>REMOTE</td>
<td>REMOTE</td>
<td>Yellow</td>
</tr>
</tbody>
</table>
3. Push Button and Switch Features:
   a. Guard: Full guard with flush button, unless otherwise noted.
   b. Push Button Color, unless otherwise indicated on the Drawings:
      1) Off, Emergency Stop, Stop, Reset: Red.
      2) All Others: Black.
   c. Switches shall be maintained or spring-return to center position as
      required and as approved by the ENGINEER.
   d. Push buttons and selector switches lockable in the OFF position where
      indicated.
4. Signal Interface:
   a. Contact Block:
      1) Type: Silver-coated butting, unless otherwise noted.
      2) Rating: 10 amps continuous at 120V AC.
      3) Sequence: Break-before-make, unless otherwise indicated.
      4) Arrangement: Normally open or normally closed as indicated and
         to perform functions required.
      5) Terminals: Screw with strap clamp, unless otherwise noted.
      6) All switches and pushbuttons shall have a minimum of one spare
         contact in addition to all required contacts.
      7) Minimum contact requirements: NEMA ICS 2, Type A600
5. NEMA Rating: NEMA 4, watertight and dusttight and NEMA 13, oiltight.
6. Manufacturers:
   a. General Electric; CR104P.
   b. Allen-Bradley; Bulletin 800T.
   c. Unless otherwise approved by the ENGINEER.
G. Switches, Current:
1. General:
   a. Function: Operate contacts at preset current signal level.
   b. Type: Electronic with electromechanical relays.
   c. When required, provide multiple current switches for the number of
      contacts indicated on the Drawings.
2. Performance:
   a. Setpoint: As indicated and required.
   b. Repeatability: ±0.1% of input span.
   c. Temperature, Operating Range: 32°F to 120°F.
3. Features:
   a. Dead Band: Continuously adjustable one to 100% full input span,
      accessible on the front of the unit.
   b. Activation: Rising or falling; internally selectable.
   c. Setpoint Adjustment: Continuously adjustable over full input span,
      accessible on the front of the unit.
   d. Input Resistance: 50 ohms maximum.
   e. Dual Setpoints: When noted; independent, with independent output
      contacts.
   f. Response Time: less than 100mS.
   g. Isolation: Input, output and power.
4. Signal Interface:
   a. Input: 4 to 20 mA DC.
   b. Contacts: Rated 5A continuous at 120V ac; DPDT for single setpoint,
      SPDT for dual setpoint.
6. Power: 24V DC, unless otherwise noted or approved by the ENGINEER.
7. Manufacturers:
   a. Acromag; model 361A, unless otherwise approved by the ENGINEER.
H. 24 V DC Power Supply:

1. General:
   a. Primary switched type.
   b. Power Input: 120 V AC
   c. Power Output: 24 V DC.

2. Features:
   a. Voltage Input Range: 90 to 130 V AC.
   c. Power: Individual power supplies shall be rated for 5 amp output. A minimum of four power supplies shall be provided. The total number of power supplies provided shall be sized for actual loads with 100% spare capacity.
   d. Residual Ripple: less than 150 mV peak to peak.
   e. Efficiency: greater than 85%.
   f. Rated for environmental conditions Specified.
   g. Overcurrent Protection: Each power supply shall be fused on the primary and secondary sides.
   h. Power supplies shall be provided with a “DC OK” signal output, that shall alarm on improper operation or failure.

3. Rail mount such that dissipated heat does not adversely affect other components.

4. Power supplies shall be furnished with all equipment necessary for the proper conditioning of the input power to prevent interruption, damage, or improper operation of the power supplies.

5. All power supplies shall run in balanced, parallel mode without external circuitry to provide redundancy.

6. DC current limiting in case of short circuit and shall automatically reset when fault is corrected.

7. Enclosure:
   a. Type: NEMA 1.
   b. Mounting: Panel, inside LCP.

8. Manufacturers:
   a. Phoenix Contact CM 125-PS-120-230AC/24DC/5/F, unless otherwise approved by the ENGINEER.

I. Timer, Reset:

1. Unit shall provide a dial selectable, timed interval upon external initiation. Reset timer shall provide ON delay function, unless otherwise noted.

2. Unit shall have scale range as noted with repeat accuracy of ±1.0% of full scale. Reset time shall not exceed 0.5 second and minimum setting shall be less than 4 % of full scale. Unit shall operate on 120-volt, 60-Hz power, unless otherwise noted. Contacts shall be rated for 10 amperes, continuous, at 120V ac. Contacts shall be rated for 250,000 operations at full resistive load.

3. Panel mounting reset timer shall have two sets of instantaneous SPDT contacts, and one set of delayed SPDT contacts. Panel unit shall have cycle progress indicator and pilot light. Unit shall be Automatic Timing and Controls, Series 305E; Eagle Signal, HP5 Series.

4. Surface mounting timer shall provide SPDT contacts rated for 10 amperes, continuous at 120V ac. Unit shall be Eagle Signal, HD50-HD60 Series; Automatic Timing and Controls, Series 322.

J. Uninterruptible Power Supply System:

1. General: An uninterruptible power system (UPS) shall be furnished for each PLC to provide a reliable source of isolated, regulated uninterruptible power with no break in AC output power during a complete or partial interruption of incoming
line power. The UPS shall provide a high degree of lightning and surge protection. The UPS shall include an intelligent interface and audiovisual alarms in order to keep operators continuously advised of system status. The UPS shall be UL-listed.

a. Lightning and Surge Protection: The UPS shall be tested using lightning standard per ANSI/IEEE C62.41 Category A (6,000V spike and 200 amp) and Category B (6,000V spike and 3,000 amp) test, and ANSI/IEEE C62.45 test procedures. The UPS must reduce the input spike to less than 3V on the output for a 2,000 to one spike attenuation.
b. Isolation, including output neutral to ground bonding: The UPS shall provide a true separately derived power source as defined by NEC 250.5d with output neutral bonded to ground. There shall be no direct connection between input and output and less than 2 pF of effective input to output capacitance.
c. Regulation: The UPS output shall be regulated to within the CBEMA and ANSI C84.1 point of utilization range of 104VAC to 127VAC over the full dynamic range from no load to full load and low line VAC to high line VAC and low battery voltage to high battery voltage.
d. Continuous no-break power: The UPS shall provide continuous no-break power during a power outage or momentary interruption. Standby power systems that have any measurable transfer time and interruption of the output wave form are unacceptable.
e. Sine-wave power: The UPS shall provide computer-grade sine-wave power with 5% or less total harmonic distortion capability. It must meet or exceed CSA C22.2 No. 107.1 for harmonic distortion.
f. Switch-mode power supply rated: Capacity shall be rated in volt amperes (VA) while loaded with typical computer-grade switch-mode power supplies having a power factor of 0.7 and crest factor of 2.7 to 3.5.
g. Intelligent Interactive Interface: The UPS shall provide an RS232 interface or equal with full-duplex output capable of providing monitoring and CRT display of meter functions and alarm conditions. The UPS interface will also include remote test capability, selectable baud rate from 50 to 38400, and ability to view and change system set points. Interface capability shall be provided for monitoring and CRT display of meter functions and alarm conditions. The UPS interface shall include meter functions including: AC Volts Out, AC Volts In, Battery Voltage, AC Current Out, VA Load, Watts, Power Factor, Percent of Full Load, DC Current Out, Frequency, Heatsink Temp., Ambient Temp., Transformer Temp., Time, Date, Number of Power Outages, Log of Power Outages, Log of Alarm Conditions, Projected Runtime Available, System Hours, Inverter Minutes, Number of Overloads, and VA Limit.

