CITY OF TULSA, OKLAHOMA
TULSA, OKLAHOMA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the
ZINK DAM IMPROVEMENTS
GATE PREPURCHASE

****

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CH2M HILL
Tulsa, Oklahoma
March 2020

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Project No. 696780

Copy No.____________________
Digitally Signed on

March 18, 2020

Lars Ostervold
Digitally Signed on 3/18/2020
Seal of Richard E. McLaughlin applies only to the following Specifications:

35 20 30 Waveshapers and Gates
Digitally Signed on

March 18, 2020

Jeff Kanyuch

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DRAWINGS

END OF SECTION
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SECTION 01 01 00
SPECIAL SPECIFICATION

This Special Specification section amends and supplements other provisions of the Contract Documents. All provisions which are not so amended or supplemented remain in full force and effect.

1. ADD the following paragraphs to supplement definitions and terms used in the specifications:

“Owner” shall mean “The City of Tulsa.”

“Specification” shall mean, collectively, all of the terms and stipulations contained in the written portion of information furnished.

“Gate System Supplier” shall mean the corporation, company, partnership, firm, or individual who will provide the gates and associated equipment and related services specified herein and its, his/her, or their duly authorized agents and other legal representations.

“Specialist”—The term refers to a person, partnership, firm or corporation of established reputation (or if newly organized, whose personnel have previously established a reputation in the same field), which is regularly engaged in, and which maintains a regular force of workers skilled in either (as applicable) manufacturing or fabricating items required by the Contract Documents, or otherwise performing Work required by the Contract Documents. Where the Specifications require the installation by a Specialist, the term shall also be deemed to mean either the manufacturer of the item, a person, partnership, firm, or corporation licensed by the manufacturer, or a person, partnership, firm or corporation who will perform the Work under the manufacturer’s direct supervision.

“Pneumatic Gate System Package” shall mean the combined gates, air bladders as specified individually herein.

“Installation Contractor” — The term shall mean the corporation, company, partnership, firm, or individual who has entered into a separate contract with the Owner for installation of the pneumatic gates, which will incorporate the gate system furnished under this Contract, and its, his/her, or their duly authorized agents and other legal representatives.

“Project Delivery Location” – The term Project Delivery Location shall mean the Zink Dam Project Site generally described as 31st Street and Riverside Drive, Tulsa, Oklahoma.
“Work Site” shall be interpreted as the Contractor’s manufacturing facility. The intent is that a single individual employed by the Contractor shall be designated as being assigned to oversee the project. The “superintendent” terminology can also mean the Contractor’s project manager who will be responsible for this project along with other ongoing manufacturing projects.

END OF SECTION
PART 1 GENERAL

1.01 WORK UNDER THIS CONTRACT

A. The Work under this Contract consists of the procurement of the pneumatic and hydraulic gates for the Zink Dam Modifications Project located on the Arkansas River in Tulsa, Oklahoma. Procurement of the gates, bladders, equipment and all related appurtenances needed for installation will be accomplished and provided as a system from a single Contractor. Detailed design requirements are contained elsewhere in these documents but can generally be described pneumatically operated and hydraulically operated Type 316 stainless steel gates as described in the Specifications and shown on the attached Drawings.

B. Without intending to limit or restrict the extent of the Work in accordance with the Contract Documents, the Work includes procurement of a gate system package with the following principal elements:

1. Gate system design, submittals, factory testing, delivery, onsite Contractor’s services.
2. Provide structural calculations and drawings for the anchoring requirements. Anchoring requirements shall include the required anchor bolt diameter and embedment depth, and the anchor bolt templates. All structural calculations shall be signed and stamped by a licensed Structural Engineer registered in the State of Oklahoma.
3. All equipment and materials shall be delivered by the Contractor to Project Site in Tulsa, Oklahoma and unloaded by the Installation Contractor.
4. The Contractor shall be responsible for and present during the unloading of all equipment and materials, subject to a joint inspection prior to unloading.
5. The Contractor shall be present during the joint inspection and Installation Contractor’s unloading of all equipment as described in Section 01 61 00, Materials and Equipment.
6. Installation of the equipment will be accomplished by the Installation Contractor under a separate contract to the Owner.
C. Coordination of Suppliers: The Gate System Supplier shall coordinate with any additional suppliers to ensure that the gate sections and systems are compatible, fit the space available, and operate per the Contract Documents as a system. The Contractor shall be responsible for and coordinate the manufacturing, testing, and delivery of all gate system components.

1.02 TIME OF COMPLETION

A. The Contractor shall complete the work by the required delivery dates indicated in the Milestone and Payment Schedule in Section 01 29 01, Measurement and Payment.

1.03 LIQUIDATED DAMAGES

A. Liquidated damages are set at $1,000.00 for each calendar day or portion thereof the Contractor is in default in completing delivery and acceptance of all equipment at the Project Delivery Location as specified in Section 01 29 01, Measurement and Payment.

B. Liquidated damages are set at $2,000.00 for each calendar day or portion thereof the Contractor is in default in completing all work and obtaining final system Testing and final acceptance of all equipment. The basis for default in completing all Work acceptance shall be 30 days from the date of the Certificate of Installation and Training.

C. The Installation Contractor shall be available during a 30-day period following the issuance of the Certificate of Installation and Training for the purpose of assisting with Final System Testing. If the Installation Contractor is unready or does not comply with the testing assistance requirements, the Contractor shall not be liable for meeting the milestone requirement of Final System Testing nor responsible for resulting Liquidated Damages.

D. In no case will the Liquidated Damages exceed 20 percent of the total Contract amount.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1  GENERAL

1.01  DEFINITION

A.  This section defines the measurement and payment for all items included in the Bid Proposal for the Contract. Payments will be made in accordance with GC-29 of the General Conditions.

1.02  SCOPE

A.  Measurement and payment will be made on the basis of completion of the Work in accordance with the Contract Documents and as stated in the Milestone and Payment Schedule.

<table>
<thead>
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<th>MILESTONE AND PAYMENT SCHEDULE(1)</th>
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<tr>
<td>Work Item Description</td>
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<td>-----------------------------------</td>
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<td>Delivery and Acceptance of all Phase 1 Gate Systems at Project Location</td>
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MILESTONE AND PAYMENT SCHEDULE\(^{(1)}\)

<table>
<thead>
<tr>
<th>Work Item Description</th>
<th>Quantity</th>
<th>Value</th>
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<td>Completion of Final System Testing and Final Acceptance of the Work</td>
<td>1 Lot</td>
<td>5%</td>
<td>900 days</td>
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\(^{(1)}\) Includes all equipment (gates, bladders, appurtenances).
\(^{(2)}\) Contract Calendar Days.

B. Payment for the various items in the Milestone and Payment Schedule will include all compensation to be received by the Contractor for furnishing all materials, tools, equipment, services, transportation, bonds and insurance, taxes, overhead, profit, and incidentals appurtenant to the items of Work being described, and for all testing, as necessary to complete the various items of the Work, all in accordance with the requirements of the Contract Documents.

C. The prices bid in the Bid Proposal will constitute complete payment for the Work as specified in the Contract Documents.

1.03 WORK NOT LISTED IN THE PROPOSAL

A. The General Conditions and items in the Specifications which are not listed in the Bid Proposal are, in general, applicable to more than one listed work item and no separate work item is provided. The Contractor shall include the cost of work not listed but necessary to complete the Work in the listed work items of the Bid Proposal.

B. Work and services of an administrative nature which are not specifically identified in the Bid Proposal are considered incidental to the entire Work of the Contract and no separate or additional payment will be paid for such.

1.04 GATE SYSTEM PACKAGE

A. The gate system package shall include all gates, bladders, and associated installation appurtenances.

B. Measurement for payment for furnishing the Phase 1 and Phase 2 gate system package shall be as indicated in the Milestone and Payment Schedule.

C. Total payment for furnishing each of the two complete gate system packages will be made at each price bid as shown in the Bid Proposal. Such each price bid shall constitute full compensation for the complete two gate systems, appurtenances, and services as specified.
D. The Contractor may at Contractor’s option deliver equipment earlier than indicated in the Measurement and Payment Schedule and receive the payment amount as specified. If the Contractor chooses to deliver prior to the specified timeline, the Contractor must make arrangements and pay for the cost of storage until the equipment is removed and installed by the Installation Contractor.

1.05 DESIGN AND SUBMITTALS

A. Measurement of payment for design and submittal preparation for all gate systems shall be as indicated in the Milestone and Payment Schedule.

B. Total payment for design and submittals will be made as designated in the Measurement and Payment Schedule based upon the total project Bid Price and shall be full compensation for providing all gate system design, preparing all required submittals and resubmittals.

1.06 CONTRACTOR’S SERVICES AND TRAINING

A. Measurement for payment for Contractor’s services and training for all systems shall be as indicated in the Milestone and Payment Schedule.

B. Total payment for Contractor’s services and training will be made as designated in the Measurement and Payment Schedule based upon the total project Bid Price and shall be full compensation for providing the required Contractor’s services at the project site during installation, through completion of final system testing and for conducting all required training of the Owner’s personnel on the operation and maintenance of the gate systems.

1.07 DELIVERY TO THE PROJECT DELIVERY LOCATION

A. Measurement for payment for delivery of all system equipment to the Project Delivery Location shall be as indicated in the Milestone and Payment Schedule.

B. Total payment for delivery to the Project Delivery Location will be made as designated in the Measurement and Payment Schedule based upon the total project Bid Price and shall be full compensation for providing the specified preparation for shipment of all system equipment spares and tools and other equipment and materials, crating or otherwise packaging all the equipment and materials, providing safe delivery by commercial transportation, and oversight of unloading all the equipment and materials at the Project Delivery Location. This also includes participating in a joint inspection at the time of delivery at the Project Delivery Location and for participating in a joint inspection at the Project Delivery Location at the time of loading by the Installation Contractor.
C. Shipment and delivery of any equipment will be coordinated with the Installation Contractor and not be accomplished until the Installation Contractor has acknowledged a readiness to receive. If Contractor delivers the equipment within the delivery milestones shown in Article Scope, the Installation Contractor will be responsible for any jobsite storage / maintenance costs if installation and startup of the equipment is delayed beyond the milestone dates shown.

1.08 OPERATIONS AND MAINTENANCE MANUALS AND SUBMITTALS

A. Measurement for payment for Operations and Maintenance Manuals and submittals shall be as indicated in the Milestone and Payment Schedule.

B. Total payment for Operations and Maintenance Manuals and Submittals will be made as designated in the Measurement and Payment Schedule based upon the total project Bid Price and shall be full compensation for providing all of the required Contractor’s Operations and Maintenance manuals and submittals as specified and providing electronic file copies of same on CD-ROM in Adobe Acrobat (.pdf) format.

1.09 FINAL SYSTEM TESTING AND FINAL ACCEPTANCE OF THE WORK

A. Measurement for payment for final system testing and final acceptance of the Work shall be as indicated in the Milestone and Payment Schedule.

B. Total payment for final system testing and final acceptance of the Work shall be full compensation for providing all of the final system testing, including but not limited to operational testing, start-up testing, and final acceptance of the Work.

C. If the final milestone shown in Article Scope for completion of final system testing and final acceptance of the work is delayed due to the Installation Contract’s nonperformance, final payment to the Contractor shall not exceed 180 days from delivery of equipment to the Project Location.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual Specification sections.

B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.

D. Where two or more standards are specified to establish quality, the product and workmanship shall meet or exceed requirements of most stringent.

E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor’s personnel, Subcontractors, Owner, and Engineer.
1.02 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1. AA Aluminum Association
2. AABC Associated Air Balance Council
3. AAMA American Architectural Manufacturers Association
4. AASHTO American Association of State Highway and Transportation Officials
5. ABMA American Bearing Manufacturers’ Association
6. ACI American Concrete Institute
7. AEIC Association of Edison Illuminating Companies
8. AGA American Gas Association
9. AGMA American Gear Manufacturers’ Association
10. AI Asphalt Institute
11. AISC American Institute of Steel Construction
12. AISI American Iron and Steel Institute
13. AITC American Institute of Timber Construction
14. ALS American Lumber Standards
15. AMCA Air Movement and Control Association
16. ANSI American National Standards Institute
17. APA APA – The Engineered Wood Association
18. API American Petroleum Institute
19. APWA American Public Works Association
20. ARI Air-Conditioning and Refrigeration Institute
21. ASA Acoustical Society of America
22. ASAE American Society of Agricultural Engineers
23. ASCE American Society of Civil Engineers
25. ASME American Society of Mechanical Engineers
26. ASNT American Society for Nondestructive Testing
27. ASSE American Society of Sanitary Engineering
28. ASTM ASTM International
29. AWI Architectural Woodwork Institute
30. AWPA American Wood Preservers’ Association
31. AWPI American Wood Preservers’ Institute
32. AWS American Welding Society
33. AWWA American Water Works Association
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<th></th>
<th>Abbreviation</th>
<th>Full Name</th>
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<td>BHMA</td>
<td>Builders Hardware Manufacturers’ Association</td>
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<td>35.</td>
<td>CBM</td>
<td>Certified Ballast Manufacturer</td>
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<td>36.</td>
<td>CDA</td>
<td>Copper Development Association</td>
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<tr>
<td>37.</td>
<td>CGA</td>
<td>Compressed Gas Association</td>
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<td>38.</td>
<td>CISPI</td>
<td>Cast Iron Soil Pipe Institute</td>
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<td>39.</td>
<td>CMAA</td>
<td>Crane Manufacturers’ Association of America</td>
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<td>40.</td>
<td>CRSI</td>
<td>Concrete Reinforcing Steel Institute</td>
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<tr>
<td>41.</td>
<td>CS</td>
<td>Commercial Standard</td>
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<td>42.</td>
<td>CSA</td>
<td>Canadian Standards Association</td>
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<td>43.</td>
<td>CSI</td>
<td>Construction Specifications Institute</td>
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<td>44.</td>
<td>DIN</td>
<td>Deutsches Institut für Normung e.V.</td>
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<td>45.</td>
<td>DIPRA</td>
<td>Ductile Iron Pipe Research Association</td>
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<td>46.</td>
<td>EIA</td>
<td>Electronic Industries Alliance</td>
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<td>47.</td>
<td>EJCDC</td>
<td>Engineers Joint Contract Documents’ Committee</td>
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<td>48.</td>
<td>ETL</td>
<td>Electrical Test Laboratories</td>
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<td>49.</td>
<td>FAA</td>
<td>Federal Aviation Administration</td>
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<td>50.</td>
<td>FCC</td>
<td>Federal Communications Commission</td>
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<td>51.</td>
<td>FDA</td>
<td>Food and Drug Administration</td>
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<td>52.</td>
<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
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<td>53.</td>
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<td>Federal Information Processing Standards</td>
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<td>54.</td>
<td>FM</td>
<td>Factory Mutual</td>
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<td>56.</td>
<td>FS</td>
<td>Federal Specifications and Standards (Technical Specifications)</td>
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<td>57.</td>
<td>GA</td>
<td>Gypsum Association</td>
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<td>58.</td>
<td>GANA</td>
<td>Glass Association of North America</td>
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<td>59.</td>
<td>HI</td>
<td>Hydraulic Institute</td>
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<td>60.</td>
<td>HMI</td>
<td>Hoist Manufacturers’ Institute</td>
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<td>61.</td>
<td>IBC</td>
<td>International Building Code</td>
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<tr>
<td>62.</td>
<td>ICBO</td>
<td>International Conference of Building Officials</td>
</tr>
<tr>
<td>63.</td>
<td>ICC</td>
<td>International Code Council</td>
</tr>
<tr>
<td>64.</td>
<td>ICEA</td>
<td>Insulated Cable Engineers’ Association</td>
</tr>
<tr>
<td>65.</td>
<td>IFC</td>
<td>International Fire Code</td>
</tr>
<tr>
<td>66.</td>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers, Inc.</td>
</tr>
<tr>
<td>67.</td>
<td>IESNA</td>
<td>Illuminating Engineering Society of North America</td>
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<tr>
<td>68.</td>
<td>IFI</td>
<td>Industrial Fasteners Institute</td>
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<tr>
<td>69.</td>
<td>IGMA</td>
<td>Insulating Glass Manufacturer’s Alliance</td>
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<tr>
<td>70.</td>
<td>IMC</td>
<td>International Mechanical Code</td>
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<tr>
<td>71.</td>
<td>INDA</td>
<td>Association of the Nonwoven Fabrics Industry</td>
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<tr>
<td>72.</td>
<td>IPC</td>
<td>International Plumbing Code</td>
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<tr>
<td>No.</td>
<td>Acronym</td>
<td>Full Name</td>
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<tr>
<td>73.</td>
<td>ISA</td>
<td>ISA Instrumentation, Systems, and Automation Society</td>
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<td>74.</td>
<td>ISO</td>
<td>ISO International Organization for Standardization</td>
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<td>75.</td>
<td>ITL</td>
<td>ITL Independent Testing Laboratory</td>
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<tr>
<td>76.</td>
<td>JIC</td>
<td>JIC Joint Industry Conferences of Hydraulic Manufacturers</td>
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<td>77.</td>
<td>MIA</td>
<td>MIA Marble Institute of America</td>
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<td>MIL</td>
<td>MIL Military Specifications</td>
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<td>79.</td>
<td>MMA</td>
<td>MMA Monorail Manufacturers’ Association</td>
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<td>80.</td>
<td>NAAMM</td>
<td>NAAMM National Association of Architectural Metal Manufacturers</td>
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<td>81.</td>
<td>NACE</td>
<td>NACE NACE International</td>
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<tr>
<td>82.</td>
<td>NBGQA</td>
<td>NBGQA National Building Granite Quarries Association</td>
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<td>83.</td>
<td>NEBB</td>
<td>NEBB National Environmental Balancing Bureau</td>
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<td>NESC National Electrical Safety Code</td>
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<td>88.</td>
<td>NETA</td>
<td>NETA InterNational Electrical Testing Association</td>
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<td>89.</td>
<td>NFPA</td>
<td>NFPA National Fire Protection Association</td>
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<td>90.</td>
<td>NHLA</td>
<td>NHLA National Hardwood Lumber Association</td>
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<td>91.</td>
<td>NICET</td>
<td>NICET National Institute for Certification in Engineering Technologies</td>
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<td>92.</td>
<td>NIST</td>
<td>NIST National Institute of Standards and Technology</td>
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<td>93.</td>
<td>NRCA</td>
<td>NRCA National Roofing Contractors Association</td>
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<tr>
<td>94.</td>
<td>NRTL</td>
<td>NRTL Nationally Recognized Testing Laboratories</td>
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<td>95.</td>
<td>NSF</td>
<td>NSF NSF International</td>
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<tr>
<td>96.</td>
<td>NSPE</td>
<td>NSPE National Society of Professional Engineers</td>
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<td>97.</td>
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<td>NTMA National Terrazzo and Mosaic Association</td>
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<td>98.</td>
<td>NWWDA</td>
<td>NWWDA National Wood Window and Door Association</td>
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<tr>
<td>99.</td>
<td>OSHA</td>
<td>OSHA Occupational Safety and Health Act (both Federal and State)</td>
</tr>
<tr>
<td>100.</td>
<td>PCI</td>
<td>PCI Precast/Prestressed Concrete Institute</td>
</tr>
<tr>
<td>101.</td>
<td>PEI</td>
<td>PEI Porcelain Enamel Institute</td>
</tr>
<tr>
<td>102.</td>
<td>PPI</td>
<td>PPI Plastic Pipe Institute</td>
</tr>
<tr>
<td>103.</td>
<td>PS</td>
<td>PS Product Standards Section-U.S. Department of Commerce</td>
</tr>
<tr>
<td>104.</td>
<td>RMA</td>
<td>RMA Rubber Manufacturers’ Association</td>
</tr>
<tr>
<td>105.</td>
<td>RUS</td>
<td>RUS Rural Utilities Service</td>
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<tr>
<td>106.</td>
<td>SAE</td>
<td>SAE Society of Automotive Engineers</td>
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<tr>
<td>107.</td>
<td>SDI</td>
<td>SDI Steel Deck Institute</td>
</tr>
<tr>
<td>108.</td>
<td>SDI</td>
<td>SDI Steel Door Institute</td>
</tr>
<tr>
<td>109.</td>
<td>SJI</td>
<td>SJI Steel Joist Institute</td>
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</tbody>
</table>
110. SMACNA   Sheet Metal and Air Conditioning Contractors National Association
111. SPI      Society of the Plastics Industry
112. SSPC     The Society for Protective Coatings
113. SWI      Steel Window Institute
114. TEMA     Tubular Exchanger Manufacturers’ Association
115. TCA      Tile Council of North America
116. TIA      Telecommunications Industry Association
117. UBC      Uniform Building Code
118. UFC      Uniform Fire Code
119. UL       Underwriters Laboratories Inc.
120. UMC      Uniform Mechanical Code
121. USBR     U.S. Bureau of Reclamation
122. VFD      Variable Frequency Drive
123. WCLIB    West Coast Lumber Inspection Bureau
124. WIC      Wood Institute of California
125. WWPA     Western Wood Products Association