1) Also included for computer interface output shall be 19 alarm conditions: Low Battery, Near Low Battery, High Battery, Low Runtime Left, Low AC Out, High AC Out, Output Overload, High Ambient Temp., High Heatsink Temp., User Test Alarm, High Transformer Temp., Check Battery, Check Inverter, Memory Check, Emergency Power Off, High PFM Temp., Probe Missing, High AC Input, and Call Service.

2) Remote Emergency Off, alarm contacts, and inverter contacts shall be connected at the RS232 port.

h. Reliability engineered: The UPS shall have a dual-track redundant configuration that utilizes either line or inverter source for power and shall be designed to meet or exceed an expected MTBF of at least 150,000 hours per proven field service.
i. Efficiency: The UPS shall have an efficiency of at least 90% when operated from AC line.

k. Production:
1) Output: Ferroresonant transformer provides inherent overload protection (current limiting).
2) Input: DC fuse provides input protection. Fuse for battery charger circuitry.
3) Remote Emergency Off shall completely shut off UPS AC output to the protected load when activated from an external switch. Alarm contacts shall be relay contacts that close upon any alarm condition. Inverter contacts shall be relay contacts that close when the inverter turns on.

l. Miscellaneous Specifications: Overload capability shall be 150% surge and 125% for 10 minutes on line (with nominal AC volts in), and 150% surge and 110% for 10 minutes on inverter (with nominal DC volts in) if battery runtime allows. VA ratings are at a power factor of 0.7, which would be the result of a capacitive or switch-mode power supply load exhibiting a high crest factor. Overload operation shall not be thermally limited.
1) The minimum UPS sizes shall be as follows:

<table>
<thead>
<tr>
<th>Local Control Panel</th>
<th>Output Capacity</th>
<th>Runtimes Full load/1/2 load</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLC-CHE cabinet</td>
<td>1000 VA minimum</td>
<td>11/28 minutes</td>
</tr>
<tr>
<td>PLC-CHE-HPU cabinet</td>
<td>1000 VA minimum</td>
<td>11/28 minutes</td>
</tr>
<tr>
<td>PLC-CHE-VH cabinet</td>
<td>1000 VA minimum</td>
<td>11/28 minutes</td>
</tr>
<tr>
<td>PLC-CHE-STR cabinet</td>
<td>500 VA minimum</td>
<td>11/28 minutes</td>
</tr>
</tbody>
</table>

Input Voltage: 120VAC single-phase
Output Voltage: 120VAC single-phase
Voltage Regulation: Plus or minus 3% nominal regulation
Frequency (Input): 60 Hz plus or minus to plus or minus 3 Hz
Operating Temperature: 0°C to -40°C
Storage Temperature: -20°C to +60°C
(-20°C to +40°C, unless battery is removed)

m. Operation: The UPS shall be comprised of an inverter, a precision battery float charger, a sealed, maintenance-free battery, a full-duplex RS232 computer interface port, and contained in a single compact package.
1) Under normal operating conditions, the critical load shall be powered by normal AC line supply that has been filtered through a Ferroresonant transformer. When AC line power is present the inverter shall be normally off.
2) When AC line power fails or goes out of tolerance, the inverter shall supply AC power from the battery source. There shall be no break in the output of the system during transfer from normal AC line supply to inverter battery supply or back to line. A single switch shall turn the system on and off.

n. All systems shall be products of one manufacturer.
o. External Bypass Switch. All systems shall include or have as a provided option an external bypass switch to permit operation during UPS servicing.
2. Manufacturers and Products:
   a. Best Power Technology, Inc., FERRUPS Model FE series with external bypass switch model BPE, unless otherwise approved by the ENGINEER.
### TABLE 1
**SUPPLEMENT B - TEST AND REPORT, FORMS, AND EXAMPLES**
**SYSTEM PROBLEM REPORT**

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Project No.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Name:</td>
<td>SPR Number:</td>
</tr>
<tr>
<td>Test Number:</td>
<td>Problem Status:</td>
</tr>
<tr>
<td>Problem Type:</td>
<td>Hardware Software Documentation Unknown Other</td>
</tr>
<tr>
<td>Symptoms:</td>
<td>Time:</td>
</tr>
<tr>
<td>Description:</td>
<td>Date:</td>
</tr>
<tr>
<td></td>
<td>By:</td>
</tr>
</tbody>
</table>

Can problem be reproduced at will? Y / N

<table>
<thead>
<tr>
<th>Diagnosis:</th>
<th>Time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>By:</td>
</tr>
<tr>
<td>Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Correction:</th>
<th>Time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>By:</td>
</tr>
<tr>
<td>Description:</td>
<td></td>
</tr>
</tbody>
</table>

Final Sign Off | Time: |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>By:</td>
</tr>
<tr>
<td>Project Name: Denver Water Marston</td>
<td>Project No.: 28382</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Test Name: Functional Acceptance</td>
<td>SPR Number: 81</td>
</tr>
<tr>
<td>Test Number: 17.B.1</td>
<td>Problem Status: Fix before Reliability Test</td>
</tr>
<tr>
<td>Problem Type: (Hardware) Software Documentation Unknown Other</td>
<td></td>
</tr>
<tr>
<td>Symptoms:</td>
<td>Time: 11:45 a.m.</td>
</tr>
<tr>
<td></td>
<td>Date: Sep-9-01</td>
</tr>
<tr>
<td></td>
<td>By: Ed Hernandez</td>
</tr>
<tr>
<td>Description: Following a lightning strike, it was observed the DPC unit 3100 would not work. Suspect surge arrestors were not installed properly.</td>
<td></td>
</tr>
<tr>
<td>Can problem be reproduced at will? (Y) / N</td>
<td></td>
</tr>
<tr>
<td>Diagnosis:</td>
<td>Time: 4:30 p.m.</td>
</tr>
<tr>
<td></td>
<td>Date: Sep-10-01</td>
</tr>
<tr>
<td></td>
<td>By: R.J. Contractor</td>
</tr>
<tr>
<td>Description: Surge arrestors missing.</td>
<td></td>
</tr>
<tr>
<td>Correction:</td>
<td>Time: 3:00 p.m.</td>
</tr>
<tr>
<td></td>
<td>Date: Sep-15-01</td>
</tr>
<tr>
<td></td>
<td>By: R.J. Contractor</td>
</tr>
<tr>
<td>Description: Contractor will replace affected DPC units and install surge arrestors.</td>
<td></td>
</tr>
<tr>
<td>Final Sign Off:</td>
<td>Time: 8:45 p.m.</td>
</tr>
<tr>
<td></td>
<td>Date: Sep-17-01</td>
</tr>
<tr>
<td></td>
<td>By: R. Weber</td>
</tr>
</tbody>
</table>
### TABLE 3
SUPPLEMENT B - LOOP STATUS REPORT

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Functional Requirements:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Component Status (Check & initial each item when complete)

<table>
<thead>
<tr>
<th>Tag Number</th>
<th>Delivered</th>
<th>Tag ID Checked</th>
<th>Installation</th>
<th>Termination Wiring</th>
<th>Termination Tubing</th>
<th>Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks:

<table>
<thead>
<tr>
<th>Loop Ready for Operation</th>
<th>By:</th>
<th>Date:</th>
<th>Loop No.:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**TABLE 4**  
**SUPPLEMENT B - LOOP STATUS REPORT EXAMPLE FORMAT**

<table>
<thead>
<tr>
<th>Project Name: Denver Water Marston</th>
<th>Project No. 82382</th>
</tr>
</thead>
</table>

**Functional Requirements:**

1. Measure, locally indicate, and transmit settled water flow to LP-10.
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.
3. Provide high settled water flow alarm on LP-10.

**Component Status (Check & initial each item when complete)**

<table>
<thead>
<tr>
<th>Component Status</th>
<th>Tag Number</th>
<th>Delivered</th>
<th>Tag ID Checked</th>
<th>Installation</th>
<th>Termination Wiring</th>
<th>Termination Tubing</th>
<th>Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FE/FIT-10-2</td>
<td>Jan-12-01 DWM</td>
<td>Jan-12-01 DWM</td>
<td>Feb-7-01 DWM</td>
<td>Mar-5-01 DWM</td>
<td>N.A.</td>
<td>May-6-01 VDA</td>
</tr>
<tr>
<td></td>
<td>FIC-10-2</td>
<td>Jan-12-01 DWM</td>
<td>Jan-12-01 DWM</td>
<td>Mar-5-01 DWM</td>
<td>Apr-4-01 DWM</td>
<td>May-4-01 VDA</td>
<td>May-7-01 VDA</td>
</tr>
<tr>
<td></td>
<td>FSH-10-2</td>
<td>Jan-12-01 DWM</td>
<td>Jan-12-01 DWM</td>
<td>Mar-5-01 DWM</td>
<td>Apr-4-01 DWM</td>
<td>May-7-01 VDA</td>
<td>May-7-01 VDA</td>
</tr>
<tr>
<td></td>
<td>FAH-10-2</td>
<td>Jan-12-01 DWM</td>
<td>Jan-12-01 DWM</td>
<td>Mar-5-01 DWM</td>
<td>Apr-4-01 DWM</td>
<td>May-7-01 VDA</td>
<td>May-7-01 VDA</td>
</tr>
<tr>
<td></td>
<td>FCV-10-2</td>
<td>Mar-2-01 DWM</td>
<td>Mar-2-01 DWM</td>
<td>Apr-20-01 DWM</td>
<td>Apr-30-01 DWM</td>
<td>May-16-01 VDA</td>
<td>May-16-01 VDA</td>
</tr>
</tbody>
</table>

**Remarks:** None.

<table>
<thead>
<tr>
<th>Loop Ready for Operation</th>
<th>By: D.W. Moneypenny</th>
<th>Date: May-18-01</th>
<th>Loop No.: 10-2</th>
</tr>
</thead>
</table>

40 90 00 SUPPLEMENT B

TEST AND REPORT FORMS, AND EXAMPLES
### TABLE 5
SUPPLEMENT B - INSTRUMENT CALIBRATION SHEET

<table>
<thead>
<tr>
<th>Component Code</th>
<th>Manufacturer Code</th>
<th>Project Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Model</td>
<td>Name</td>
</tr>
<tr>
<td>Serial #</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Functions

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicate? Y / N</td>
<td>Chart:</td>
<td>Describe:</td>
<td>Modes? P / I / D</td>
<td>Switch? Y / N</td>
<td>Unit Range:</td>
</tr>
<tr>
<td>Record? Y / N</td>
<td>Scale:</td>
<td></td>
<td></td>
<td></td>
<td>Differential: fixed/adjustable</td>
</tr>
<tr>
<td>Transmit/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unit Range:</td>
</tr>
</tbody>
</table>

#### Analog Calibrations

<table>
<thead>
<tr>
<th>Required</th>
<th>As Calibrated</th>
<th>Required</th>
<th>As Calibrated</th>
<th>Note.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Indicated</td>
<td>Output</td>
<td>Increasing Input</td>
<td>Decreasing Input</td>
</tr>
<tr>
<td>Indicated</td>
<td>Output</td>
<td>Indicated</td>
<td>Output</td>
<td>(note rising or falling)</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Discrete Calibrations

<table>
<thead>
<tr>
<th>Control Mode Settings: P:</th>
<th>I:</th>
<th>D:</th>
</tr>
</thead>
<tbody>
<tr>
<td># Notes:</td>
<td>Component Calibrated and Ready for Startup</td>
<td></td>
</tr>
</tbody>
</table>

By: |
Date: |
Tag No.: |
### TABLE 6
SUPPLEMENT B - INSTRUMENT CALIBRATION SHEET EXAMPLE - ANALYZER/TRANSMITTER

<table>
<thead>
<tr>
<th>Component</th>
<th>Manufacturer</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: A7</td>
<td>Name: Leeds &amp; Northrup</td>
<td>Number: 82382</td>
</tr>
<tr>
<td>Name: pH Element &amp; Analyzer/Transmitter</td>
<td>Model: 12429-3-2-1-7</td>
<td>Name: Denver Water Marston</td>
</tr>
<tr>
<td>Serial #: 11553322</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Functions

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale:</th>
<th>Value</th>
<th>Units</th>
<th>Computing Functions? N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-14</td>
<td>pH units</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transmit/</th>
<th>Input:</th>
<th>1-14</th>
<th>pH units</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Convert?</th>
<th>Y</th>
<th>Output:</th>
<th>4-20 mA dc</th>
</tr>
</thead>
</table>