PART 2  PRODUCTS (NOT USED)

PART 3  EXECUTION (NOT USED)

END OF SECTION
SECTION 01 43 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section covers the requirements for project meetings and supplements the meeting requirements of the General Conditions.

B. Project meetings shall be attended by the Engineer and the Gate System Supplier.

C. The Engineer will record minutes of each meeting and will furnish copies to the Gate System Supplier within 5 working days thereafter. If the Gate System Supplier does not submit written objection to the contents of such minutes within 7 days after presentation, it shall be understood and agreed that the Gate System Supplier accepts the minutes as a true and complete record of the meeting.

D. The dates, times, and locations for the various meetings shall be agreed upon and recorded at the preprocurement conference. Thereafter, changes to the schedule shall be by agreement between the Engineer and Gate System Supplier with appropriate written notice to all parties involved. Progress meetings will be held at least every other month and will include the Contractor’s project manager. These progress meetings can be conducted via teleconference.

PART 2 MATERIALS (NOT USED)

PART 3 EXECUTION

3.01 PREPROCUREMENT CONFERENCE

A. After Notice to Award, a preprocurement conference will be held at the location, date, and time designated by the Engineer. The meeting may be attended by other contractors working for the Authority on related or nearby projects, by the representatives of regulatory agencies having jurisdiction over the Work, if required, and by such other persons the Engineer may designate.
B. In general, the matters to be discussed or resolved and the instructions and information to be furnished to or given by the Contractor at the preprocurement conference include:

1. Project meeting schedule.
2. Manufacturing plans, progress schedule, and Milestone and Payment Schedule.
3. Communication procedures between the parties.
4. The names, titles, addresses, and telephone numbers of all persons and consultants authorized by the Engineer to act on their behalf.
5. The names and titles of all persons authorized by the Supplier to represent and execute documents for him, with samples of all authorized signatures.
6. Forms and procedures for submittals.
7. Change Order forms and procedures.
8. Payment application forms (invoices) and procedures and the necessary documentation and attachments to accompany the applications.
10. Insurance requirements.
11. Delivery, receipt, inspection, and storage at the Project Delivery Location.
12. Coordination with Installation Contractor.
13. Other administrative and general matters as needed.
14. Coordination with Subsuppliers.

3.02 PROGRESS MEETINGS

A. Progress meetings shall be held in accordance with agreed schedule as stated in Article Description as hereinbefore. All matters bearing on the progress and performance of the Work since the preceding progress meeting shall be discussed and resolved, including without limitation any previously unresolved matters and problems, difficulties, or delays which may be encountered.

3.03 SPECIAL MEETINGS

A. Upon appropriate notice to the other parties, special meetings may be called by the Engineer and attended by the Gate System Supplier.

B. To expedite the equipment information and Shop Drawing submittal process, a presubmittal meeting shall be held. The Engineer will schedule this required special meeting during the preprocurement conference. See Section 01 60 01, Contractor Submittals, for details of this required meeting.
C. At the date and time agreed to by the Engineer and the Gate System Supplier, a formal submittal meeting will be held. The purpose of this required meeting is to have the Gate System Supplier present entire Work submittal to the Engineer in a continuous, multi-day (if necessary) review session. The Gate System Supplier shall provide the submittal review package to the Engineer no later than 21 calendar days prior to the scheduled formal review meeting date. The objective of this meeting will be an approvable submittal that allows the Gate System Supplier to proceed. Contractor shall submit additional information or clarified information, as agreed at the meeting, within 15 calendar days.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes the requirements for preparing and submitting submittals. This section is further supplemented by the requirements in each of the equipment specification sections. Submittals include Shop Drawings, Progress Schedules, Certified Test Results, Spare Part List, Operations and Maintenance Manuals, and other items as required by the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01 64 35, Contractor’s Field Services.

B. Section 01 78 23, Operation and Maintenance Data.

C. Section 35 20 25, Pneumatic Gates.

D. Section 35 20 30, Waveshapers and Gates.

E. Section 40 99 90, Package Control Systems.

1.03 GENERAL REQUIREMENTS

A. Unless otherwise noted, provide six copies of all submittals. All submittals and samples shall become the property of the Owner.

B. All submittals shall clearly identify the item(s) by Specification section number and include references to applicable standards and codes.

C. Submittals shall be complete in all respects. If the submittals show any deviations from the requirements of the Contract Documents, the deviations and the reasons therefore shall be set forth in the Letter of Transmittal.

D. By submitting the submittals, the Gate System Supplier represents that the material, equipment, and other work, shown thereon conforms to the Contract Documents, except for the deviations set forth in the Letter of Transmittal.
E. For any submittal requiring more than two submittals (original submittal plus one resubmittal) to obtain the approval of the Engineer, the Owner shall withhold monies from each progress payment to cover all costs incurred by the Owner to review and process any resubmittals subsequent to the second submittal.

F. Gate System Supplier shall have reviewed and coordinated each Shop Drawing or Submittal with other Shop Drawings and Submittals and will indicate on each that the Contractor has reviewed, coordinated, and approved that submission. The Gate System Supplier will give specific indication of and variations from the requirements of the Contract Documents at the time of submission. Each submission will be identified clearly as to material, supplier, pertinent data such as catalog numbers, and the use for which intended and otherwise as Engineer may require.

1.04 SHOP DRAWINGS

A. The term “Shop Drawings” as used herein shall be understood to include Detail Design Calculations, Shop Drawings, Test Plans and Procedures, Fabrication and Installation Drawings, Erection Drawings, lists, graphs, operating instructions, Catalog Sheets, Data Sheets, and similar items.

B. Review, stamp with approval, and submit for review by the Engineer, Shop Drawing submittals as called for in the Contract Documents, or as requested by the Engineer. Submit Shop Drawings in electronic PDF format to the Engineer and transmit with a letter of transmittal listing the Shop Drawing submitted. Indicate on each Shop Drawing submittal the name of the project, the names of the manufacturers and suppliers, if any. Promptly submit Shop Drawing submittals in an orderly, consecutively numbered sequence, so as to cause no delay in the prosecution of the work.

C. Except for the main submittal package, and the presubmittal and formal submittal meetings, within 15 calendar days after receipt of said additional submittals, the Engineer will return the submittal to the Contractor with comments noted thereon. If so noted by the Engineer, correct the submittal and resubmit in the same manner as specified for the original submittal. The letter of transmittal accompanying the resubmitted submittal shall make specific reference to any revisions other than the specific corrections requested by the Engineer on the previous submittal.

D. If a submittal is returned to the Contractor marked RESUBMITTAL IS NOT REQUIRED, CORRECTIONS, IF ANY, ARE NOTED, formal revision and resubmission of said submittal will not be required.
E. Fabrication of an item shall commence only after the Engineer has reviewed the pertinent submittals and returned copies to the Contractor marked RESUBMITTAL IS NOT REQUIRED. CORRECTIONS, IF ANY, ARE NOTED. Correction indicated on submittals shall be considered revisions necessary to meet the requirements of the Contract Documents.

F. As soon as practicable and within 30 calendar days after approval by the Engineer of any Shop, Assembly, or Layout Drawing, forward to the Engineer one clear, legible, transparent mylar and an electronic file of the approved drawing and submittal information.

1.05 SPARE PARTS LIST FOR PERMANENT EQUIPMENT

A. Furnish to the Engineer a list of spare parts information for all mechanical and electrical equipment specified in the Contract Documents. Limit the spare parts list to those spare parts which each manufacturer recommends be maintained by the City of Tulsa in inventory. Include on the Spare Parts List the current list price of each spare part. Indicate the name, address, telephone and fax number of the nearest outlet of each manufacturer or supplier of spare parts to facilitate the City of Tulsa in ordering. Cross-reference all spare parts to the equipment numbers designated in the Contract Documents.

PART 2 MATERIALS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01 61 00
MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes administrative and procedural requirements governing the Contractor’s selection of products for use in the work. This section also includes requirements for equipment delivery from factory to the Project Delivery Location, equipment storage, and equipment transfer from storage to the Project Site.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01 60 01, Contractor Submittals.

1.03 DEFINITIONS

A. Definitions used in this section are not intended to change the meaning of other terms used in the Contract Documents, such as “specialties,” “systems,” “structure,” “finishes,” “accessories,” and similar terms. Such terms are self-explanatory and have well recognized meanings in the construction industry.

1. Products are items purchased for incorporation in the work, whether purchased for the project or taken from previously purchased stock. The term “product” includes the terms “material,” “equipment,” “system,” and terms of similar intent.

a. Named Products are items identified by the manufacturer’s product name, including make or model number of other designation, shown or listed in the manufacturer’s published product literature that is current as of the date of the Contract Documents.

b. Foreign Products as distinguished from “domestic products,” are items substantially manufactured (50 percent or more of value) outside the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50 percent) by persons who are not citizens of, nor living within, the United States and its possessions are also considered to be foreign products.
2. Materials are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the work.

3. Equipment is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.04 PREPARATION FOR SHIPMENT

A. Factory assemble products to the greatest extent possible. 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, 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 Contract Documents.
   2. Properly package to avoid damage, in original cartons insofar as possible. Replace damaged or otherwise inoperable parts.
   3. Deliver materials to the Project Delivery Location.
   4. 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) Project name.

D. Protect equipment from exposure to the elements and keep thoroughly dry and dust-free at all times during shipment and storage. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.
E. Factory Test Results: Results must be reviewed and accepted in writing by the Engineer prior to product shipment as required per the Contract Documents.

F. Provide the Engineer a minimum 7-day advance written notice prior to the dates of all shipments from Contractor.

1.05 PROJECT DELIVERY LOCATION

A. All equipment shall be delivered to the Zink Dam Project staging area, west bank of the Arkansas River on 23rd Street, Tulsa, Oklahoma and will be off-loaded by the Installation Contractor.

B. Coordinate delivery and unloading of all equipment at the Project Delivery Location with the Installation Contractor based upon the Milestone and Payment Schedule in Section 01 29 01, Measurement and Payment.

C. Shipment of all equipment by the Contractor shall be directly to the Project Delivery Location. Delivery or storage at any other location is not allowed.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment and materials in accordance with the Milestone and Payment Schedule. Deliver anchor bolts and templates with sufficient time to permit transfer to Installation Contractor in a timely manner.

B. Deliver, store, and handle products according to each Contractor’s specific recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.

1. Schedule and plan deliveries to minimize the total number of shipments.
2. Coordinate delivery with the Engineer and Installation Contractor for joint inspection of each shipment.
3. Deliver products in an undamaged condition in the manufacturer’s original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

PART 2 PRODUCTS

2.01 PRODUCT SELECTION

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, new at the time of installation.
PART 3 EXECUTION

3.01 JOINT INSPECTION

A. Each shipment received at the warehouse shall be jointly inspected, on the delivery vehicle, by the Contractor, the Engineer, and the Installation Contractor before it is unloaded. The inspection will ensure that all equipment is delivered in compliance with these Contract Documents and to ensure that products are undamaged and properly protected. A written field inspection report, signed by all parties, shall be provided by the Contractor verifying the results of the joint inspection and approval to unload the equipment. The field inspection report shall use the approved submittals as the basis for inspecting the equipment and materials.

B. Any damaged equipment not accepted by the Engineer shall not be unloaded and shall be returned to the Contractor. Contractor shall be solely responsible for repair or replacement of any damaged equipment. Contractor shall submit to the Engineer for approval a written plan for repair or replacement of any damaged equipment.

C. As the equipment is unloaded or within 2 weeks after each shipment is unloaded, the Engineer, the Contractor, and the Installation Contractor shall inspect the equipment for proper storage and environmental procedures.

D. Equipment shall not be moved without written notification to the Engineer.

3.02 TRANSFER OF EQUIPMENT

A. The transfer of equipment from Contractor to Installation Contractor shall be at the Project Delivery Location at times coordinated with the Installation Contractor.

END OF SECTION
PART 1  GENERAL

1.01  SUBMITTALS

A. Preliminary Training Plan: Submit 90 days prior to delivery of equipment.
B. Training Schedule: Submit 90 days prior to delivery of equipment.
C. Proposed Training Material and Detailed Outline of Each Lesson: Submit 45 days prior to scheduled training.
D. Contractor’s Certificate of Proper Installation: One certificate per piece of equipment furnished, as further required in this section.
E. Contractor Certified Field Test Results: One certified set of field test results per piece of equipment furnished, as further required in this section.

1.02  FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Coordinate the schedule of Contractor’s services (assistance with installation, testing, start-up, and training) with the Installation Contractor to avoid conflicting with other onsite construction, testing, or other manufacturer’s onsite services.
B. Contractor’s services shall include as a minimum:
   1. Verify foundation size and foundation anchor bolt layout.
   2. Supervise equipment installation.
   3. Supervise alignment of equipment.
   4. Verify installation of field electrical conduits and instrumentation and control terminations from the pump and motor to the motor starters.
   5. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by Contractor and necessary to furnish written Contractor’s Certificate of Proper Installation.
   6. Equipment testing as specified in the Contract Documents.
7. Minimum site visit requirements for startup and field adjustment by the Contractor are specified for each of the major pumping system components in under Article Pump Inspection Startup and Field Adjustment, Article Motor Inspection Startup and Field Adjustment. This shall not limit whatever time onsite is required for the Contract to successfully complete all startup and acceptance requirements.