#### Analog Calibrations

<table>
<thead>
<tr>
<th>Input</th>
<th>Indicated</th>
<th>Output</th>
<th>Increasing Input</th>
<th>Decreasing Input</th>
<th>Number</th>
<th>Trip Point</th>
<th>Reset Pt.</th>
<th>Number</th>
<th>Trip Point</th>
<th>Reset Point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indicated</td>
<td>Output</td>
<td>Indicated</td>
<td>Output</td>
<td>No.</td>
<td>(note rising or falling)</td>
<td>(note rising or falling)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>1.0</td>
<td>4.0</td>
<td>1.0</td>
<td>4.0</td>
<td>1.</td>
<td>N.A.</td>
<td>N.A.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>2.3</td>
<td>5.6</td>
<td>2.2</td>
<td>5.5</td>
<td>2.</td>
<td>N.A.</td>
<td>N.A.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>7.5</td>
<td>12.0</td>
<td>7.5</td>
<td>11.9</td>
<td>3.</td>
<td>N.A.</td>
<td>N.A.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.7</td>
<td>12.7</td>
<td>18.4</td>
<td>12.7</td>
<td>18.3</td>
<td>4.</td>
<td>N.A.</td>
<td>N.A.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.0</td>
<td>14.0</td>
<td>20.0</td>
<td>14.0</td>
<td>20.0</td>
<td>5.</td>
<td>N.A.</td>
<td>N.A.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Control Mode Settings:

P: N.A.
I: D:
D: 7.

#### Notes:

1. Need to recheck low pH calibration solutions.

By: Martin Garcia
Date: Jun-6-01
Tag No.: AIT-12-6[pH]

Component Calibrated and Ready for Startup
### TABLE 9  
**SUPPLEMENT C - PERFORMANCE ACCEPTANCE TEST SHEET**

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Project No.:</th>
</tr>
</thead>
</table>

Demonstration test(s): For each functional Requirement of the loop:
(a) List and number the requirement.
(b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance.
(d) Provide space for signoff.

<table>
<thead>
<tr>
<th>Forms/Sheets Verified</th>
<th>By</th>
<th>Date</th>
<th>Loop Accepted By Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop Status Report</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrument Calibration Sheet</td>
<td>By:</td>
<td>Date:</td>
<td></td>
</tr>
<tr>
<td>I&amp;C Valve Calibration Sheet</td>
<td>Date:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Acceptance Test</td>
<td>By</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Witnessed</td>
<td></td>
<td></td>
<td>Loop No.:</td>
</tr>
</tbody>
</table>
TABLE 10
SUPPLEMENT C - PERFORMANCE ACCEPTANCE TEST SHEET EXAMPLE

<table>
<thead>
<tr>
<th>Demonstration test(s): For each functional Requirement of the loop:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) List and number the requirement.</td>
</tr>
<tr>
<td>(b) Briefly describe the demonstration test.</td>
</tr>
<tr>
<td>(c) Cite the results that will verify the required performance.</td>
</tr>
<tr>
<td>(d) Provide space for signoff.</td>
</tr>
</tbody>
</table>

1. Measure Effluent Flow

1.a With no flow, water level over weir should be zero and FIT indicator should read zero.  
   Jun-20-01 BDG

2. Flow Indication and Transmission to LP & CCS

With flow, water level and FIT indicator should be related by expression

\[ Q(\text{mgd}) = 429 \cdot H^{2/3} \]  

\( H = \) height in inches of water over weir.

Vary \( H \) and observe that following.

<table>
<thead>
<tr>
<th>( H(\text{measured}) )</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Q(\text{computed}) )</td>
<td>0</td>
<td>47.96</td>
<td>135.7</td>
<td>251.7</td>
</tr>
<tr>
<td>( Q(\text{FIT indicator}) )</td>
<td>0</td>
<td>48.1</td>
<td>137</td>
<td>253</td>
</tr>
<tr>
<td>( Q(\text{LI on LP-521-1}) )</td>
<td>0</td>
<td>48.2</td>
<td>138</td>
<td>254</td>
</tr>
<tr>
<td>( Q(\text{display by CCS}) )</td>
<td>0</td>
<td>48.1</td>
<td>136.2</td>
<td>252.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forms/Sheets Verified</th>
<th>By</th>
<th>Date</th>
<th>Loop Accepted by Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop Status Report</td>
<td>E. Hernandez</td>
<td>May-18-01</td>
<td>By: R. Fellows</td>
</tr>
<tr>
<td>Instrument Calibration Sheet</td>
<td>E. Hernandez</td>
<td>May-18-01</td>
<td>Date: Jun-6-01</td>
</tr>
<tr>
<td>I&amp;C Valve Calibration Sheet</td>
<td>N.A.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Acceptance Test</td>
<td>By</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Performed</td>
<td>Lou S. Ratchet, Pizzachalley Co.</td>
<td>Jun-6-01</td>
<td></td>
</tr>
<tr>
<td>Witnessed</td>
<td>R. Weber</td>
<td>Jun-6-01</td>
<td>Loop No.: 30-12</td>
</tr>
</tbody>
</table>
APPENDIX A

LOW LEVEL GATE MANUFACTURER'S DRAWINGS
APPENDIX A DRAWINGS ARE APPENDED
TO THE PHASE 1B DRAWING SET
APPENDIX B

MID LEVEL GUARD GATE
MANUFACTURER’S DRAWINGS
APPENDIX B DRAWINGS ARE APPENDED

TO THE PHASE 1B DRAWING SET
APPENDIX C

AUXILIARY LEVEL GUARD GATE
MANUFACTURER’S DRAWINGS
APPENDIX C DRAWINGS ARE APPENDED
TO THE PHASE 1B DRAWING SET
APPENDIX D DRAWINGS ARE APPENDED
TO THE PHASE 1B DRAWING SET
APPENDIX E

SUPPLEMENTAL SURVEY INFORMATION
APPENDIX E DRAWINGS ARE APPENDED
TO THE PHASE 1B DRAWING SET
APPENDIX F

CHEESMAN RESERVOIR ELEVATIONS
<table>
<thead>
<tr>
<th>YEAR</th>
<th>MAX. ELEV.</th>
<th>MIN. ELEV.</th>
<th>ELV ABOVE SPILL WAY</th>
<th>ELV BELOW SPILL WAY</th>
<th>OUTFLOW MAX.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>212.72</td>
<td>185.22</td>
<td>0.72</td>
<td>26.78</td>
<td>796</td>
</tr>
<tr>
<td>1961</td>
<td>212.40</td>
<td>183.15</td>
<td>0.40</td>
<td>28.85</td>
<td>826</td>
</tr>
<tr>
<td>1962</td>
<td>212.60</td>
<td>168.00</td>
<td>0.60</td>
<td>45.40</td>
<td>469</td>
</tr>
<tr>
<td>1963</td>
<td>169.10</td>
<td>110.34</td>
<td>99.66</td>
<td>103.31</td>
<td>408</td>
</tr>
<tr>
<td>1964</td>
<td>134.84</td>
<td>108.69</td>
<td>103.31</td>
<td>611</td>
<td>652</td>
</tr>
<tr>
<td>1965</td>
<td>212.56</td>
<td>118.36</td>
<td>0.66</td>
<td>93.64</td>
<td>1,005</td>
</tr>
<tr>
<td>1966</td>
<td>212.32</td>
<td>142.53</td>
<td>0.32</td>
<td>69.47</td>
<td>374</td>
</tr>
<tr>
<td>1967</td>
<td>153.44</td>
<td>136.96</td>
<td>75.04</td>
<td>440</td>
<td>460</td>
</tr>
<tr>
<td>1968</td>
<td>181.14</td>
<td>153.50</td>
<td>58.50</td>
<td>725</td>
<td>772</td>
</tr>
<tr>
<td>1969</td>
<td>213.50</td>
<td>156.76</td>
<td>1.50</td>
<td>55.24</td>
<td>2,017</td>
</tr>
<tr>
<td>1970</td>
<td>214.60</td>
<td>203.52</td>
<td>2.60</td>
<td>8.48</td>
<td>3,415</td>
</tr>
<tr>
<td>1971</td>
<td>212.92</td>
<td>204.18</td>
<td>0.92</td>
<td>7.82</td>
<td>790</td>
</tr>
<tr>
<td>1972</td>
<td>212.44</td>
<td>167.92</td>
<td>0.44</td>
<td>44.08</td>
<td>394</td>
</tr>
<tr>
<td>1973</td>
<td>212.58</td>
<td>180.20</td>
<td>0.58</td>
<td>31.80</td>
<td>1,478</td>
</tr>
<tr>
<td>1974</td>
<td>201.40</td>
<td>160.75</td>
<td>51.25</td>
<td>354</td>
<td>475</td>
</tr>
<tr>
<td>1975</td>
<td>199.88</td>
<td>160.05</td>
<td>51.92</td>
<td>906</td>
<td>1,002</td>
</tr>
<tr>
<td>1976</td>
<td>175.63</td>
<td>120.72</td>
<td>91.28</td>
<td>677</td>
<td>574</td>
</tr>
<tr>
<td>1977</td>
<td>151.69</td>
<td>139.44</td>
<td>72.56</td>
<td>406</td>
<td>272</td>
</tr>
<tr>
<td>1978</td>
<td>157.40</td>
<td>132.10</td>
<td>79.90</td>
<td>326</td>
<td>553</td>
</tr>
<tr>
<td>1979</td>
<td>212.98</td>
<td>151.35</td>
<td>0.98</td>
<td>60.65</td>
<td>1,465</td>
</tr>
<tr>
<td>1980</td>
<td>213.23</td>
<td>199.08</td>
<td>1.23</td>
<td>12.92</td>
<td>1,312</td>
</tr>
<tr>
<td>1981</td>
<td>212.01</td>
<td>190.54</td>
<td>0.01</td>
<td>21.46</td>
<td>285</td>
</tr>
<tr>
<td>1982</td>
<td>212.44</td>
<td>168.68</td>
<td>0.44</td>
<td>43.32</td>
<td>804</td>
</tr>
<tr>
<td>1983</td>
<td>213.17</td>
<td>209.00</td>
<td>1.17</td>
<td>3.00</td>
<td>2,265</td>
</tr>
<tr>
<td>1984</td>
<td>213.39</td>
<td>202.45</td>
<td>1.19</td>
<td>9.55</td>
<td>1,853</td>
</tr>
<tr>
<td>1985</td>
<td>213.12</td>
<td>200.80</td>
<td>1.12</td>
<td>11.20</td>
<td>1,694</td>
</tr>
<tr>
<td>1986</td>
<td>212.60</td>
<td>155.98</td>
<td>0.60</td>
<td>56.02</td>
<td>560</td>
</tr>
<tr>
<td>1987</td>
<td>213.25</td>
<td>166.53</td>
<td>1.25</td>
<td>54.70</td>
<td>1,581</td>
</tr>
<tr>
<td>1988</td>
<td>211.67</td>
<td>178.82</td>
<td>33.18</td>
<td>1,017</td>
<td>1,420</td>
</tr>
<tr>
<td>1989</td>
<td>209.88</td>
<td>183.46</td>
<td>28.54</td>
<td>660</td>
<td>802</td>
</tr>
<tr>
<td>1990</td>
<td>212.60</td>
<td>187.56</td>
<td>0.60</td>
<td>24.44</td>
<td>635</td>
</tr>
<tr>
<td>1991</td>
<td>212.65</td>
<td>180.23</td>
<td>0.65</td>
<td>31.77</td>
<td>473</td>
</tr>
<tr>
<td>1992</td>
<td>212.45</td>
<td>181.13</td>
<td>0.45</td>
<td>30.87</td>
<td>450</td>
</tr>
<tr>
<td>YEAR</td>
<td>MAX.</td>
<td>MIN.</td>
<td>SPILL WAY</td>
<td>SPILL WAY</td>
<td>ELEV.</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td>1993</td>
<td>199.02</td>
<td>168.44</td>
<td>44.56</td>
<td>540</td>
<td>597</td>
</tr>
<tr>
<td>1994</td>
<td>211.82</td>
<td>179.56</td>
<td>32.44</td>
<td>653</td>
<td>789</td>
</tr>
<tr>
<td>1995</td>
<td>213.69</td>
<td>172.29</td>
<td>1.69</td>
<td>39.71</td>
<td>2.728</td>
</tr>
<tr>
<td>1996</td>
<td>211.61</td>
<td>182.93</td>
<td>24.04</td>
<td>658</td>
<td>723</td>
</tr>
<tr>
<td>1997</td>
<td>212.41</td>
<td>190.58</td>
<td>0.41</td>
<td>21.42</td>
<td>665</td>
</tr>
<tr>
<td>1998</td>
<td>212.54</td>
<td>173.71</td>
<td>0.54</td>
<td>38.29</td>
<td>521</td>
</tr>
<tr>
<td>1999</td>
<td>212.86</td>
<td>169.10</td>
<td>0.86</td>
<td>42.90</td>
<td>1.167</td>
</tr>
<tr>
<td>2000</td>
<td>211.88</td>
<td>167.01</td>
<td>44.99</td>
<td>498</td>
<td>551</td>
</tr>
<tr>
<td>2001</td>
<td>211.60</td>
<td>166.38</td>
<td>45.62</td>
<td>509</td>
<td>506</td>
</tr>
<tr>
<td>2002</td>
<td>187.46</td>
<td>124.17</td>
<td>0.00</td>
<td>87.83</td>
<td>784</td>
</tr>
<tr>
<td>2003</td>
<td>211.33</td>
<td>166.91</td>
<td>0.00</td>
<td>45.09</td>
<td>392</td>
</tr>
<tr>
<td>2004</td>
<td>210.70</td>
<td>187.08</td>
<td>0.00</td>
<td>24.02</td>
<td>475</td>
</tr>
<tr>
<td>2005</td>
<td>212.69</td>
<td>198.89</td>
<td>0.69</td>
<td>13.11</td>
<td>493</td>
</tr>
<tr>
<td>2006</td>
<td>212.68</td>
<td>193.56</td>
<td>0.68</td>
<td>18.44</td>
<td>480</td>
</tr>
<tr>
<td>2007</td>
<td>212.71</td>
<td>188.76</td>
<td>0.71</td>
<td>23.24</td>
<td>730</td>
</tr>
<tr>
<td>2008</td>
<td>212.60</td>
<td>191.12</td>
<td>0.60</td>
<td>20.88</td>