8. Assist during final system testing and startup, and until final written acceptance of the work.

9. Training of Owner personnel in the operation and maintenance of respective product as required.

10. Completion of Contractor’s Certificate of Proper Installation and Certified Field Test Results.

11. The following table summarizes all of the Contract requirements to be provided onsite for installation, startup, testing, and training:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Contractor Days/Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verify Fdn Size/Anchor Bolt Layout</td>
<td>1/1</td>
</tr>
<tr>
<td>Supervise Equipment Delivery</td>
<td>1/1</td>
</tr>
<tr>
<td>Set Equipment</td>
<td>10/1</td>
</tr>
<tr>
<td>Supervise Alignment</td>
<td>2/1</td>
</tr>
<tr>
<td>Adjustment</td>
<td>2/1</td>
</tr>
<tr>
<td>Startup Assistance &amp; Field Testing</td>
<td>6/1</td>
</tr>
<tr>
<td>Owner Training</td>
<td>2/1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>24/7</strong></td>
</tr>
</tbody>
</table>

1.03 PUMP INSPECTION STARTUP AND FIELD ADJUSTMENT

A. Contractor’s representative shall witness installation of the equipment and certify in writing the following:

1. Equipment, wiring, and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
2. Inspected, checked, and performed field adjustments to ensure that the equipment installation and operation comply with requirements.
3. Complete the Contractor’s Certificate of Proper Installation.

B. Contractor’s representative shall be at site a minimum of 14 working days to complete this task, and longer if necessary to coordinate with the other equipment furnished under this Contract.
1.04 MOTOR INSPECTION STARTUP AND FIELD ADJUSTMENT

A. Contractor’s representative shall witness installation of the equipment and certify in writing the following:

1. Equipment, wiring, and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
2. Inspected, checked, and performed field adjustments to ensure that the equipment installation and operation comply with requirements.
3. Complete the Contractor’s Certificate of Proper Installation.

B. Contractor representative shall be at site a minimum of 1 working day to complete this task, and longer if necessary to coordinate with the other equipment furnished under this Contract.

1.05 PUMP FIELD TESTING

A. After Contractor’s Certificate of Proper Installation for each piece of equipment has been duly executed and issued, each pump system shall be tested after installation to demonstrate:

1. Satisfactory operation without excessive noise and vibration.
2. No overheating of bearings.
3. Comply with the indicated head, flow, and efficiency at design point.

B. The following field testing shall be conducted:

1. Startup, check, and operate each pump system. Vibration shall be within the indicated amplitude limits defined by the Engineer.
2. Obtain concurrent readings of motor voltage, amperage, kilowatts, (for each phase), pump suction head, and pump discharge head for at least four pumping conditions on the pump curve.
3. Determine bearing temperatures by contact type thermometer. A run time until bearing temperatures have stabilized, shall precede this test, unless insufficient liquid volume is available.

C. The Engineer and the Contractor shall witness all testing.

D. The Contractor shall arrange for at least two site visits by the manufacturer’s specialist during testing of the equipment covered by torsional and vibration analysis submittals to measure the amount of vibration and prepare written recommendations for keeping the vibration within acceptance limits. Include these dates and activities in the progress schedule submittal. If vibration readings exceed the specified or the applicable referenced standard vibration
limits for the type of equipment, the Contractor shall make necessary corrections for the equipment to meet the acceptance criteria.

E. In the event any pumping system fails to meet the indicated requirements, the pump shall be modified or replaced and retested, at no additional cost to the Owner, in accordance with the test procedure indicated above until it satisfies all requirements.

F. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. The Certified Field Test Results shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

G. Contractor’s representative shall be at site a minimum of 6 working days to complete this task, and longer if necessary to coordinate with the other equipment furnished under this Contract.

1.06 MOTOR FIELD TESTING

A. The Contractor shall perform the following field tests, after the Contractor’s Certificate of Proper Installation for each motor has been duly executed and issued.

1. Inspect each motor installation for any deviation from rated voltage, phase or frequency, or improper installation.
2. Visually check for proper phase and ground connections. Verify that multi-voltage motors are connected for proper voltage.
3. Check winding and bearing temperature detectors and space heaters for functional operation.
4. Test for proper rotation prior to connection to the driven equipment.
5. Test insulation (hi-pot) of all motors in accordance with NEMA MG 1. Test voltage shall be 1,000V ac plus twice the rated voltage of the motor.
6. The motor shall be checked for proper temperatures and vibratory behavior following no less than four hours at full operating load and speed.
7. The motor shall be tested to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings. The vibration limits used for shop testing with a temporary machinery support shall also be applicable to the field testing condition with a proper rigid support structure below the machinery.

B. The Engineer, the Contractor, and the Installation Contractor shall witness all testing.
C. Contractor representative shall be at site a minimum of 2 working days to complete this task, and longer if necessary to coordinate with the other equipment furnished under this Contract.

D. The Engineer and Contractor shall witness all testing.

E. Contractor representative shall be at site a minimum of six working days to complete this task, and longer if necessary to coordinate with the other equipment furnished under this Contract.

1.07 TRAINING

A. Preliminary Training Plan: Submit for each proposed course:

1. Title and objectives.
2. Training schedule.
3. Prerequisite training and experience of attendees.
4. Recommended types of attendees (e.g. operators, maintenance, engineers).
5. Course description and outline of course content.
6. Duration.
7. Format (e.g. lecture, self-study, demonstration, hands-on).
8. Instruction materials and equipment requirements.

B. Final Training Plan:

1. Submit the following after training coordination meeting:
   a. Updated versions of course descriptions, including Owner’s comments from the Preliminary Training Plan review.
   b. Who will attend each course.
   c. Detailed course schedule for each day showing time allocated to each topic.
   d. Resumes of instructors providing the training.
   e. An electronic copy of all final training documents shall be submitted by the Contractor, in Microsoft Word, Excel, or Adobe (.pdf) format on CD-Rom disk.

1.08 INSTRUCTION OF OWNER’S PERSONNEL

A. Qualified training representatives, approved in writing by the Engineer, shall visit the site to instruct the Owner’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
B. Training shall be scheduled three weeks in advance of the scheduled session, at a date mutually agreeable by the Owner and Contractor.

C. Proposed training material and a detailed outline of each lesson shall be submitted for review. Review comments from the Owner shall be incorporated into the material prior to the training sessions.

D. The training materials shall remain with the trainees after the session.

E. Owner’s personnel shall be trained in the operation and maintenance of the pumps for 2 working days.

F. Owner’s personnel shall be trained in the operation and maintenance of the motors for 1 working day.

G. Owner’s personnel shall be trained in the operation and maintenance of the entire pump systems for 3 additional working days.

1.09 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification:

1. Contractor’s Certificate of Proper Installation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
CONTRACTOR’S CERTIFICATE OF PROPER INSTALLATION

Project: Zink Dam Improvements Project

System No: ____________________________

PROJECT NO: __________________________

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer’s recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested and meets or exceeds specified performance requirements.

Note: Attach any performance test documentation from Contractor.

Comments: __________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

I, the undersigned Contractor’s Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the contractor to inspect, approve, and operate equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the Contractor is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: ________________________________, 20___
PART 1  GENERAL

1.01  DESCRIPTION

A.  Submit six copies of all manufacturer’s operation and maintenance data, and other data pertinent to equipment supplied for the work, as provided herein. The requirements of this section are in addition to the individual operation and maintenance manuals submitted with each final shop drawing submittal. Compile and organize the Manufacturer’s operation and maintenance materials in three-ring binders with divider tabs and appropriate labeling. Include a table of contents for each binder, and list each type of equipment with the name of the Manufacturer. Provide electronic files of all operation and maintenance manuals in Adobe Acrobat (.pdf) format on CD-ROM disk.

1.02  OPERATION AND MAINTENANCE DATA

A.  Prepare and submit the operation and maintenance data to include, but not be limited to, the following items:

1.  List of equipment furnished for project with name, address, telephone, and fax number of manufacturer and vendor.
2.  List of model and serial numbers of equipment furnished.
3.  A copy of shop drawings for mechanical, electrical, and instrument equipment in final form per Section 01 60 01, Contractor Submittals.
4.  Manufacturer’s operation and maintenance instructions and parts lists.
5.  List of seals, and other expendable equipment and devices. Specify size, type, and ordering description. List name, address, and telephone and fax number of vendor.
6.  A troubleshooting guide which indicates common problems or malfunction, and the steps necessary to identify and correct the problem.
7.  Provide maintenance (required and optional) schedules for gate and bladder systems.
8.  Provide list and description of any necessary parts, lubricants, or equipment needed to perform each scheduled maintenance requirement.

1.03  EQUIPMENT DATA SHEETS

A.  Provide equipment data sheets at the beginning of each equipment section of the operation and maintenance manuals, summarizing the equipment manufacturer’s maintenance instructions and recommendations. A blank data sheet and a sample data sheet are attached.
1.04 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification:

1. Preventive Maintenance and Operating Requirement Sheet.

PART 2 MATERIALS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
## PREVENTIVE MAINTENANCE AND OPERATING REQUIREMENT SHEET

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### EQUIPMENT DESCRIPTION

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<td>Mfr.:</td>
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<td>Vendor Rep.:</td>
<td>Voltage:</td>
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<tr>
<td>Phone:</td>
<td>Amps:</td>
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<tr>
<td>Maintenance work to be Done:</td>
<td>Frequency*</td>
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</table>

### OPERATING REQUIREMENTS AND REFERENCE

* D - daily, W - weekly, B - biweekly, M - monthly, Q - quarterly, S - semiannually, A - annually
SECTION 01 88 15
ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the ICC 2015 International Building Code (IBC), for seismic, wind, gravity, soil, and operational loads.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:


1.03 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

B. Designated Seismic System: Architectural, electrical, and mechanical system or their components for which component importance factor is greater than 1.0.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Oklahoma.
2. Design anchorage into concrete including embedment in accordance with ACI 318-14; Chapter 17 (or other industry standard approved by Engineer), and Project Specifications.
   a. Unless otherwise noted, design for cracked concrete condition.
3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
6. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
7. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
8. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
9. Design anchorage and bracing for:
   a. Equipment and components that weigh more than 400 pounds and have center of mass located 4 feet or less above adjacent finished floor.
   b. Equipment weighing more than 75 pounds that has center of mass located more than 4 feet above adjacent finished floor.
   c. Distribution systems that weigh more than 5 pounds per foot that are mounted more than 5 feet above adjacent finished floor.
10. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for
components such as roofing and flashing to verify attachments meet Project-specific design criteria.

3. Operational:
   a. For loading supplied by equipment manufacturer for IBC required load cases.
   b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
   c. Locate braces to minimize vibration to or movement of structure.

4. Seismic:
   a. In accordance with 2015 IBC, Section 1613, and Chapter 13 of ASCE 7.
   b. Design anchorage and bracing for design criteria listed on General Structural Notes on Drawings.
   c. Anchorage and bracing Risk Category shall be same as that for supporting structure as shown on Drawings.
   d. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2 as applicable for Project Seismic Design Category.

C. Seismic Design Requirements:

1. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component Ip = 1.5.
2. Fire protection sprinkler systems designed and constructed in accordance with NFPA 13 shall be considered to meet requirements of Chapter 13 of ASCE 7.
3. Provide support drawings and calculations for electrical distribution components if any of the following conditions apply:
   a. Conduit diameter is greater than 2.5-inch trade size.
   b. Total weight of bus duct, cable tray, or conduit supported by trapeze assemblies exceeds 10 pounds per foot.
4. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new architectural, mechanical and electrical components, systems, or equipment.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
b. Manufacturers’ engineered seismic and non-seismic hardware product data.

c. Attachment assemblies’ drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.

d. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer’s specific criteria used for design; sealed by a civil or structural engineer registered in the State of Oklahoma.

2. Manufacturer’s hardware installation requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and construct attachments and supports transferring seismic and non-seismic loads to structure of materials and products suitable for application and in accordance with design criteria shown on Drawings and nationally recognized standards.

B. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

C. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

D. Do not use powder-actuated fasteners or sleeve anchors for seismic attachments and anchorage where resistance to tension loads is required. Do not use expansion anchors for nonvibration isolated mechanical equipment rated over 10 hp.
PART 3 EXECUTION

3.01 GENERAL

A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.

B. Design, provide, and install overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.

C. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

D. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

1. Piping and ductwork suspended more than 12 inches below supporting structure shall be braced for seismic effects to avoid significant bending of hangers and their attachments, unless high- or limited-deformability piping is used per ASCE 7, Section 13.6.8 or HVAC ducts have a cross-sectional area of less than 6 square feet or weigh 17 pounds per foot or less.

E. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Engineer.

F. Do not attach architectural, mechanical, or electrical components to more than one element of a building structure at a single restraint location where such elements may respond differently during a seismic event. Do not make such attachments across building expansion and contraction joints.

3.02 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer and AHJ.

B. Notify Engineer upon completion of installation of seismic restraints.

END OF SECTION
SECTION 35 20 25

PNEUMATIC GATE SYSTEM

PART 1  GENERAL

1.01  DESCRIPTION

   A. This Section covers the Work and materials necessary for the design, fabrication, delivery, installation, startup, and operation training for the pneumatic gate system, including compressed air system, gate sections, air bladders and appurtenances as identified and dimensioned on Drawings, instruments, control panel, control hardware, control system software, and control applications software. The specific design and fabrication details for all materials and equipment shall be the responsibility of the Pneumatic Gate System Supplier. Shop Drawings shall be submitted as specified herein and in Section 01 60 01, Contractor Submittals.

1.02  SCOPE OF SUPPLY

   A. Items to be supplied by the Gate System Supplier include (but are not limited to) the following:

   1. Type 316 stainless steel gate panels.
   2. Polyester reinforced air bladders for gates and associated piping components to attach to main air piping that is provided by the Installation Contractor.
   3. Reinforced rubber interpanel seals and Type 316 stainless steel attachment hardware.
   4. Gate clamping hardware, anchor bolts, nuts, and washers. Materials shall be Type 316 stainless steel, duplex alloy 2205, or alloy CD4-MCu as required for fabrication type and strength.
   5. Reinforced rubber restraining straps and Type 316 stainless steel attachment hardware.
   6. UHMW polyethylene knappe breakers and Type 316 stainless steel attachment hardware.
   7. UHMW abutment plates with Type 316 stainless steel anchor bolts, nuts, and washers.
   8. Anchor bolt setting template.
   9. Installation supervision, training, and functional and performance testing support by gate system supplier’s technician.
   10. Delivery FOB project delivery location, with freight prepaid.
   11. Crest Gate Valve Panel.
   12. Gate control cabinets, per Article Instrumentation and Control.
13. Field instruments and cable per Article Instrumentation and Control, Paragraph Field Instrumentation, herein.
14. Compressed air supply system per Article Compressed Air Supply System.
15. Two-year written warranty on pneumatic crest gate system.

B. Items to be supplied and Work to be performed by the Installation Contractor include (but are not limited to) the following:

1. Verify conditions.
2. Provide concrete work as shown on Drawings.
3. Provide and install air supply pipe. This includes, but is not limited to:
   a. AHP piping in Compressor and Control Building.
   b. Encased AHP lines from Compressor and Control Building to crest gates.
   c. AHP lines in dam structure which terminate as specified by the gate manufacturer for connection to the air bladders.
   d. AHP vent lines and purge valves as shown on Drawings.
4. Design and install air supply pipe support systems in accordance with Section 01 88 16, Anchorage and Bracing.
5. Install gate anchor bolts.
6. Install the pneumatic gate system, including air bladders, gate panels, and other related components.
7. Install abutment plates, and any associated vents, including grouting.
8. Provide and install all electrical conduit and wiring, junction boxes, and fiber optic cables as shown on Drawings.
9. Provide and install all control conduit, cable, and junction boxes as shown on Drawings.
10. Install all pneumatic crest gate control equipment.
11. Install all compressed air supply equipment in accordance with equipment manufacturer’s requirements and as shown on Drawings.
12. Commission, and test all gates in conjunction with the Pneumatic Gate System Supplier’s technical support staff.
13. Provide Neversieze or other approved lubricating compound for all anchor bolts and fasteners.
14. Provide 100 percent silicone caulk for all interpanel seals.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Outdoor Temperature: Maximum 110 degrees F; minimum -10 degrees F.

B. Humidity: Maximum 100 percent relative humidity; minimum 30 percent relative humidity.
C. Atmosphere: If located outdoors, equipment is subject to rain, ice, wind, and snow.


2. Mean Annual Dissolved Solids Load: 7.32 tons per year.
3. Mean Annual Dissolved Solids Concentration: 1,101 mg/L.
4. Chloride Concentration: Greater than 250 mg/L more than 50 percent of the time.