<td>610</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIN</td>
<td>130.84</td>
<td>108.69</td>
<td>0.00</td>
<td>3.00</td>
<td>285</td>
</tr>
<tr>
<td>MAX</td>
<td>214.60</td>
<td>209.00</td>
<td>2.60</td>
<td>103.31</td>
<td>3415</td>
</tr>
<tr>
<td>AVG</td>
<td>203.72</td>
<td>169.57</td>
<td>0.75</td>
<td>42.51</td>
<td>855</td>
</tr>
<tr>
<td>YEAR</td>
<td>ICE ON MONTH</td>
<td>ICE ON DAY</td>
<td>ICE OFF MONTH</td>
<td>ICE OFF DAY</td>
<td>SPRING RUN OFF DAY</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>------------</td>
<td>---------------</td>
<td>-------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>1960</td>
<td>JAN</td>
<td>2</td>
<td>APR</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td>JAN</td>
<td>15</td>
<td>APR</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>JAN</td>
<td>28</td>
<td>APR</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>1963</td>
<td>DEC</td>
<td>29</td>
<td>APR</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>1964</td>
<td>JAN</td>
<td>5</td>
<td>APR</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>1965</td>
<td>FEB</td>
<td>3</td>
<td>MAR</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>1966</td>
<td>JAN</td>
<td>3</td>
<td>MAR</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>1967</td>
<td>DEC</td>
<td>25</td>
<td>APR</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1968</td>
<td>JAN</td>
<td>4</td>
<td>MAR</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>1969</td>
<td>DEC</td>
<td>25</td>
<td>APR</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>JAN</td>
<td>4</td>
<td>MAR</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>1971</td>
<td>JAN</td>
<td>11</td>
<td>MAR</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>DEC</td>
<td>25</td>
<td>MAR</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td>JAN</td>
<td>9</td>
<td>MAR</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td>JAN</td>
<td>11</td>
<td>MAR</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td>JAN</td>
<td>14</td>
<td>MAR</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td>JAN</td>
<td>1</td>
<td>MAR</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>JAN</td>
<td>2</td>
<td>MAR</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>JAN</td>
<td>1</td>
<td>MAR</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>FEB</td>
<td>14</td>
<td>APR</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>FEB</td>
<td>4</td>
<td>APR</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>FEB</td>
<td>5</td>
<td>APR</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>DEC</td>
<td>29</td>
<td>APR</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>FEB</td>
<td>12</td>
<td>APR</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>JAN</td>
<td>10</td>
<td>MAR</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>JAN</td>
<td>9</td>
<td>MAR</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>JAN</td>
<td>7</td>
<td>MAR</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>JAN</td>
<td>12</td>
<td>MAR</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>JAN</td>
<td>16</td>
<td>MAR</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>FEB</td>
<td>4</td>
<td>APR</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>FEB</td>
<td>14</td>
<td>APR</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>JAN</td>
<td>16</td>
<td>MAR</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>JAN</td>
<td>25</td>
<td>APR</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>DEC</td>
<td>28</td>
<td>APR</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YEAR</td>
<td>MONTH</td>
<td>DAY</td>
<td>MONTH</td>
<td>DAY</td>
<td>MONTH</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>-----</td>
<td>-------</td>
<td>-----</td>
<td>-------</td>
</tr>
<tr>
<td>1995</td>
<td>APR</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>APR</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>APR</td>
<td>9</td>
<td>JUNE</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>APR</td>
<td>2</td>
<td>SEPT</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>MAR</td>
<td>22</td>
<td>JUNE</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>APR</td>
<td>5</td>
<td>JUNE</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>JAN</td>
<td>21</td>
<td>APR</td>
<td>3</td>
<td>JUNE</td>
</tr>
<tr>
<td>2002</td>
<td>MARCH</td>
<td>2</td>
<td>APR</td>
<td>8</td>
<td>APRIL</td>
</tr>
<tr>
<td>2003</td>
<td>APRIL</td>
<td>2</td>
<td>AUG</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>MAR</td>
<td>20</td>
<td>JULY</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>APR</td>
<td>4</td>
<td>MAY</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>FEB</td>
<td>18</td>
<td>MAR</td>
<td>27</td>
<td>July</td>
</tr>
<tr>
<td>2007</td>
<td>JAN</td>
<td>15</td>
<td>MAR</td>
<td>22</td>
<td>MAY</td>
</tr>
<tr>
<td>2008</td>
<td>JAN</td>
<td>17</td>
<td>MAR</td>
<td>29</td>
<td>JULY</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2026</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVG</td>
<td>JAN</td>
<td>13</td>
<td>APR</td>
<td>14</td>
<td>JUN</td>
</tr>
<tr>
<td>YEAR</td>
<td>SNOW FALL</td>
<td>SNOW FALL</td>
<td>TOTAL SNOW</td>
<td>TOTAL PRECIP</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-----------</td>
<td>-----------</td>
<td>------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JAN - JUNE</td>