1.04 SUBMITTALS

A. Action Submittals:

1. Complete catalog information, descriptive literature, specifications, and identification of materials of construction for all equipment items provided.
2. Detailed structural, mechanical, electrical, and instrument and control drawings showing the equipment dimensions, size, tolerances, locations of connection, and weights of associated equipment.
3. Provide design calculations required for anchorage and bracing including drawings and cut sheets, as needed.

B. Informational Submittals:

1. Manufacturer’s printed installation instructions.
2. Suggested spare parts list to maintain equipment in service for period of 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
3. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
4. Design calculations for compressed air system. Calculations shall establish sizes for all components in the system (equipment, piping, valves, etc.).
5. Operation and Maintenance Data.
6. Special shipping, storage and protection, and handling instructions.

1.05 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT AND MATERIALS

A. Insofar as is practical, the equipment specified herein shall be factory assembled. The parts and assemblies that are, of necessity, shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field. Generally, machined and unpainted parts, excluding stainless steel alloys, shall be protected from damage by the elements of weather with the application of a strippable protective coating.
1.06 EXTRA MATERIALS

A. One complete set of any special tools required to service the equipment.

B. Three sets of coalescing prefilter and particulate after filter cartridges for air filters associated with each air dryer.

C. Two media replacements for condensate treatment units.

PART 2 PRODUCTS

2.01 PNEUMATIC GATES

A. General: The gates shall consist of Type 316 stainless steel panels actuated by inflation and deflation of polyester reinforced rubber air bladders.

B. Operational Requirements:

1. The crest gates shall operate within an ambient temperature range of plus 110 degrees F to minus 10 degrees F and shall be capable of withstanding impact from floating ice and debris.
2. The crest gates shall be designed to operate in both a fully raised and a partially raised position for extended periods of overtopping without experiencing significant oscillation, adverse flow conditions, or wear.
3. The crest gates shall be suitable for a position adjustment operation and be able to maintain gate position within 0.1 degrees.
4. The head on the gate in the fully upright position is no more than 5 inches.
5. The maximum working pressure for the air bladders and controls shall not exceed 30 psi.
6. The space between adjacent gate panels that operate as a single unit shall be sealed by a reinforced rubber web clamped to each gate panel to provide a watertight system at the seals.
7. End seals shall be maintained on the gates by “L” shape seals mounted on the gate panel sweeping against abutment plates installed at each concrete abutment, and between adjacent independently-operated gate sections.
8. The complete system shall be designed, manufactured, and installed to not cause binding or damage to component parts of the system under operation.

C. Materials:

1. Gate Panels and Hardware:
   a. The steel gate panels, hinge retainers, splitters, and restraining strap clamps will be manufactured from Type 316 stainless steel plate.
   b. Steel hinge retainers, web retainers, and other nonstructural components to be manufactured from Type 316 stainless steel.
c. T316 stainless steel that is welded shall be ‘L’ (low carbon) grade (T316L) or else heat-treated after fabrication.
d. All welded stainless steel components shall be cleaned and passivated in accordance with ASTM A380.
e. All stainless steel components to be designed so that the maximum stress level in each component is less than 40 percent of yield strength and less than 25 percent of ultimate strength.

2. Knappe Breakers: Provide UHMW polyethylene knappe breakers with Type 316 stainless steel attachment hardware spaced to prevent excessive vibration of the gate panels. No knappe breakers are required for the flume entrance gates.

3. Air Bladders:
   a. Rubber reinforced with not less than two layers of polyester bias ply fabric with a total thickness of a minimum 0.3125-inch as measured in accordance with ASTM D751.
   c. The adhesion between the rubber and polyester reinforcement shall be a minimum of 23 kilograms per inch before aging and a minimum of 16 kilograms per inch after aging at 70 degrees C for 96 hours.
   d. An abrasion test using an H18 stone with a 1-kilogram load for 1,000 repetitions, as modified from ASTM C501, shall show less than 500 cubic millimeters of abrasion.
   e. An ozone test shall show no abnormality in appearance when conducted at 100 mPa, 40 degrees C, and 50 percent elongation, in accordance with ASTM D1149.
   f. Individually test all air bladders prior to shipment. Test pressure shall be based upon anticipated operational service pressures.

4. Restraining Strap Clamps: Stainless steel per above.

5. Hinge Retainers, Web Retainers, Splitters, and Other Components:
   Type 316 stainless steel.

6. Anchor Bolts: Type 316 stainless steel or stainless alloy CD4-MCu as required for strength, cast into concrete.

7. Other Threaded Fasteners: Type 316 stainless steel.

2.02 COMPRESSED AIR SUPPLY SYSTEM

A. General:

1. The compressed air system shall be complete and shall consist of air compressors with motor and motor starters, air receivers, heatless regenerative air dryers, coalescing prefilters, particulate afterfilters, control panels, piping, valving, wiring and associated accessories. All necessary piping, and wiring for all system components shall be Gate System Supplier-supplied.
2. The gate air supply system shall be capable of fully raise the gates within 120 minutes or fully lower the gates within 15 minutes without damage to either the dam structures or any of the gate system components.

B. Air Compressors:

1. High Capacity:
   a. Quantity: Two.
   b. Air-cooled, rotary screw-type, with base-mounted motors and V-belt drives with guards.
   c. Capacity: 196 scfm at 125 psig.
   d. Motor: Squirrel-cage type, with drip-proof enclosure. Rating shall be 40 hp minimum, 480 volts, three-phase, 60-Hz.
   e. Sound-attenuating enclosure that limits sound to less than 80 decibels at the machine.
   f. Manufacturer and Product: Ingersoll Rand; R30I-110.

2. Low Capacity:
   a. Quantity: One.
   b. Air-cooled, rotary screw-type, with base-mounted motors and V-belt drives with guards.
   c. Capacity: 19 scfm at 125 psig.
   d. Motor: Squirrel-cage type, with drip-proof enclosure. Rating shall be 10 hp minimum, 480 volts, three-phase, 60-Hz.
   e. Sound-attenuating enclosure that limits sound to less than 80 decibels at the machine.
   f. Manufacturer and Product: Ingersoll Rand; R7.5I-110.

3. Equip compressor with full-discharge size flexible stainless steel hose (ASTM A276, Type 321; close pitch, annular corrugated with single braided jacket; U.S. Hose Corp.; Series 401M, “or-equal”) discharge connection, and isolation valve.

4. Provide combination circuit breaker style motor starter for motor control.

5. Controls: As described in Article Instrumentation and Control.

C. Air Dryers:

1. Type: Heatless Regenerative.
2. Power: 120V ac, single-phase, 60-Hz.
3. High Capacity:
   a. Quantity: Two.
   b. Maximum Operating Pressure: 200 psig.
   c. Capacity: 200 scfm.
   d. Manufacturer and Product: Ingersoll Rand; HLA200.
4. **Low Capacity:**
   a. **Quantity:** One.
   b. **Maximum Operating Pressure:** 232 psig.
   c. **Capacity:** 42 scfm at 232 psig.
   d. **Manufacturer and Product:** Ingersol Rand; D71M.

D. **Accessories:**

1. **Coalescing Prefilter:**
   a. Provide to protect desiccant bed from oil or free water contamination in compressed air supply.
   b. Capable of removing 100 percent of aerosols 0.75 micron and larger, and 100 percent of 0.3-micron solid particles.
   c. Include automatic float drain.

2. **Particulate Afterfilter:**
   a. Protect air-lines from desiccant dust fines carried over from desiccant towers.
   b. Capable of removing 100 percent of 1 micron and larger particles.

E. **Receiver:**

1. **Quantity:** Two.
2. 400-gallon, minimum capacity, suitable for 125 psi working pressure and shall bear the ASME code stamp and plate for pressure vessels.
3. Furnish suitable safety valve, pressure gauge, and electronic no-loss drain valve with isolation valve located at low point.

F. **Condensate Treatment Unit:**

1. **Quantity:** Two.
2. Lubricant adsorbing media filtration.
3. **Maximum Contaminant Concentration in Treated Condensate:** 10 ppm.
4. **Manufacturer and Product:** Clean Resources, Inc.; CRP Pak 15; Industrial Air Power; IAP Pak 15, “or-equal.”
5. **Condensate Receptacle:** Furnish container suitable for collecting condensate for period of 6 months. Container to be manually emptied to drain external to building.

G. **Crest Gate Valve Panel:**

1. The Valve Panel shall include, but not be limited to, the following:
   a. Air pressure regulator.
   b. Pressure gauges.
   c. Pressure transmitters for the gate bladders.
   d. Supply pressure transmitter.
e. Isolation valves.
f. Pressure relief valves.
g. Manual and automatic control valves.

2. Gate control shall include local, remote automatic, and remote manual operating modes.

3. LOCAL-OFF-REMOTE (LOR) switch for the crest gate shall be located in the Compressed Air Control Panel or Gate Valve Panel. It shall be monitored by the Compressed Air Control Panel PLC to determine the gate operating mode. If a switch is placed in the OFF position, the gate will not move and will not respond to LOCAL or REMOTE commands.
   a. Remote AUTOMATIC Mode: The PLC shall be capable of incremental raising and lowering gates automatically to maintain the associated Level Setpoint as described in Section 40 99 90, Package Control Systems.
   b. Remote MANUAL Mode:
      1) Operators shall be able to override the automatic control of the gate from the Compressed Air Control Panel, and place the crest gate controls in Remote MANUAL mode.
      2) The PLC shall provide the capability for the operator to manually raise or lower gates.

4. External Interfaces:
   a. Provide the following external interfaces:
      1) Discrete Inputs from Compressed Air Control Panel:
         a) Provide for the following contacts:
            (1) Gate RAISE command.
            (2) Gate LOWER command.
      2) Analog Output to Crest Gate Control Panel:
         a) Provide for the following 4 mA dc to 20 mA dc outputs:
            (1) Crest Gate Bladder Pressure.

H. Gate Inclinometer: Gates shall be fitted with integrally mounted inclinometers as shown on Drawings. Inclinometers shall produce 4 mA to 20 mA dc signal in direct proportion to gate angle (from horizontal) for remote monitoring purposes. Angle shall be measure 0 degree to 90 degrees (from horizontal), with 20 mA signal equivalent to gate fully extended (90 degrees). Provide cable from each inclinometer to the terminal junction box as shown on approved gate manufacturer’s shop drawings.

   1. Resolution: 0.01 degrees.
   2. Null Repeatability: Less than 0.04 degrees.
   3. Repeatability: Less than 0.08 degrees.
   5. Environmental: Minus 30 degrees C to 75 degrees C.
6. Manufacturer and Product:
   a. Obermeyer; TSM-005.
   b. "Or-equal."

I. Uninterruptible Power Supply: Size to provide 8 hours of battery life for controls (PLC and mechanical valve panel).

J. Factory Finish: Compressed air system components shall be coated with manufacturer’s standard coating.

2.01 INSTRUMENTATION AND CONTROL

A. General:
   1. The crest gate control system shall be in accordance with Section 40 99 90, Package Control Systems, including, but not limited to, instruments, panels, control equipment, application software, control logic, and control system testing.
      a. Compressed Air Control Panel
      b. Wi-Fi Extension Panel

PART 3 EXECUTION

3.01 INSTALLATION

A. The equipment specified herein shall be located as indicated on Drawings and installed in conformance with the Gate System Supplier’s suggested method as approved. Installation Contractor shall provide such additional incidental materials and labor as required for a complete and proper installation.

3.02 FIELD QUALITY CONTROL

A. Installation Contractor is responsible for startup, functional testing, and performance testing of the gate system.

B. Prior to startup, all equipment shall be tested and inspected for proper alignment, quiet operation, proper connection, and satisfactory performance in conformance with requirements of this Section.

C. Functional Tests:
   1. Each gate shall be fully raised and lowered three times. The gates shall operate smoothly with no binding.
2. Each gate system shall be inflated to one-half normal operating pressure. The gate system shall be isolated from the air supply system and held at pressure for 24 hours. Pressure and outside ambient temperature, and the position of the upper edge of each gate shall be recorded at the beginning and at 3-hour to 6-hour intervals during the test. Test data are considered satisfactory if the temperature-corrected bladder pressure is maintained, and gates do not drop more than 4 inches. Any bladders exhibiting leakage will be repaired by the Gate System Supplier at no cost to the Owner. If the Installation Contractor is responsible for the damage, the Installation Contractor shall be responsible for making the necessary repairs that shall be acceptable to the Owner and the Gate Supplier at no cost to the Owner or Gate Supplier.

3. The gates shall be fully tested including the following functions:
   b. Remote automatic control.
   c. Level setpoint (Group 1 and Group 2 Gates) and flow setpoint (Flume Entrance Gates) adjustment and PID control to maintain the associated control setpoint.
   d. Validate all remote monitoring status and alarm signals.

4. Documentation of the functional tests will be provided by the Installation Contractor to the Owner’s representative for approval. If test results are unsatisfactory, the Installation Contractor must remedy the cause of test failure, and retest.

D. Performance Tests:

1. In coordination with Owner and the Gate System Supplier, the gates shall be tested through the full operating range:
   a. Fully lowered.
   b. Partially raised in 10-degree increments with 0.5 feet overtopping at each increment. Hold gate position with 0.5 feet overtopping for 30 minutes at each increment.
   c. Fully raised with 0.2 feet overtopping.
   d. Validate gates were able to maintain position and meet all operational requirements specified.
   e. Validate all remote monitoring status and alarm signals.
   f. Documentation of the performance tests will be provided by the Installation Contractor to the Owner’s representative for approval. If test results are unsatisfactory, the Installation Contractor must remedy the cause of test failure, and retest.
3.03 GATE SYSTEM SUPPLIER’S SERVICES

A. Present at the Site or classroom designated by Owner, for at least four trips, and minimum person-days listed below, travel time excluded:

1. 10 person-days for installation assistance and inspection.
2. 6 person-days for functional and performance testing.
3. 4 person-days for prestartup classroom training.

3.04 WARRANTY

A. Provide manufacturer’s extended guarantee or warranty with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall cover all aspects of the pneumatic gate system and shall provide for correction of items found defective during a period of 2 years after the date of Substantial Completion. This Special Guarantee includes all work (including parts, labor, equipment, shipping, testing) to remove, replace, and correct equipment furnished by responsible Pneumatic Gate System supplier. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. General: There shall be designed, furnished and installed adjustable WaveShapers™ and Gates to adjust and control the shape of waves in the waterway and, where shown, control upstream water levels and flow rates into waterways. These shall collectively be referred to as gates. The equipment shall include plates, hinges, racks, hydraulic cylinders, rubber bladders, hinges actuators, valves, seals, and control panels as schematically shown on Drawings. A hydraulic system including cylinders, valves, reservoir and hydraulic pump, and a pneumatic system, including a compressor, bladder, valves and piping to move the gates are referred to as the “actuators.”

B. Related Work:

1. Section 01 61 00, Materials and Equipment.
2. Section 01 64 35, Contractor’s Field Services.
3. Section 35 20 25, Pneumatic Gate System.
4. Section 40 99 90, Package Control Systems.

1.02 SUPPLIER

A. The equipment specified in this Section shall be as designed and supplied by Obermeyer Hydro, Inc. (Gate System Supplier), telephone: (970) 568-9844. The Gate System Supplier shall have previously designed, manufactured, and supplied equipment similar in function and size and have at least 15 years’ experience. All reinforced rubber components shall be fabricated in the Gate System Supplier’s own facilities. Substitute equipment, if allowed, must be modified as necessary to provide the specified gates and to meet the specified operating conditions. The Gate System Supplier shall have expertise in the hydraulics of flow that impacts the gates.

1.03 QUALITY ASSURANCE

A. References: Reference in this Section of a Standard, such as ASTM, AWWA, or ACI, is to be interpreted to be the latest revision of that Standard.
B. Industry Standards and Specifications:

1. American Society for Testing and Materials:
   b. A53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   d. A153: Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   e. A181/A181M: Forgings, Carbon Steel for General Purpose Piping.
   g. A536: Ductile Iron Castings.
   h. D751: Coated Fabrics, Test Method.
   i. D1149: Rubber Deterioration – Surface Ozone Cracking in a Chamber (Flat Specimens), Test Method.


4. Obermeyer Hydro, Inc.: The gates and controls shall meet the requirements of Obermeyer Hydro, Inc.

1.04 SUBMITTALS

A. Submit the following in accordance with requirements presented in Section 01 60 01, Contractor Submittals:

1. Final design drawings, computations and engineering analysis of gates prior to commencement of Shop Drawings, fabrication submittals and fabrication of gates. Design Loads, including dead loads, safety factors, etc. are to be included. Drawings, computations and engineering analysis are to be sealed by a licensed Professional Engineer. Shop drawings shall detail all connections, fabrication details, final dimensions, clearances, tolerances, finishes, etc. An anchor bolt template shall also be shown on the Shop Drawings and shall be furnished unless waived in writing by the Engineer.


3. Handling and storage plan and requirements, prior to delivery of gates, and any components to the project site. Written instructions from manufacturer will be provided.
4. The Installation Contractor shall be responsible for following the manufacturer’s installation and storage instructions, as approved by the Engineer, until acceptance by the City. No equipment shall be delivered unless such instructions have been approved by the Engineer.

5. Work plan and schedule for construction by Installation Contractor, including foundation work, anchors, concrete forming and steel placement, placement of embeds and anchors, hydraulic lines and sensing piping, special concrete work to fill areas of difficult placement, concrete finishing and placement, testing of anchor bolts, work area plan for placement, detailed sequential steps of placement, equipment for placement, controls and sensing line installation, and all testing procedures.

6. Specific minimum tolerances required by manufacturer for construction of reinforced concrete, painting, torque for anchor bolts and fasteners, pressures, deadbands, dimensions and related construction. Manufacturer’s requirements do not supersede other stricter requirements elsewhere in these specifications and as shown on Drawings.

7. Written instructions regarding concrete embedded anchor system hardware, to include tolerances, 30 days prior to anticipated delivery of the concrete embedded anchor system hardware.

8. Installation and Operations Inspection Report by Gate System Supplier: Equipment manufacturer, or their authorized representative, shall submit a written report with respect to the equipment certifying that: (1) the equipment has been properly installed and lubricated under their supervision, (2) the equipment is in accurate alignment, (3) they were present when the equipment was placed in operation, (4) the equipment has been operated and inspected under full load conditions and operated satisfactorily, (5) they are fully covered under the terms of the guarantee. Report(s) shall include report from on-site inspection by Gate System Supplier. Inspections will be periodic as required for installation of critical components or at critical times. At least one inspection report approving installation of each gate prior to running water over the gate during the construction dewatering phase. The Engineer shall be informed of the date for each inspection at least 2 weeks prior to all onsite inspections by the Gate System Supplier. Refer to Article Installation. for additional details.

9. Leakage Test Records prior to final inspection by Engineer.

1.05 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT AND MATERIALS

A. Insofar as is practical, the equipment specified herein shall be factory assembled. The parts and assemblies that are, of necessity, shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field. Generally, machined and unpainted parts shall be protected from damage by the elements of weather with the application of a strippable protective coating.

B. Box, crate, or otherwise enclose and protect equipment during shipment, handling, storage, and following installation so as to ensure the preservation of the required quality and fitness of all materials and equipment until final acceptance of the project. Keep equipment dry and covered from exposure to weather. Store pumps, motors, electrical equipment, controls, insulation, and equipment having anti-friction or sleeve bearings in weather-tight storage facilities. Lift large equipment items only at the points designated by the manufacturer. Protect factory painted surfaces against impact, abrasion, discoloration, and other damage. Repair damage as directed and approved.

1.06 WARRANTY

A. The Gate System Supplier shall provide a 5-year warranty on the gates commencing at final acceptance of the Work. The warranty shall cover all manufactured and supplied components and parts and include on-site assessment, removal, and replacement. Dewatering efforts are not included in the warranty and shall be the responsibility of the Owner.

B. In addition to the general warranty requirements, the equipment warranty shall cover (1) faulty or inadequate design by the equipment manufacturer; (2) improper assembly or fabrication; (3) defective workmanship or materials, and (4) leakage, breakage or other failure. It shall be the gate System Supplier’s responsibility to ascertain the conditions and service under which the equipment will operate and to warrant that operation under those conditions shall be successful. The supplier shall furnish a copy of the warranty to the City of Tulsa with the City named as beneficiary. Any defects or failure within the warranty period shall immediately be repaired or replaced by the Gate System Supplier.

1.07 DESIGN

A. The shape, dimensions, some details and range of motions of gates are as specified on Drawings. Design efforts by the Gate System Supplier shall include structural analysis and hydraulic modeling if required. The Gate System Supplier shall provide a detailed, working 3D model of the gates in
Rhinoceros 3D (computer application) or other acceptable similar program. This shall be fully moveable and readily able to demonstrate the range of motion and verify the absence of interference of the various components and structural members.

1.08 GATE DESCRIPTION

A. Gates shall consist of composite panels with elastomeric hinges anchored to concrete and elastomeric hinges between composite panels where shown on Drawings. There are two types of WaveShapers in the project – Entrance Gates with WaveShaper and WaveShapers. Entrance Gate with WaveShapers control both the upstream water levels and the downstream waves with an upstream crest/pneumatic gate panel that is hinged to both the concrete and to one of the downstream panels that comprise the WaveShaper gate. WaveShapers only control the formation of waves downstream with panels hinged to the concrete. Crest gate panels shall be actuated with a pneumatic system and be fully compatible with the hydraulic system actuating the WaveShaper gates. Actuators for WaveShaper gates shall include hydraulic cylinders mounted between the hinged gate panels and the concrete foundations. The elastomeric hinges and actuators shall allow the gates to operate through a range from fully raised to fully lowered and as otherwise shown on Drawings.

B. Operational Requirements:

1. The Gate Control System operational requirements shall be in accordance with Section 40 99 90, Package Control Systems, including operational control strategy.
   a. WaveShaper Gate Controls.

1.09 HYDRAULIC LOADING

A. The Gates and WaveShapers, including attachments, hinges, bearings, and connectors, shall be analyzed and designed using the loadings and considerations shown in the figures below and as described herein. The moveable panels that make up the WaveShapers and Gates shall be designed to move within the limits as shown on Drawings with water flowing in the waterway. The general shape of the WaveShapers and Gates are shown schematically, and the overall dimensions and shape shall not be changed significantly.

B. The WaveShaper gates will be in a rapidly varying flow regime (transition from super critical to subcritical flow) at a hydraulic jump. Depending on the hydraulic jump formation the gate will experience downward or upward (uplift) loading. The WaveShaper gate and system components (including
actuators) shall be designed to withstand the loads shown in the table below. Loads shown do not include dead loads, and do not include a safety factor. Gate System Supplier shall assign an appropriate safety factor based on their experience with similar systems.

<table>
<thead>
<tr>
<th>Gate Panel</th>
<th>Gate Loading Type</th>
<th>Live Load (lbf/ft^2)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>WaveShaper Entrance Gate - Crest Panel</td>
<td>Upward Hydraulic Loading (Uplift)</td>
<td>150</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td></td>
<td>Downward Hydraulic Loading</td>
<td>250</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td>WaveShaper Entrance Gate - WaveShaper Panels</td>
<td>Upward Hydraulic Loading (Uplift)</td>
<td>150</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td></td>
<td>Downward Hydraulic Loading</td>
<td>250</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td>Drop 3 - Center WaveShaper Gate</td>
<td>Upward Hydraulic Loading (Uplift)</td>
<td>150</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td></td>
<td>Downward Hydraulic Loading</td>
<td>200</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td>Drop 3 - Side WaveShaper Gates</td>
<td>Upward Hydraulic Loading (Uplift)</td>
<td>150</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td></td>
<td>Downward Hydraulic Loading</td>
<td>300</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td>Drop 4 – Center and Side WaveShaper Gates</td>
<td>Upward Hydraulic Loading (Uplift)</td>
<td>150</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td></td>
<td>Downward Hydraulic Loading</td>
<td>200</td>
<td>No Safety Factor Applied</td>
</tr>
</tbody>
</table>

Notes:
Alternative loading than shown above: All pneumatic air bladders and attached panels shall withstand a differential upstream and downstream head of 8 feet.

All pneumatic air bladders shall be equipped with a valve that will deflate when the load is within 75 percent of the given design load.
1.10 OTHER LOADING

A. The Gate System Supplier shall evaluate and include in the design other loads on the system, including momentum, impact, shear, dead loads, actuator dynamic loads, and others identified by supplier based on experience with similar systems. Gate System Supplier shall also consider operational loadings such as when the waterway is filling or draining during startup and shutdown.

1.11 UNEQUAL CYLINDER LOADING

A. The gates, including the frame, panels, cylinders, connections, pivots, and attachments, shall be designed so as to accommodate an unequal loading of any individual cylinder of 50 percent of its maximum design loading without excessive deflection or stresses of the gate, including the frame, connections, supports, pivots, clevises, etc.

PART 2 MATERIALS

2.01 GATE CONTRACTOR SUPPLIED COMPONENTS

A. The gates and all necessary ancillary components required to allow successful operation of the gates shall be provided by Obermeyer Hydro, Inc. of Fort Collins, Colorado (Contractor/Gate System Supplier). All equipment provided by the Gate System Supplier shall be Class 1, Division 2, Group D compliant. Equipment to be so provided includes, but is not limited to, the following:

1. Final design drawings and calculations, shop drawings, computer modeling (if conducted) results and engineering analysis of gate system forces prior to commencement of fabrication of the gate.
2. Steel gate panels and associated piping attachments.
4. Seals with attachment hardware.
5. Gate clamping hardware with anchor bolts, nuts, and washers.
6. Pneumatic system including compressor, bladders, connections, embedded items, valves, and control components (see Section 35 20 25, Pneumatic Gate System).
7. Hydraulic system controls including hydraulic pump and reservoir, all valves and control components.
8. The hydraulic cylinders including all bearings, attachments, pivots, flexible hoses that attach from the cylinders to the stainless steel hydraulic lines, attachment fittings, clevises, etc.
9. Inclinometers with LCD output display.
10. Ultra High Molecular Weight (UHMW) polyethylene abutment plates with Type 316 stainless steel anchor bolts, nuts, and washers.
2.02 STEEL COMPONENTS

A. Hinge retainers, splitters, and restraining strap clamps will be manufactured from Type 316 stainless steel.

B. Other non-structural components to be manufactured from Type 316 stainless steel.

C. All threaded fasteners, including anchor bolts and attachment hardware, shall be Type 316 stainless steel, or approved equal. Anchor bolt allowable shear and tension stresses for attachment to concrete shall not exceed that recommended by the anchor bolt manufacturer.

D. Stainless steel plates and other stainless items shall be Type 316 stainless steel, or approved equal.

E. All steel and Type 316 stainless steel components shall be designed so that the maximum stress level in each component is less than 40 percent of yield strength and less than 25 percent of ultimate strength.

F. All attachment hardware shall not protrude above adjacent surfaces. All bolts on exposed faces of steel gates shall be countersunk flush to surface.

G. All welds and edges shall be ground smooth.

2.03 EDGES AND GAPS

A. Exposed edges on gates shall have a minimum radius of 2 inches as shown on Drawings. All other exposed edges on all panels, hinge attachments, steel, etc., shall be rounded to no less than 1/4 inch. Edges of panels and hinges shall have no gaps between gate panels/frames and concrete walls greater than 1/4 inch. All gaps between gate panels and concrete walls shall be filled with rubber securely attached to the frame to prevent fingers or lose articles of clothes from becoming entrapped.

2.04 INCLINOMETERS/TILT GAUGES

A. Inclinometers shall be accurate to at least 0.5 degree, be reliable and suitable for river conditions and be as supplied by Obermeyer Hydro, Inc. The inclinometers shall be mounted so as to facilitate maintenance and replacement.
B. Inclinometers (a total of twenty) shall be installed on:

1. Ten hydraulic gate panels to provide feedback signal to display the angle/slope in the upstream to downstream orientation of the panel to the operator.
2. Two pneumatic gate panels as shown on Drawings.

2.05 HYDRAULIC CYLINDERS AND ATTACHMENTS

A. Cylinders shall be double acting and designed to support the entire design hydraulic loads, dead loads, and other loads. The cylinders and all hardware shall be designed for submerged conditions and for vegetable oil based hydraulic fluid. Cylinders shall have a stainless steel body. The cylinders shall have an operating pressure of no more than 3,000 psi. All bolts, rods, clevises, rod eyes, pivoting hardware, and all other hardware shall be Type 316 stainless steel. Seals shall be designed for vegetable oil operation and submerged conditions. Cylinder supports, pivots, clevises, etc. shall be designed to allow for inaccuracies in construction, unequal loadings, etc. so as to not put any non-axial loading or moment on the hydraulic cylinders. Both cylinder mounts shall be spherical connections. Cylinders shall be provided with a 5-year manufacturer’s warranty.

2.06 WAVESHAPER HYDRAULIC SYSTEM

A. The hydraulic system supplying and controlling the hydraulic cylinders of the WaveShaper Gates shall provide smooth, reliable, and efficient operations of the WaveShaper Gates. The hydraulic system shall be designed so that there is not a loss of hydraulic pressure over time and that the cylinders and the gate panels stay in-place when the system is turned off or unattended.

1. Hydraulic Fluid: The hydraulic system will be supplied and all components designed to operate with vegetable base hydraulic fluid. Hydraulic fluid shall be readily and totally biodegradable, maintain low viscosity at minus 20 degrees F, and be stable for a period longer than 25 years. Base fluid shall be canola (rapeseed) oil as manufactured by Hydro Safe ® Oil Division, Inc., or approved equal. The grade shall be as determined for the application. Twenty gallons of additional fluid for future use shall be supplied.

2. Hydraulic Line: Hydraulic Line (tubing) shall be 3/8-inch diameter Type 316 stainless steel with a minimum wall thickness of 0.049 inch and a maximum working pressure of greater than 3,000 psi. Fittings shall be stainless steel with equivalent or greater strength than the tubing. Hydraulic hoses shall be rated for a working pressure of 3,000 psi and be attached with stainless steel quick connects and
stainless steel fittings, or approved equal. Hose and fittings shall be approved for Marine Applications (SAEJ1942), and shall be Global M3K Mega3000® Hose – SAE 100R17, or approved equal. Where routed under lip plates, tubing shall be fastened to the gate support slab at no greater than 4 feet intervals with stainless steel straps. All hoses shall be protected with stainless steel anti-abrasion sleeves or wraps.

3. Hydraulic Control Valves: Valves shall be the directional control type with a single lever operator per gate. Valves shall operate such that in one position the gates raise, in the other position the gates are lowered, and the hydraulic cylinders do not move when the valve is in the neutral position.

4. Valves: Ball and check valves shall be Type 316 stainless steel.

5. Pressure Relief Valves (PRV) Valves: PRV valves in the hydraulic system of the WaveShaper Gates shall release pressure so as not to allow over pressuring of any cylinder at any time. PRV valves shall be self-actuated safety valves designed to relieve excess upstream pressure from the line. The PRV valves shall be adjustable from 1,000 psi to 3,000 psi. The PRV valves shall be connected to a drain valve so that hydraulic fluid is released back to the hydraulic pump reservoir.

6. Hydraulic Pump: The Gate System Supplier shall supply a hydraulic pump capable of operating the hydraulic cylinders required to operate the WaveShapers. The pump single speed with a minimum reservoir capacity equal to at least 1.5 times the difference between the volume of hydraulic fluid between all cylinders up and all cylinders down. It shall have a maximum operating pressure of 3,000 psi. The pump shall be capable of lifting WaveShaper panels at full range within 2 minutes but not faster than 1 degree of gate rotation per second. The pump shall have a pressure regulating valve to adjust the maximum operating outlet pressure from 1,000 psi to 3,000 psi. The pump shall be designed to work with vegetable based hydraulic fluid.

7. Hydraulic Valves and Manifold: The hydraulic valves and manifold shall be neatly arranged into a well and uniform layout control panel. The valves shall be labeled as to each cylinder that they control. Valving system shall be designed to isolate the individual WaveShaper gate cylinders at each hydraulically actuated drop/feature for future operation and maintenance.

8. Pressure Gauge: Provide liquid filled pressure gauge manufactured by Ashcroft, or approved equal rated per the maximum system pressure operating pressure. Include an isolation valve between gauge and hydraulic system.

2.07 PNEUMATIC GATE SYSTEM

A. The pneumatic gate system supplying and controlling the air bladders of the Entrance Gates with WaveShaper Gates shall provide smooth, reliable, and efficient operations of the gates. The pneumatic system shall be designed so that there is not a loss of air pressure over time and that the bladders and the gate panels stay in-place when the system is turned off or unattended.

B. The pneumatic air system, including but not limited to, the pneumatic air system, air bladders, airlines, and other system appurtenances shall meet the requirements and be integrated with the pneumatic air system specified in Section 35 20 25, Pneumatic Gate System. If conflicts arise, the more restrictive criteria shall apply, however the Engineer will be notified of any inconsistencies or discrepancies.

2.08 UHMW POLYETHYlene ABUTMENT/SKID PLATES AND J BULB SEALS

A. All panels including the crest panels and all panels that make up each WaveShaper shall have adjustable J bulb seals (or reinforced rubber spacers) along all outside edges that abut to the abutment walls. All abutment walls shall have UHMW abutment plates embedded in the walls. The plates shall be set parallel and flat so as to allow for sealing with the J bulb seals. The UHMW abutment plates shall be designed so as to allow for eventual 1/2-inch degradation of the concrete surface of the concrete abutment walls adjacent to the plates (i.e. design the thickness and anchoring of the abutment/skid plates to adequately account for this potential concrete degradation).