<td>SEPT - DEC</td>
<td>YEAR</td>
<td>INCHES</td>
<td>YEAR</td>
</tr>
<tr>
<td>1960</td>
<td>37.0</td>
<td>23.0</td>
<td>60.0</td>
<td>14.04</td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td>43.0</td>
<td>16.0</td>
<td>59.0</td>
<td>19.31</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>33.0</td>
<td>11.5</td>
<td>44.5</td>
<td>10.14</td>
<td></td>
</tr>
<tr>
<td>1963</td>
<td>28.0</td>
<td>19.0</td>
<td>47.0</td>
<td>16.35</td>
<td></td>
</tr>
<tr>
<td>1964</td>
<td>49.5</td>
<td>16.0</td>
<td>65.5</td>
<td>12.18</td>
<td></td>
</tr>
<tr>
<td>1965</td>
<td>42.0</td>
<td>15.0</td>
<td>57.0</td>
<td>17.10</td>
<td></td>
</tr>
<tr>
<td>1966</td>
<td>42.5</td>
<td>7.0</td>
<td>49.5</td>
<td>14.54</td>
<td></td>
</tr>
<tr>
<td>1967</td>
<td>45.0</td>
<td>29.0</td>
<td>74.0</td>
<td>13.80</td>
<td></td>
</tr>
<tr>
<td>1968</td>
<td>28.0</td>
<td>26.0</td>
<td>54.0</td>
<td>14.74</td>
<td></td>
</tr>
<tr>
<td>1969</td>
<td>22.0</td>
<td>79.0</td>
<td>101.0</td>
<td>24.58</td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>49.0</td>
<td>24.0</td>
<td>73.0</td>
<td>18.19</td>
<td></td>
</tr>
<tr>
<td>1971</td>
<td>35.0</td>
<td>41.0</td>
<td>76.0</td>
<td>17.05</td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>39.0</td>
<td>64.0</td>
<td>103.0</td>
<td>16.44</td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td>61.0</td>
<td>27.0</td>
<td>88.0</td>
<td>19.70</td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td>37.0</td>
<td>18.0</td>
<td>55.0</td>
<td>14.91</td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td>42.0</td>
<td>44.0</td>
<td>86.0</td>
<td>14.51</td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td>35.0</td>
<td>27.0</td>
<td>62.0</td>
<td>17.39</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>34.0</td>
<td>13.0</td>
<td>47.0</td>
<td>16.29</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>23.0</td>
<td>18.0</td>
<td>41.0</td>
<td>12.75</td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>53.0</td>
<td>37.0</td>
<td>90.0</td>
<td>19.80</td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>34.0</td>
<td>13.0</td>
<td>47.0</td>
<td>13.45</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>30.0</td>
<td>20.0</td>
<td>50.0</td>
<td>17.05</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>21.0</td>
<td>33.0</td>
<td>54.0</td>
<td>25.59</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>67.0</td>
<td>36.0</td>
<td>103.0</td>
<td>18.74</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>65.0</td>
<td>35.0</td>
<td>100.0</td>
<td>21.06</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>32.0</td>
<td>27.0</td>
<td>59.0</td>
<td>16.94</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>40.0</td>
<td>22.0</td>
<td>62.0</td>
<td>16.11</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>55.0</td>
<td>29.0</td>
<td>84.0</td>
<td>17.80</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>40.0</td>
<td>17.0</td>
<td>57.0</td>
<td>14.85</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>44.0</td>
<td>25.0</td>
<td>69.0</td>
<td>13.51</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>51.0</td>
<td>20.0</td>
<td>71.0</td>
<td>22.27</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>26.0</td>
<td>34.0</td>
<td>60.0</td>
<td>18.48</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>24.0</td>
<td>17.0</td>
<td>41.0</td>
<td>18.42</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>18.0</td>
<td>18.0</td>
<td>36.0</td>
<td>14.77</td>
<td></td>
</tr>
<tr>
<td>YEAR</td>
<td>SNOW FALL</td>
<td>SNOW FALL</td>
<td>TOTAL SNOW</td>
<td>TOTAL PRECIP</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-----------</td>
<td>-----------</td>
<td>------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JAN - JUNE</td>
<td>SEPT - DEC</td>
<td>FOR YEAR</td>
<td>FOR YEAR</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>25.00</td>
<td>25.00</td>
<td>50.00</td>
<td>17.20</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>51.00</td>
<td>11.00</td>
<td>62.00</td>
<td>19.45</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>21.50</td>
<td>8.00</td>
<td>29.50</td>
<td>13.72</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>37.00</td>
<td>46.00</td>
<td>83.00</td>
<td>20.56</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>38.50</td>
<td>12.50</td>
<td>51.00</td>
<td>15.49</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>39.50</td>
<td>25.50</td>
<td>65.00</td>
<td>16.19</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>37.00</td>
<td>14.00</td>
<td>51.00</td>
<td>16.04</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>47.00</td>
<td>9.50</td>
<td>56.50</td>
<td>15.02</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>22.50</td>
<td>7.50</td>
<td>30.00</td>
<td>8.80</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>55.50</td>
<td>10.00</td>
<td>65.50</td>
<td>11.91</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>37.00</td>
<td>18.75</td>
<td>56.50</td>
<td>16.24</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>57.50</td>
<td>13.60</td>
<td>71.00</td>
<td>14.47</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>21.00</td>
<td>72.00</td>
<td>93.00</td>
<td>19.94</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>36.00</td>
<td>20.00</td>
<td>56.00</td>