2.09 WAVESHAPER RACKS

A. Type 1: The WaveShaper Type 1 Racks shall be installed on the Entrance Gate WaveShapers and shall consists of a heavy steel frame with sections of rounded polyethylene bars attached to the heavy steel frame. The weight of the rack is important to prevent inadvertent “floating” due to strong currents as experienced at other installations.

1. The polyethylene bars shall have a maximum 2-inch clear opening between 1/2-inch-thick or thicker polyethylene bars. The section of polyethylene bars shall be similar and equal to those manufactured by Hydrothane Systems, Inc. The bars and connectors shall be designed for a minimum of 120 pounds per square foot loading.

2. One section of polyethylene bars shall be readily removable for maintenance access.

3. All exposed rack components shall be smooth with edges rounded. See Drawings for details.
4. All rectangular steel sections shall have a minimum wall thickness of 3/8-inch-thick.
5. The steel frame shall be grout-filled, Type 316 stainless steel as shown on Drawings.
6. All rectangular steel sections shall be sealed watertight to prevent internal corrosion and filled with linseed oil. Fill plugs will be installed as required.
7. All connectors shall be Type 316 stainless steel.
8. The clearance between the bottom portion of the frame and foundation surface shall be from 4 inches.
9. No sharp edges shall be created on the exposed surface of the rack including but not limited to the hinge with the WaveShaper and the joint between the steel frame and the polyethylene bar rack sections.

B. Type 2: The WaveShaper Type 2 Racks shall be of the bar screen style, having a 4-inch or less clear openings between all bars and sides.

1. Type 2 racks including all connectors will be constructed of Type 316 stainless steel. Pipe shall be Schedule 40 or Schedule 80 as shown on Drawings.
2. The clearance between the bottom portion of the frame and foundation surface shall be from 4 inches.
3. The bar racks shall be designed to allow the gates to be rotated down to allow access during maintenance.
4. See Drawings for details.

2.10 REMOVEABLE ACCESS PLATES

A. A total of four steel removable access plates and all attachment hardware, as shown on Drawings, shall be supplied with the gates. These shall allow access to hydraulic cylinders and have adequate clearances to allow access below the gate for a 6-inch diameter hose for removal of sediment/debris. All plates and hardware shall be flush to the surrounding gate and shall be smooth with no sharp edges.

2.11 HINGES

A. The hinges shall be reinforced elastomeric type. Hinges and attachment hardware shall be flush or slightly recessed below the concrete foundation upstream of the hinge.
2.12 INSTRUMENTATION AND CONTROL

A. General: The Gate Control System shall be in accordance with Section 40 99 90, Package Control Systems, including, but not limited to, instruments, panels, control equipment, application software, control logic, and control system testing.

1. Hydraulic System Control Panel.

2.13 TESTING RECORDS

A. Submit written certificate attesting to product compliance with physical material requirements of this Section prior to installation of the gates and any related equipment.

PART 3 EXECUTION

3.01 PIPING, FOUNDATION SLAB AND WALL GENERAL REQUIREMENTS

A. The Installation Contractor shall store, protect, and install all manufacturer provided components listed in Part 2 of this Section.

B. The Installation Contractor shall prepare the foundations for the gates, including all anchors, sleeves, and embedments. Provide anchor bolts of length to allow for 1-1/2 inches of grout under base plates and adequate anchorage into structural concrete. Other specifically detailed lengths either shown or specified will supersede this requirement. Provide sleeves of at least 1-1/2 times anchor bolt diameter and of the same material as the anchor bolts. Anchor bolts shall be stainless steel Type 316 which conforms to ASTM A193.

C. The Installation Contractor shall furnish and install all auxiliary components necessary to make a complete and operational Gate. Never seize, or other approved lubricating compound, shall be used for all stainless steel anchor bolts and fasteners, 100 percent polyurethane caulk for all inter panel seals, and condensate piping.

D. The reinforcing steel and embeds will be placed in the foundation slab, with careful placement to achieve pull out capacity requirements of anchors as specified by the gate system supplier and structural engineering requirements. Care will be taken such that complete concrete penetration under and around embeds is achieved.
E. A steel trowel finish will be used on the base slabs below and downstream of the gates. Any rough points, edges or other defects will be ground smooth and as directed.

F. The foundation walls will be placed with a tolerance of plus or minus 1/8-inch of the designated vertical plane, with no edges, form ridges or other defects.

G. Embedment plates (or UHMW Abutment/Skids plates) or other provisions to provide a uniform and low-friction surface may be required at the foundation walls adjacent to the moveable panels of the WaveShapers. These surfaces will be in contact with the Reinforced Rubber Spacer (see below).

H. Reinforced Rubber Spacer (or J Bulbs) shall be provided to fill the gap between all WaveShaper panels and the concrete foundation walls. The design and detailing of this Reinforced Rubber Spacer shall prevent the formation of gaps during operations and shall provide for the longest practical life without maintenance. Smallest practical gaps and rubber spacers shall be used.

I. All embeds will be cleaned, threads cleaned, and bolts temporarily placed to determine that threads are clean and in good condition. Torque test pull-out resistance as directed.

J. Hydraulic piping shall be run in conduit, in covered raceways, or embedded in concrete as shown on Drawings. Conduits shall have long-radius bends and pull boxes at bends to facilitate pulling hydraulic piping lines through the conduit. Outside of conduits all lines shall be securely fastened with stainless steel connectors to prevent vibration and to uniformly support the hydraulic piping. Connectors from the hydraulic piping to the hoses shall be mounted with stainless steel bulkheads and bulkhead fittings so as to prevent movement of the hydraulic piping. Bulkheads shall be at least 4-inch square and 1/4-inch-thick.

3.02 INSTALLATION

A. General Requirements:

1. Installation Plan and Facilities: The Installation Contractor will develop an installation plan describing site storage and work areas, equipment needs, and other details in consultation with the Gate System Supplier, so that the gates and controls can be properly installed, tested, and operated.

2. Installation: The gates will be installed to achieve the requirements of the plans and specifications, and as directed by the Gate System Supplier. All materials and surfaces will be protected against damage. The sequence of construction will be as directed by the Gate System Supplier.
Supplier's technical advisor and to achieve the gate operational characteristics.

3. **Testing:** The equipment, bladders, panels, hinges, and controls will be tested in advance and during initial operation. Thereafter, any defects repaired as directed.

**B. Gate System Supplier’s Technical Advisor and Engineer’s Representative:**

1. **General:** The Gate System Supplier shall provide a factory-trained technical advisor to oversee installation of the gates, startup and testing of the operating equipment, and to instruct operating personnel. A representative of the Engineer will attend all meetings and installations as may be designated.

2. **Pre-installation Meeting:** A pre-installation meeting to be attended by the Gate System Supplier's technical advisor, Client, Engineer, and Installation Contractor personnel will be held within 2 weeks prior to the scheduled installation of any gate or gate component. The technical advisor shall provide the attendees with information regarding the proper procedures for installing the gates and related equipment.

3. **Pre-installation Inspection:** The Gate System Supplier's technical advisor and Engineer shall inspect the concrete foundation with anchoring system hardware and reinforcing steel prior to placement of concrete. The Engineer and manufacture shall receive 10 days advance notice of the scheduled concrete placement.

4. **The installation of the hydraulic cylinders and gate panels, including preparatory work, shall be done with the Gate System Supplier’s technical advisor at the site. The Engineer and the Gate System Supplier will receive 10 days advance notice of scheduled installation. The technical advisor shall notify the Engineer as soon as possible of any discrepancies discovered in the work which may hinder successful installation of the gates.**

5. **Final Testing:** The installed systems shall be leak tested, as specified elsewhere, for leakage by the Installation Contractor with the assistance of the gate manufacturer's technical advisor.

6. **Final Inspection:** A final inspection of the gate installation and related equipment will be performed by the Engineer with the assistance of the Gate System Supplier's technical advisor in conjunction with the final testing.
C. Testing:

1. General:
   a. The Installation Contractor shall be responsible for conducting testing of the installed system. Tests shall be conducted in the presence of the Engineer and the Gate System Supplier's technical advisor.
   b. All hydraulic lines shall be tested and accepted before installation of the gates commences.
   c. Hydraulic lines and hoses shall be tested by pressurizing to 3,000 psi. Pressure readings and ambient air temperature shall be recorded at six different times during each test. Any joints or fittings exhibiting leakage during this time shall be repaired or replaced.
   d. After installation of the system the gates shall be fully raised and lowered three times. The gates shall operate smoothly with no binding. WaveShaper gates shall be tested an additional three times, each time varying the position of each lip throughout the range of operation.
   e. After installation of the gates with hydraulic cylinders, the hydraulic system shall be isolated from the pump system and held at a pressure of 3,000 psi for 24 hours. All hydraulic lines and hoses shall have no drop in pressure over a 24-hour period.

2. Reporting: The Gate System Supplier’s technical advisor shall prepare a written report of all tests. The report shall be attached to an Installation Acceptance which shall be submitted within 2 weeks of the end of the testing period.

3. Adjustments: During the Starting of Systems (Tuning) Phase, the gates shall be adjusted and tested as Directed by Engineer to verify a fully functioning system in the active flow condition.

4. Warranty: A written warranty with terms and conditions specified herein shall be submitted within 2 weeks following the final inspection. All equipment shall be warranted to be free from defects for a minimum period of 5 years from the date of final acceptance of the Work of this Contract.

END OF SECTION
SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1  GENERAL

1.01  REFERENCES

A.  The following is a list of standards which may be referenced in this Section:

2.  International Society of Automation (ISA):
   a.  PR12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.
   b.  S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).
   d.  S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   e.  S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
3.  National Electrical Manufacturers Association (NEMA):
   a.  250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b.  AB 1, Molded Case Circuit Breakers and Molded Case Switches.
   c.  ICS 2, Industrial Control Devices, Controllers and Assemblies.
5.  Telecommunications Industry Association (TIA) 568-B.2-1 Category 6.

1.02  DEFINITIONS

A.  Gate System refers to the gates included in following Sections:

1.  Section 35 20 25, Pneumatic Gate System.
2.  Section 35 20 30, Waveshapers™ and Gates.

B.  Gate System Supplier refers to the gate system supplier.

C.  Control system refers to Gate System Supplier provided control system in its entirety.

D.  Installation Contract refers to the contract for installation of the gates.
E. Installation Contractor refers to the contractor for installation of the gates.

F. Camera System Supplier refers to the supplier that will provide the camera system to the Installation Contractor as part of the Installation Contract.

1.03 SYSTEM DESCRIPTION

1. Major Work Items: Includes, but is not limited to, engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete system.
   a. Provide control panels, wireless panel, and fiber patch panels as shown on the Drawings:
      1) Section 35 20 25, Pneumatic Gate System: Compressed Air Control Panel.
      2) Section 35 20 30, Waveshapers and Gates: Hydraulic System Control Panel.
      3) Wi-Fi Extension Panel.
   b. Process instrumentation including primary elements, transmitters, control devices, and control panels.
   c. Programmable controllers (PLCs), communication modules, input/output modules, racks, power supplies, and associated cabling and termination hardware. Shall include all PLC programming software, PLC applications software, and any other software to execute the PLC programming.
   d. Human Machine Interface (HMI), including computer workstations, workstation operating system software, HMI software, and all HMI applications software. HMI shall include all additional system, and applications software, programs required for fully executing the HMI software.
   e. Remote HMI access shall include all additional system and applications software programs required for fully executing the HMI software including remote desktop login from remote location over cell network. Refer to the drawings for block diagram and remote access.
   f. Drawings including, but not limited to, loop wiring diagrams, network diagrams, panel drawings, modification of existing panel drawings, and finalization of instrument installation details. Shall include all other Drawings and diagrams specified hereinafter.
   g. Complete and thorough testing of all control loop circuits including testing of I/O wiring to the control panels, package system panel interfaces, interface to devices supplied by others including but not limited to motor control centers, drives, valves, gates, instruments and other similar devices.
h. Complete and thorough testing of all network components including testing of network devices and cabling to the control panels, package system panel interfaces, interface to devices supplied by others.

i. Applications Software:
   1) Use the following as the basis for software and network configuration:
      a) Final approved panel drawings with all final inputs and outputs.
      b) Gate Specifications:
          (1) Section 35 20 25, Pneumatic Gate System.
          (2) Section 35 20 30, Waveshapers and Gates.
          (3) Drawings:
              (a) P&IDs.
              (b) Network Block Diagrams.
      c) Control Equipment approved submittals.
      d) Network Equipment approved submittals.
      e) Control Narratives included in article Supplements:
          (1) Pneumatic Crest Gate Controls.
          (2) Waveshaper Gate Controls.
   2) Provide all applications software, including all configuration for all system devices, including PLCs, HMI, Switches, Firewall, all network devices, and all other system components that require configuration.
   3) Software coordination workshops.
   4) Provide onsite testing and checkout of all applications software.
      a) Provide testing and checkout of all remote access to the HMI systems. Remote login shall be via the cell modem in the Compressed Air Control Panel and then ghost from the Compressed Air Control Panel to the Hydraulic System Control Panel.
   5) Provide offsite and onsite Win911 alarming.

j. Network Configuration:
   1) Provide all network devices and components configuration software, device configuration.
   2) Provide onsite testing and checkout of all network devices and configuration.
   3) Provide offsite testing and checkout of all remote access to the HMI.
B. Coordination:

1. Provide extensive coordination with other systems, other suppliers, and other system providers including, but not limited to:
   a. Section 35 20 25, Pneumatic Gate System:
      1) Compressed Air Control Panel.
      2) Pneumatic Gates.
      3) All equipment interfaced to the Compressed Air Control Panel.
   b. Section 35 20 30, Waveshapers and Gates:
      1) Hydraulic System Control Panel.
      2) Hydraulic Gates.
      3) All equipment interfaced to the Hydraulic System Control Panel.
   c. Division 26, Electrical:
      1) Electrical Systems.
      2) Fiber optic cabling.
   d. Coordination with Installation Contract Camera System Supplier:
      1) Refer to Block Diagrams in the Drawings.
      2) Camera system will be supplied by Camera System Supplier.
      3) The camera system will share fiber optic infrastructure, and offsite remote cellular access with the PLC/HMI control system after completion of functional testing of each system.
      4) The Camera System will be supplied with a cell modem separately from the control system so that each supplier can test each of the systems for offsite Remote access. However, the Camera System cell modem and cell data plan will be only used for testing and commissioning of the camera system. At the successful completion of each system functional testing, the two systems will share the control system cell modem and data plan. The camera system cell modem system will be kept by the Owner as a spare unit. The purpose for two systems is for checkout of each system independent from the other, while merging them after successful functional testing such that the end user will only log on from offsite remote access to one account with access to each system.
   e. Coordination with Installation Contractor:
      1) All activities shall be executed in conjunction with Contractor in accordance with:
         a) Section 01 11 01, Summary of Work, for quantity and definition of Milestones.
b) Section 01 64 35, Contractor's Field Services.
c) Coordinate testing and delivery of control panels and all other equipment with Contractor and project milestones.
f) Coordination with Installation Contractor and equipment supplied as part of that contract.
   1) Equipment to be supplied by Installation Contractor Camera System Supplier includes:
      a) Camera Network System.
      b) Network infrastructure that will be utilized and shared by this Section, as well as a Camera Network System.
         (1) Fiber optic cables and fiber optic patch panels.
         (2) Refer to the Block Diagrams as shown on Drawings.
   2) Equipment to be supplied by Section 40 99 90, Package Control Systems, that requires coordination with Installation Contract Camera System Supplier supplied equipment and Suppliers includes:
      a) Cellular modem system and data plan.
      b) The Camera Network System will use the fiber network, cell modem system, and the cell data plan.

C. Assemble panels and wiring in Gate Supplier panel fabrication facility.

D. Test panels and panel assemblies for proper operation prior to shipment from equipment assembly location.

E. Install and test panels and instruments in the field.

F. Test all interfaces from field equipment to each panel field.

G. Test all external interfaces from each panel to offsite Remote Access in the field.

1.04 SUBMITTALS

A. Action Submittals:
   1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
   2. Catalog information on all equipment, devices, and software furnished with system.
   3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
4. Communications and Digital Networks Diagrams:
   a. Scope: Includes connections to all network devices including, but not limited to, patch panels, switches, servers, firewall, and all other network equipment.
   b. Format: Network schematic diagrams for each different type of network.
   c. Show:
      1) Interconnected devices, both passive and active.
      2) Device names and numbers.
      3) Terminal numbers.
      4) Communication Media: Type of cable.
      5) Connection Type: Type of connector.
      6) Node and device address numbers.
      7) Fiber, wire, and cable numbers and colors.

5. Panel Elementary Wiring Diagrams: For all control, network, and power circuits. Include all panel power and systems, including device power, air conditioning, heating, fans, lights, and all other devices.
   a. Diagram Type:
      1) Ladder Diagrams: Include devices, related to discrete functions, that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.
   b. Item Identification: Identify each item with attributes listed.
      1) Wires: Wire number and color. Cable number if part of multiconductor cable.
      2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
      3) Discrete Components:
         a) Tag number, terminal numbers, and location (“FIELD”, enclosure number, or MCC number).
         b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
      4) 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. Underline normally closed contacts.
      5) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
   c. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be permitted.
d. Ground wires, surge protectors, and connections.

6. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.

7. Loop wiring diagrams that include numbered terminal designations showing all external interfaces.
   a. Individual wiring diagram for each analog or pulse frequency loop, one loop per drawing.
   b. Divide each loop diagram into areas for panel face, back-of-panel, and field.
   c. Show: Terminal numbers, dc power supply connection, and location of common dropping resistors.

8. Software submittals for all systems software, including all operating systems, all licensed application software components, and all custom configured software applications.
   a. Preliminary PLC and HMI Software (prior to Applications Software Workshop):
      1) Preliminary Pneumatic Crest Gate Controls document that updates the Pneumatic Crest Gate Controls included in the Article Supplements. Shall conform with, and to include, all interfaces, controls, alarms, and any other required functionality based on all final submitted and approved systems and equipment.
     2) Preliminary Waveshaper Gate Controls document that updates the Waveshaper Gate Controls included in Article Supplements. Shall conform with, and to include, all interfaces, controls, alarms, and all other functionality based on any other required functionality base on all final submitted and approved systems and equipment.
     3) Preliminary HMI graphics that conform with the Preliminary Pneumatic Crest Gate Controls.
     4) Preliminary HMI graphics that conform with the Preliminary Waveshaper Gate Controls.
     5) Preliminary Remote Access Document to each HMI that provides information and procedures for remote desktop access.

9. Final PLC and HMI Software (after Applications Software Workshop):
   a. Incorporate all agreements from the applications software workshops:
      1) All PLC applications.
      2) All HMI applications.
      3) All modifications shall be included in an updated and Final Pneumatic Crest Gate Controls document.
      4) All modifications shall be included in an updated and Final Waveshaper Gate Controls document.
5) All modifications shall be incorporated in the Remote Access Document.

10. Network Software:
   a. All network device applications software and configuration.
   b. Offsite Remote Access:
      1) Workshop materials in advance of workshop.
      2) End user logon process and procedures and requirements.
      3) Final logon process and procedure that results from the remote access workshop.

11. Seismic anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

2. Programmable Controller and HMI Submittals:
   a. Complete set of user manuals.
   b. Complete and fully documented all applications ladder logic, function blocks, and any other PLC programming listings.
   c. Complete and fully documented HMI graphics and all applications configuration.
   d. Complete and fully documented any custom applications for remote access.
   e. Gate System Suppliers list of proposed spares, expendables, and test equipment.

3. Manufacturer’s Certificate of Proper Installation.

4. Functional Test and Performance Tests Submittals:
   a. Final Test Procedures: Final test procedures, forms, and checklists.
   b. Test Documentation: Copy of signed off test procedures when tests are completed.

5. Operation and Maintenance (O&M) Manuals: In accordance with Section 01 78 23, Operation and Maintenance Data, unless otherwise specified in this Section.
   a. Content and Format:
      1) Complete sets O&M manuals.
      2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PIC component.
      3) Manual format in accordance with Section 01 78 23, Operation and Maintenance Data.
b. Include:
   1) Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PIC design.
   2) Drawings and Software:
      a) Bill of Materials.
      b) Catalog Cuts.
      c) Component Data Sheets.
      d) Panel Wiring Diagrams.
      e) Loop Diagrams.
      f) Application Software Documentation.
   3) Device O&M manuals for components, electrical devices, and mechanical devices include:
      a) Operations procedures.
      b) Installation requirements and procedures.
      c) Maintenance requirements and procedures.
      d) Troubleshooting procedures.
      e) Calibration procedures.
      f) Internal schematic and wiring diagrams.
      g) Component Calibration Sheets from field quality control calibrations.
   4) List of spares, expendables, test equipment and tools provided.
   5) List of additional spares, expendables, test equipment and tools recommended.

1.05 APPLICATION SOFTWARE DEVELOPMENT WORKSHOPS

A. Gate System Supplier control system team shall lead an application software development workshop for each of the two major gate system panels to ensure conformance with project-wide application software requirements. The workshops will be held at the Owner's site. Workshop shall be split into two separate sessions of up to 8 hours each, one for each gate system type (Pneumatic Crest Gate Controls; pneumatic gates, and the Waveshaper Gate Controls; hydraulic gates).

1. All software and panel submittals shall be complete and approved prior to the workshops.
2. Provide all necessary information for all workshop topics, lead the workshop, provide coordination with all attendees, and document all applications software decisions in final software submittal.
3. Purpose: Coordinate with Owner, Gate System Supplier, and Engineer to ensure software controls interface requirements are understood, and necessary information is exchanged to complete a fully functional
control system. Workshop to be held no less than 30 days prior to applications software development.

4. Preparation in Advance: Provide preliminary submittals and receive approval of submittals in advance of the workshop, including all preliminary concepts, details, control functionality, alarming, remote access, graphics, and all other details for each of the system controls that require input from the Owner and Engineer.

B. Workshop Topics:

1. One workshop for each of the Pneumatic Crest Gate Controls and the Waveshaper Gate Controls.
   a. Final control of the respective system.
   b. Specific signals, alarms, and control functions required and/or available from the HMI.
   c. Tagname assignments for every data points.
   d. Local HMI alarm management and identification of all alarms.
   e. Remote Win911 alarm management procedures, including receipt of alarms, remote acknowledgment or not, and identification of all dial out alarms.
   f. Identify all control functionality.
   g. Identification and content for all HMI graphics.
   h. Network address assignments.
   i. Preliminary HMI interface graphics for the respective systems.
   j. Respective system PLC and HMI test plans.

C. Required Attendance:

1. Provide for workshop attendance for the following individuals:
   a. Gate System Supplier PLC software programmer responsible for project PLC application software.
   b. Gate System Supplier HMI software programmer responsible for project HMI application software.
   c. Gate System Supplier Project Manager.
   d. Owner.
   e. Engineer.
1.06 OFFSITE REMOTE ACCESS APPLICATION WORKSHOP

A. Gate System Supplier controls team, and Camera System supplier shall lead an offsite application workshop for coordination, setup, and configuration of the two system access from offsite remote login over cellular network to ensure conformance with end user only logging on via a single cell service and single log in requirement and full access to each of the control system and the camera system. The workshop will be held at the Owner’s site. Workshop shall be one sessions of up to 8 hours.

1. All software and panel submittals shall be complete and approved prior to the workshops.
2. Provide all necessary information for all workshop topics, lead the workshop, provide coordination with all attendees, and document all applications software decisions in final software submittal.
3. Purpose: Coordinate with Owner, camera system supplier, Gate System Supplier control system team, and Engineer to ensure fully coordinated offsite remote access has been coordinated between the two systems. Workshop to be held no less than 90 days prior to field functional startup.
4. Preparation in Advance:
   a. Coordination with camera system supplier.
   b. Provide preliminary submittals and receive approval of submittals in advance of the workshop, including all preliminary concepts, details, control functionality, alarming, remote access, graphics, and all other details for each of the system controls to that require input from the Owner and Engineer.

B. Workshop Topics:

1. System configuration to accommodate single end user offsite remote log on to both the camera system and the control system.
2. Offsite Remote access, logon, security, alarms, use, and complete functionality.

C. Required Attendance:

1. Provide for workshop attendance by for the following individuals:
   a. Gate System Supplier PLC software programmer responsible for project PLC application software.
   b. Gate System Supplier HMI software programmer responsible for project HMI application software.
   c. Gate System Supplier Project Manager.
   d. Camera System Supplier network configuration specialist.
1.07 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.08 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:
   1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
   2. Light Bulb: 100 percent, 2 minimum, of each type used.
   3. Fuse: 100 percent, 5 minimum, of each type used.
   4. Surge Suppressors: 20 percent, one minimum, of each type used.
   5. PLC Modules and PLC Power Supply: One of each type used.
   6. DC Power Supply and Batteries: One of each type, or module, used.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide process instrumentation and control functions shown on Drawings and required in related sections for each system and loop. Furnish equipment items required in related sections. Furnish materials, equipment, and software, whether indicated or not, necessary to effect required system and loop performance.

2.02 HYDRAULIC GATE SYSTEM

A. Waveshaper Gate Control Requirements: Refer to Article Supplements for gate controls.

2.03 PNEUMATIC GATE SYSTEM

A. Pneumatic Gate Control Requirements: Refer to Article Supplements for gate controls.

2.04 SIGNAL CHARACTERISTICS

A. Analog Signals:
   1. 4 mA dc to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
3. Transmitters: Load resistance capability conforming to Class L.
4. Fully isolate input and output signals of transmitters and receivers.

B. Discrete Signals:
   1. Two-state logic signals.
   2. Utilize 120V ac sources for control and alarm signals.
   3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

2.05 LEVEL COMPONENTS

A. As shown on Drawings for each instrument type and location. Refer to Instrumentation & Controls, Mechanical, Electrical, and Structural drawings for each instrument application.

B. Level Element and Transmitter, Radar:
   1. General:
      a. Function: Measure and transmit a lake level signal proportional to level. Utilize 80-GHz radar developed according to the international functional safety directive IEC 61508. Size the unit, including sensor, bell, extensions, and mounting such that the beam angle shall not exceed 3 degrees.
      b. Type: Radar pulse-time-of-flight, loop powered.
   2. Service:
      b. Pressure: 0 psig to 150 psig.
      c. Process Temperature: Minus 40 degrees F to 392 degrees F.
      d. Range: As noted.
      e. Accuracy: Plus or minus 0.04 inch.
   3. Process Connections: As shown on Drawings.
   4. Signal Interface: 4 mA dc to 20 mA dc output, for load impedance of 0 ohms to 500 ohms, minimum for 25V dc supply, without load adjustments.
   5. Enclosure: Dual housing stainless steel with integral antenna and stainless steel weather protection cover for outdoor mounted transmitter and integral antenna.
   6. Antenna: PTFE cladded flush mount, 3 inches with PTFE seal.
   7. Wetted Parts: Type 326 stainless steel, unless otherwise noted.
C. Level Element/Transmitter, Submersible:

1. General:
   a. Function: Measure and transmit signal proportional to flume level.
   b. Type: Totally submersible pressure sensor (loop powered).
   c. Parts: Sensor, interconnecting cable, mounting screw for connection to thread-o-let mounting on flange, other parts as noted.

2. Service:
   a. Fluid: Well water, unless otherwise noted.

3. Performance:
   a. Process Range:
      1) As noted.
      2) Provide calibrated factory range to match noted process range.
   b. Accuracy: 0.3 percent of full scale.
   c. Temperature, Operating: 14 degrees F to plus 140 degrees F.
   d. Overpressure:
      1) Proof: At least 1.5 times full scale.
      2) Burst: At least 2.0 times full scale.

4. Features:
   a. Element:
      1) Type 316 stainless steel or titanium pressure module assembly, unless otherwise noted.
      2) NEMA 6/IP 68 rating (submersible).
      3) Dimensions, Nominal:
         a) Diameter: 0.92 inches or less, suitable for installation in 1-inch diameter well sensor pipe.
         b) Length: 10 inches maximum.
      4) Loop powered, 10V dc to 30V dc.
   b. Interconnecting Cable:
      1) Length: As required on Drawings.
      2) Strain relief cord.
      3) Integral vent tube.
   c. Element Termination Enclosure:
      1) Enclosure: NEMA 4X.
      2) Termination of cable wiring.
      3) Houses moisture control elements, including desiccant vent, filter, microfilter.
   d. Accessories:
      1) Moisture Control:
         a) Terminate the integral vent tube with one of the following:
            (1) Moisture filter cap.
(2) Aneroid bellows.

(3) Desiccant module.

2) Spare Desiccant Modules: One per element when desiccant modules are provided.

3) Cable Hanger, Kellems Type Grip: Required, unless otherwise noted.

4) Anchor Assembly: If noted.
   a) Marine anchor, clamps, Type 316 stainless steel cable or chain, length as required, nominally 3 feet longer than interconnecting cable.

5. Signal Interface: 4 mA to 20 mA dc output, for load impedance of 0 ohm to 600 ohms, minimum for 24V dc supply without load adjustment.

6. Manufacturers and Products:
   a. Endress and Hauser; Waterpilot FMX 21.
   b. GE Sensing; Druck PTX 1830.

2.06 PRESSURE COMPONENTS

A. As shown on Drawings.

B. Pressure Transmitter:

1. General:
   a. Function: Measure pressure and transmit signal proportional to pressure.
   b. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; “smart electronics.”
   c. Parts: Transmitter and accessories.

2. Performance:
   a. Range: As noted. Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
   b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
   c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
   d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
   e. Humidity: 0 percent to 100 percent relative humidity.
   f. Hazardous Location Certifications: If and as noted.
3. Features:
   a. Type: Gauge pressure, unless otherwise noted.
   b. Adjustable damping.
   c. LCD indicator, unless otherwise noted. Display in either percent or engineering units, field configurable.
   d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted. Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
   e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
   f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
   g. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.

5. Signal Interface: 4 mA dc to 20 mA dc output.

6. Enclosure:
   a. Type: NEMA 4X, minimum, unless otherwise noted.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.

7. Accessories:
   a. Two-valve (isolate and vent) Stainless Steel Manifold: Required unless otherwise noted.

8. Manufacturers and Products:
   a. Absolute Pressure Units:
      1) Endress and Hauser; Cerabar PMC71.
      2) Rosemount; Model 3051S.

2.07 ALARM COMPONENTS

A. Horn and Beacon:

1. General: Devices shall be electronic horn with integral beacon.

2. Requirements:
   a. Recordable horn with amber LED beacon, gray housing.
   b. Power: 120V ac with 602 mA maximum current.
   c. Horn Type: 126 dB (A) tone at 1 m (3.3 feet), 45 tones.
2.08 CONTROL PANELS - NETWORK COMPONENTS AND CONTROL COMPONENTS

A. Refer to Instrumentation & Controls and Electrical drawings for quantities and locations.

B. Programmable Logic Controller:

1. Solid state units capable of performing same function as conventional relays, timers, counters, sequencers, arithmetic, and other special functions necessary to perform required control functions. Provide quantity of all modules for inputs and outputs (I/O) to accommodate all signals as shown on the drawings, all I/O required to conform with the final approved equipment submittals, all I/O required to conform with the final approved Pneumatic Crest Gate Controls and Waveshaper Gate Controls, and all spare I/O requirements.

2. Discrete inputs shall be 120V ac. Discrete outputs shall be relay type discrete contacts rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator. All discrete I/O shall be optically isolated at 2,500V rms.

3. Analog Inputs and Outputs: 4 mA dc to 20 mA dc per channel. Inputs and outputs shall be isolated.

4. Rack power supplies shall be integral to the rack, Allen-Bradley P/N 1756-PA75.

5. Minimum of 10 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions. All spare points on each card shall be wired to spare terminal blocks inside the panel.

6. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 degrees C to 60 degrees C and up to 95 percent humidity, noncondensing.

7. Environmental:
   a. Operating Temperature: 32 degrees F to 140 degrees F.
   b. Humidity: 5 percent to 9 percent noncondensing.
   c. Vibration: 5 g at 10 to 500-Hz.
   d. Operating Shock: 20g.
   e. ESD Immunity:
      1) 6 kV contact discharges.
      2) 8 kV air discharges.
8. Mounting: DIN rail or panel mount.

9. Memory Size:
   a. Shall be sized to allow for 30 percent spare memory after final PLC program is completed.
   b. Minimum 10 MB with 750 KB user memory.

10. CompactFlash Card: Yes.

11. Communications:
   a. Processor Ports: One Ethernet/IP 10/100 Base-T port.
   b. Ethernet Communication Module, Non-redundant: Allen-Bradley P/N 1756-EN2T,

12. Power Dissipation: 5.5 Watts.

13. Weight: 0.66 pounds.


15. Programming Languages:
   a. Ladder diagram.
   b. Function block diagram.


17. I/O Modules:
   a. Discrete Input:
      1) Operating Voltage: 120V ac.
      2) Individually isolated.
      3) Eight points per module.
      4) Allen Bradley P/N 1756-IB16I.
   b. Discrete Output:
      1) Operating Voltage:
         a) 5V ac to 265V ac.
         b) 5V dc to 125V dc.
      2) Individually isolated, relay contact module.
      3) Current Rating Point: 2.5 amperes minimum.
      4) Current Rating per Module: 16 amperes minimum.
      5) 16 points per module.
      6) Allen Bradley P/N 1756-OW16I.
   c. Analog Input:
      1) 4 mA to 20 mA.
      2) Individually isolated.
      3) Four channels per module.
      4) Allen Bradley P/N 1756-IF8I.
   d. Analog Output:
      1) 4 mA to 20 mA.
      2) Individually isolated.
      3) Four channels per module.
      4) Allen Bradley P/N 1756-OF8I.
18. Manufacturer and Product: Allen-Bradley; Control Logix. Provide 1756-L83 CPU.