<td>18.09</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>49.00</td>
<td>14.50</td>
<td>63.50</td>
<td>12.28</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIN</td>
<td>18.00</td>
<td>7.00</td>
<td>29.50</td>
<td>8.80</td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td>67.00</td>
<td>79.00</td>
<td>103.00</td>
<td>25.59</td>
<td></td>
</tr>
<tr>
<td>AVG</td>
<td>38.78</td>
<td>24.66</td>
<td>63.45</td>
<td>16.60</td>
<td></td>
</tr>
<tr>
<td>YEAR</td>
<td>MAX</td>
<td>MONTH</td>
<td>DAY</td>
<td>MIN</td>
<td>MONTH</td>
</tr>
<tr>
<td>------</td>
<td>-----</td>
<td>-------</td>
<td>-----</td>
<td>-----</td>
<td>-------</td>
</tr>
<tr>
<td>1960</td>
<td>92</td>
<td>JUNE</td>
<td>29</td>
<td>-27</td>
<td>FEB</td>
</tr>
<tr>
<td>1961</td>
<td>93</td>
<td>JUNE</td>
<td>29</td>
<td>-14</td>
<td>FEB</td>
</tr>
<tr>
<td>1962</td>
<td>92</td>
<td>JULY</td>
<td>10</td>
<td>-41</td>
<td>JAN</td>
</tr>
<tr>
<td>1963</td>
<td>95</td>
<td>JUNE</td>
<td>30</td>
<td>-38</td>
<td>JAN</td>
</tr>
<tr>
<td>1964</td>
<td>93</td>
<td>JULY</td>
<td>4</td>
<td>-26</td>
<td>FEB</td>
</tr>
<tr>
<td>1965</td>
<td>91</td>
<td>JULY</td>
<td>21</td>
<td>-20</td>
<td>FEB</td>
</tr>
<tr>
<td>1966</td>
<td>96</td>
<td>JULY</td>
<td>10</td>
<td>-15</td>
<td>FEB</td>
</tr>
<tr>
<td>1967</td>
<td>91</td>
<td>JULY</td>
<td>22</td>
<td>-16</td>
<td>JAN</td>
</tr>
<tr>
<td>1968</td>
<td>93</td>
<td>JUNE</td>
<td>21</td>
<td>-11</td>
<td>DEC</td>
</tr>
<tr>
<td>1969</td>
<td>94</td>
<td>AUG</td>
<td>10</td>
<td>-13</td>
<td>DEC</td>
</tr>
<tr>
<td>1970</td>
<td>91</td>
<td>JUNE</td>
<td>26</td>
<td>-24</td>
<td>JAN</td>
</tr>
<tr>
<td>1971</td>
<td>92</td>
<td>JULY</td>
<td>12</td>
<td>-28</td>
<td>JAN</td>
</tr>
<tr>
<td>1972</td>
<td>92</td>
<td>JULY</td>
<td>14</td>
<td>-24</td>
<td>DEC</td>
</tr>
<tr>
<td>1973</td>
<td>94</td>
<td>JULY</td>
<td>5</td>
<td>-18</td>
<td>JAN</td>
</tr>
<tr>
<td>1974</td>
<td>94</td>
<td>JUNE</td>
<td>28</td>
<td>-25</td>
<td>JAN</td>
</tr>
<tr>
<td>1975</td>
<td>92</td>
<td>JULY</td>
<td>1</td>
<td>-28</td>
<td>JAN</td>
</tr>
<tr>
<td>1976</td>
<td>96</td>
<td>JULY</td>
<td>10</td>
<td>-21</td>
<td>JAN</td>
</tr>
<tr>
<td>1977</td>
<td>97</td>
<td>JULY</td>
<td>19</td>
<td>-16</td>
<td>JAN</td>
</tr>
<tr>
<td>1978</td>
<td>92</td>
<td>JUNE</td>
<td>24</td>
<td>-32</td>
<td>DEC</td>
</tr>
<tr>
<td>1979</td>
<td>96</td>
<td>AUG</td>
<td>7</td>
<td>-28</td>
<td>JAN</td>
</tr>
<tr>
<td>1980</td>
<td>93</td>
<td>AUG</td>
<td>8</td>
<td>-11</td>
<td>FEB</td>
</tr>
<tr>
<td>1981</td>
<td>94</td>
<td>JULY</td>
<td>8</td>
<td>-11</td>
<td>FEB</td>
</tr>
<tr>
<td>1982</td>
<td>96</td>
<td>JULY</td>
<td>24</td>
<td>-26</td>
<td>FEB</td>
</tr>
<tr>
<td>1983</td>
<td>92</td>
<td>JULY</td>
<td>7</td>
<td>-19</td>
<td>DEC</td>
</tr>
<tr>
<td>1984</td>
<td>91</td>
<td>JULY</td>
<td>20</td>
<td>-28</td>
<td>JAN</td>
</tr>
<tr>
<td>1985</td>
<td>94</td>
<td>JULY</td>
<td>7</td>
<td>-25</td>
<td>FEB</td>
</tr>
<tr>
<td>1986</td>
<td>93</td>
<td>JULY</td>
<td>29</td>
<td>-15</td>
<td>FEB</td>
</tr>
<tr>
<td>1987</td>
<td>93</td>
<td>JULY</td>
<td>30</td>
<td>-16</td>
<td>JAN</td>
</tr>
<tr>
<td>1988</td>
<td>94</td>
<td>JULY</td>
<td>14</td>
<td>-22</td>
<td>JAN</td>
</tr>
<tr>
<td>1989</td>
<td>98</td>
<td>JULY</td>
<td>8</td>
<td>-31</td>
<td>FEB</td>
</tr>
<tr>
<td>1990</td>
<td>97</td>
<td>AUG</td>
<td>30</td>
<td>-29</td>
<td>DEC</td>
</tr>
<tr>
<td>1991</td>
<td>92</td>
<td>JULY</td>
<td>16</td>
<td>-8</td>
<td>NOV</td>
</tr>
<tr>
<td>1992</td>
<td>94</td>
<td>JULY</td>
<td>7</td>
<td>-15</td>
<td>DEC</td>
</tr>
<tr>
<td>1993</td>
<td>94</td>
<td>JULY</td>
<td>29</td>
<td>-17</td>
<td>FEB</td>
</tr>
<tr>
<td>1994</td>
<td>99</td>
<td>JUNE</td>
<td>28</td>
<td>-28</td>
<td>JAN</td>
</tr>
<tr>
<td>YEAR</td>
<td>MAX</td>
<td>DATE</td>
<td>MIN</td>
<td>DATE</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-----</td>
<td>------</td>
<td>-----</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>96</td>
<td>JULY</td>
<td>-22</td>
<td>JAN</td>
<td>3</td>
</tr>
<tr>
<td>1996</td>
<td>94</td>
<td>JULY</td>
<td>-20</td>
<td>DEC</td>
<td>18</td>
</tr>
<tr>
<td>1997</td>
<td>92</td>
<td>JULY</td>
<td>-20</td>
<td>DEC</td>
<td>5</td>
</tr>
<tr>
<td>1998</td>
<td>97</td>
<td>JULY</td>
<td>-24</td>
<td>JAN</td>
<td>8</td>
</tr>
<tr>
<td>1999</td>
<td>90</td>
<td>JULY</td>
<td>-4</td>
<td>DEC</td>
<td>9</td>
</tr>
<tr>
<td>2000</td>
<td>87</td>
<td>JULY</td>
<td>-9</td>
<td>JAN</td>
<td>30</td>
</tr>
<tr>
<td>2001</td>
<td>88</td>
<td>JUNE</td>
<td>-15</td>
<td>JAN</td>
<td>17</td>
</tr>
<tr>
<td>2002</td>
<td>96</td>
<td>AUG</td>
<td>-28</td>
<td>MAY</td>
<td>2</td>
</tr>
<tr>
<td>2003</td>
<td>97</td>
<td>JULY</td>
<td>-12</td>
<td>FEB</td>
<td>8</td>
</tr>
<tr>
<td>2004</td>
<td>92</td>
<td>JULY</td>
<td>-10</td>
<td>FEB</td>
<td>12</td>
</tr>
<tr>
<td>2005</td>
<td>97</td>
<td>JULY</td>
<td>-13</td>
<td>DEC</td>
<td>7</td>
</tr>
<tr>
<td>2006</td>
<td>96</td>
<td>July</td>
<td>-9</td>
<td>Nov</td>
<td>30</td>
</tr>
<tr>
<td>2007</td>
<td>93</td>
<td>JUNE</td>
<td>-14</td>
<td>JAN</td>
<td>15</td>
</tr>
<tr>
<td>2008</td>
<td>94</td>
<td>July</td>
<td>-14</td>
<td>JAN</td>
<td>16</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2026</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MIN  | 87  | -41  |
MAX  | 99  | -4   |
AVG  | 94  | -20  |