C. Operator Interface Unit:

1. Color LCD display with graphics and text displays, screen navigation, status and alarm indication, and operator control and setpoint adjustment.
2. Touch screen or membrane keypad interface.
3. Manufacturers and Products:
   a. Allen Bradley; Panelview Plus 6; size 1000 or higher.

D. Industrial Cell Modem and Antenna:

1. Provide real-time remote connectivity.
2. DIN rail mount with accessory bracket.
3. Low power consumption, 2G with LTE performance at 900 mW in idle.
4. Support wide range of LTE bands and LTE-advanced up to 300 Mbps downlink speeds.
5. Fully automatic network operator switching (insert SIM).
6. Network connectivity via Ethernet, Serial, and USB.
7. Dual-SIM functionality to enable automatic failover between SIMs.
8. Support up to five VPN tunnels for secure cellular communications.
9. Remote configuration, software update, and monitoring with cloud-based management services or on-premises with Mobility Manager.
11. Antenna:
   a. Low profile housing.
   b. Ground plane independent.
   c. Omni directional patterned with two antenna elements with effective isolation and correlation covering all current global cellular and LTE bands in frequency range 698-960/1710-3800 MHz, and active GNSS antenna for positioning or timing and single Wi-Fi element.
   d. Greater than 50 percent efficiency.
E. Hardened Wireless Access Point (WAP) with External Antenna:

1. WAP:
   a. Hardware:
      1) IP67 high density 802.11 ac (Wave 2) outdoor case.
      2) Two radio plus one BT/BLE.
      3) Four external (Type N) plus one BT/BLE external (RP-SNA).
      4) Dipole Antenna Type/Gain: 5 dBi for 2.4-GHz and 7 dBi for 5-GHz.
      5) Radio 1: 2-GHz up to 400 Mbps.
      6) Radio 2: 5-GHz up to 867 Mbps.
      7) Bluetooth (BT/BLE).
      8) One GE RJ45 interface.
      9) IEEE 802.3 af at PoE.
      10) Sixteen simultaneous SSIDs (14-client/2 monitor).
      11) SSID Types Supported: Local-Bridge, Tunnel, and Mesh.
      12) Up to 512 per radio client capacity.
   b. Advanced Features:
      1) 802.11 ac (Wave 2) MU-MIMO.
      2) Transmit beam forming.
      3) Low-density parity check encoding.
      4) Maxi Likelihood demodulation.
      5) Maxi ratio combining.
      6) 802.11 ac 20/40/80 MHz channel.
      8) MIMO power save.
      9) Short guard interval.
   c. Manufacturer and Model Number: FortiNet FortiAP FAP-222E-A.

2. Antenna:
   a. Low profile housing.
   b. Ground plane independent
   c. Omni directional patterned with two antenna elements with effective isolation and correlation covering all current global cellular and LTE bands in frequency range 698-960/1710-3800 MHz, and active GNSS antenna for positioning or timing and single Wi-Fi element
   d. Greater than 50 percent efficiency.
   e. Manufacturer and Product: Sierra Wireless AirLink Antenna; 4-in-1 panel.
F. Cellular Phone and Data Plan:
   1. Provide 5G unlimited plan with 4G LTE up to 75 GB for remote access.
   2. Account shall be provided and paid by Gate System Supplier thru substantial completion at which time the account shall be switched to end user.
   3. Account shall be set up in the end user name.

G. WiFi Switch:
   1. Unmanaged hardened gigabit Ethernet PoE+ switch:
      a. Complies with IEEE 802.3 at and IEEE 802.3 af.
      b. Four 10/100/1000 Base-T PoE+ ports with two 100/1000 dual speed SFP slots with up to 30 watts on each PoE port simultaneously.
      c. Manufacturer and Model: Transition Networks SISTP1040-342-LRT.
   2. MSA Compliant 1000Base Fiber Channel SFP Modules:
      a. 1000Base-LX Single Mode (LC).
      b. Manufacturer and Model: Transition Networks TN-SFP-LX Series.

H. Control Switch:
   1. Industrial managed Ethernet switch:
      a. 10-Port switch:
         1) FE: Eight RJ45.
         2) GE: Two combination Gigabit ports.
         3) Firmware: Full.
         4) Manufacturer and Model: Rockwell Automation; Stratix 5700 Ethernet Managed Switches, 1783-BMS10CGA.
      b. Small Form-factor Pluggable (SFP) Modules for Single Mode Fiber and Dual LC Connector Interface:
         1) 100/1000Base SFP Slot: SFP Module.
         2) Manufacturer and Model: Rockwell Automation Stratix 1783-SFP1GLX.

I. Firewall:
   1. All-in-one high performance network security and virtual private network (VPN) gateway.
   2. Fanless, ruggedized design.
   3. Interfaces:
      a. USB Management Port.
      b. Console Port (RJ45).
c. 4x GE RJ45 Ports.
d. 2x Shared Media (GE RJ45 ports/GE SFP slots) Pairs.
e. 1x DB9 Serial Interface.

4. System:
   a. 1.5 Gbps IPv4 firewall throughput.
   b. 4 microsecond latency.
   c. 2.2 Mpps firewall throughput.
   d. 500,000 concurrent sessions (TCP).
   e. 4,000 new sessions per second (TCP).
   f. 5,000 firewall policies.
   g. 1 Gbps IPsec VPN throughput.
   h. 200 gateway-gateway VPN tunnels.
   i. 500 client-gateway VPN tunnels.
   j. 30 Mbps SSL-VPN throughput.
   k. 100 concurrent SSL-VPN users.
   l. 95 Mbps application control throughput.
   m. Maximum 10 virtual domains.
   n. Maximum 10 Aps.
   o. Maximum 100 tokens.
   p. Maximum 200 registered clients.
   q. Active-active, active-passive, and clustering high availability configurations.

5. Security Services: Bundle - 24/7 Enterprise Protection.


7. Mobile Password Application with Push Notification:
   a. One-time password application with push notification.
   b. Two-factor solution for authentication.
   c. Android, iOS, Windows mobile device compatible.
   d. Push notification view login on mobile device.

8. Manufacturer and Product: FortiGate Rugged Series; Model 60D with FortiToken Mobile FTM-ELIC-20.

J. Fiber Optic Patch Panel:

1. Compact DIN-Rail, or surface, mounted fiber optic patch panel sized to match quantity of single mode fibers, per Division 26 Electrical, and as shown on Drawings.
2. UL Listed 1863, CE.
3. 18-gauge powder-coat painted steel.
4. UL 90 V-0 thermoplastic fiber optic adapters.
5. Plastic cable glands as required for cable size and fiber quantity.
7. Manufacturer and Model: Dinspace, SNAP XL Compact Fiber Optic Patch Panel.
K. Panel Mount Industrial HMI Personal Computer (PC), Software, and Monitor:

1. General:
   a. Stable, durable, industrial rated, in a small form factor PC and external monitor, for use with Rockwell Automation FactoryTalk View SE.
   b. Featuring an ultra-long lifecycle with mandatory high heat and dust tolerance.
   d. Workstation: Panel internal with mounting bracket.

2. PC System:
   a. Processor: Intel Core™ i7-8700 (6 Cores/12MB/12T/up to 4.6GHz/65W).
   c. Software:
      1) Windows 10 Professional 64-bit Media Kit.
      2) Microsoft Office.
      3) Adobe Reader.
   e. Memory: 16 GB (1x16GB), 2666 MHz, DDR4 Non-ECC.
   f. Hard Drive: M.2 1TB PCIe NVMe, Class 40, Solid State Drive, SSD.
   h. Chassis: Small Form Factor.
   k. Additional Networking Card: 2nd Intel Gigabit NIC PCIe Card (Low Profile).
   l. DVD Drive: 8X DVD-ROM Drive.
   m. Speaker: Internal Dell Business Audio Speaker.
   n. Accessories and Options:
      1) No diagnostic/Recovery CD media.
      2) No quick reference guide.
      3) No Parallel or Serial Port.
      4) No Out-of-Band Systems Management.
      5) Dust filter for Small Form Factor.
      6) DP to DVI dongle.
      7) Waves Maxx Audio.
      8) Chassis intrusion switch.
      9) Computrace Disable Info Mod.
      10) System Power Cord.
Support:
1) ProSupport: 5 Years ProSupport with 4HR 7x24
   In-Home/Onsite Service After Remote Diagnosis.

Manufacturer and Product: Dell; OptiPlex XE3 Small Form Factor.

Accessory Mounting Bracket:
1) Internal panel mounting.
2) Wall Mount Desktop Small Form Factor CPU Bracket:
   a) Maximum dimension 7.75-inch wide by 18-inch depth.
   b) 75-pound weight capacity.
   c) Incorporate mounting with control panel design.
      (1) Hydraulic System Control Panel.
      (2) Compressed Air Control Panel.
      (3) Optional mount on side panel or back of front panel. Provide custom panel support if back of door mounted.
3) Kendall Howard; 1915-1-300-0.

HMI Software:
1) Rockwell Automation FactoryTalk View SE.
   1) FactoryTalk View SE Server 100 w/RSLinx Enterprise, one each to be installed on:
      a) Compressed Air Control Panel PC.
      b) Hydraulic System Control Panel PC.
      c) Total Quantity: Two.
   2) FactoryTalk View SE Client to be installed on the Compressed Air Control Panel:
      a) Total Quantity: One.
   3) FactoryTalk View Studio for FactoryTalk View Enterprise:
      a) Total Quantity: One.

Remote Desktop Logon Application:
1) Configure TightVNC to Remote Desktop to the Compressed Air Control Panel via cell modem and ghost to the Hydraulic System Control Panel from the Compressed Air Control Panel using FactoryTalk View SE Workgroup.

Industrial Monitor and Touchscreen System:
1) 23-inch Industrial Monitor:
   a) Touchscreen:
      (1) 5-wire resistive system.
      (2) Mouse emulation.
      (3) RS-232 and USB connection to host computer.
   b) Bright 250 NIT display, 1000:1 contrast ratio.
   c) High Resolution, 1920 by 1080 (1080p).
d) Widescreen aspect ratio (16:9).

2) Physical:
   a) Panel mount, rear collar compressed gasket against panel held with 14 M, 5 studs.
   b) Depth: 2.05 inches behind panel maximum.
   c) Stainless steel bezel.
   d) Environmental Rating:
      (1) Compressed Air Control Panel HMI shall be NEMA 12 rated.
      (2) Hydraulic System Control Panel HMI shall be NEMA 4X rated.
      (3) High Temperature Rate: 32 degrees F to 122 degrees F.
      (4) Shock Resistant: 15 g, 6 msec, half-sine.
      (5) Vibration Resistant:
         a) Sine: 1.0g, swept sine 9-Hz to 500-Hz.
         b) Random: 0.1 g^2/Hz 10-Hz to 200-Hz, 0.03 g^2/Hz, 200-Hz to 2,000-Hz.

   e) Ratings:
      (1) 120V ac input.
      (2) UL508A.

3) Hope Industrial Systems; HIS-ML23

6. Industrial Monitor and Touchscreen Lockable Cover:
   a. General:
      1) Provides a hinged, locking window cover for the Hydraulic System Control Panel HMI that is located outdoors and accessible to the public.
      2) HMI cover to provide protection for HMI Monitor. The cover shall be a strong and rigid design, mounting securely to the outside of enclosure, and accessibility to HMI.
      3) HMI cover kits are UL recognized and maintain a NEMA 4X seal with the use of our Formed-In-Place (FIP) polyurethane gasket system, and is well-suited for outdoor applications. Multiple cover latching options are also available, including a hinge screw, tamper proof screw, and snap latch model. All are available in solid opaque or polycarbonate thermoplastic clear covers.
   b. Requirements:
      1) Clear polycarbonate thermoplastic cover sized to cover the HMI Monitor.
      2) Hinged, or latching, with locking mechanism.
3) HMI cover shall be UL recognized and maintain a NEMA 4X seal with the use of our Formed-In-Place (FIP) polyurethane gasket system, and well-suited for outdoor applications.

c. Manufacturer: Allied Moulded Products, Hoffman.

L. Alarm Notification System:

1. General: Provides advances in reliability, security, and flexibility in a complete run-time, all the time alarm notification system. Provide direct connections with HMI system. Direct connect shall enable ease of configuration, performance optimization, and syncing of alarm acknowledgments and other data. Alarm subscriptions filter alerts into Alarm Notification System, eliminating the need to maintain two databases for faster integration, simplified setup, and reduced maintenance.

2. Requirements:
   a. Includes 2-way Communication with All Notifiers: SMS, Email, Voice, and up to 10 Smartphone Apps.
   b. Includes Announcer.
   c. Allows for remote acknowledgments, alarm requests, report requests.
   d. Includes Basic Escalation/Call Out List.


M. Operator Tablet:

1. General: Provide two completely identical and fully configured tablets that shall provide operator staff to carry a mobile device to access the HMI system for the purpose of standing at the Flume Entrance and to monitor and control all of the Flume Entrance Gates from the operator mobile device.

2. Quantity: Two, to provide for redundancy and spare.

3. Requirements:
   a. 32GB memory.
   b. WiFi + Cellular with GSM/Edge, UMTS/HSPA/HSPA+/DC-HSDPA, Gigabit-class LTE.
   c. Screen: Nominal 10 inches by 7 inches with a 10.2-inch diagonal LED-backlit Multi-Touch display with IPS technology, 2160x1620 pixel resolution at 264-pixel per inch.
   d. Built in GPS/GNSS.
   e. Cellular.
   f. Case: Otterbox Defender Series Case.
4. Manufacturer and Model: Apple, iPad (7th Generation) with WiFi + Cellular.

2.09 CONTROL PANELS

A. Refer to the Drawings, Instrumentation & Controls drawings, and the Electrical drawings, for:

1. Panel quantities.
2. Panel maximum panel dimensions.
3. Panel locations.
4. Panel air conditioners and air conditioner power supply.
5. Panel hardware including all panel control components, all panel network components.
6. NOTES:
   a. Hydraulic System Control Panel shall be lockable.
   b. Not all panel control components are shown in final quantities. This includes but not limited to internal power supplies, final PLC I/O modules, and other control components.

B. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

C. Conform to NEMA ratings as required to meet locations on Drawings.

D. Minimum Metal Thickness: 12-gauge.

E. Outdoor Panels: NEMA 250, Type 4X Outdoor Panels: Type 12 gauge Type 304 stainless steel construction unless otherwise specified.

F. Indoor Panels: NEMA 250, Type 12 gauge steel construction.

G. Doors:
   1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and 12 panels with doors higher than 18 inches.
   2. For other doors, stainless steel quick release clamps.
   3. Outdoor panels shall be lockable. Include a very heavy duty keyed padlock with each outdoor panel that will be permanently installed and key accessed by the end user.

H. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.
I. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

J. Temperature Control:
   1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
   2. Furnish cooling fans with air filters if required to dissipate heat.
   3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.
   4. Size and include air conditioner for all panels as shown on Drawings.
      a. Manufacturer: Ice Qube or EIC.

K. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

L. Lighting: Minimum of one hand switch controlled internal light for panels 12 cubic feet and larger.

M. Finish:
   1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer’s standard gray unless otherwise specified.
   2. Internal Surfaces: White enamel.

N. Panel Manufacturers:
   1. Hoffman.
   2. H.F. Cox.

O. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.
   1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

2.10 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:
   1. Northern Instruments; Model Zerust VC.
   2. Hoffmann Engineering; Model A-HCI.

2.11 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.
B. Control hardware, network hardware, and electrical components, terminals, wires, and enclosures UL recognized or UL listed. All components shall be modified as necessary and included in the submittals that conform to the UL 508A code such that any non-compliant components would not constitute any deviation from the UL 508A labelling of the panels.

C. Control Panels without Motor Starters:

1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
3. Circuit Breakers:
   a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
   b. Branch Circuit Breakers: 15 amps at 250V ac.
   c. Breaker Manufacturers and Products:
      1) Heineman Electric Co.; Series AM.
      2) Airpax/North American Philips Controls Corp.; Series 205.

D. Wiring:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleeve.
      2) Tyco Electronics.
E. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer’s standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

F. Terminal Blocks:

1. Quantity:
   a. For external connections.
   b. Wire all spare PLC I/O points, or unused panel mounted elements, to their panels’ terminal blocks.
   c. Spare Terminals: 10 percent of connected terminals, but not less than 10 of each type terminal.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
   a. Connection Type: Screw connection clamp.
   b. Compression Clamp:
      1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
      2) Guides strands of wire into terminal.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funnel shaped inputs to facilitate wire entry.
   f. Mounting:
      1) DIN Rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: One at each end of rail, minimum.
   g. Wire Preparation: Stripping only.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block.
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown.
3. Terminal Block, 120-Volt Power:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 22 through 10 AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Gray body.
f. Spacing: 0.25-inch, maximum.
g. Manufacturer and Product: Phoenix Contact, Entrelec.

4. Terminal Block, Ground:
   a. Wire Size: 22 through 12 AWG.
   b. Rated Wire Size: 12 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25-inch, maximum.
   e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
   f. Manufacturer and Product: Phoenix Contact, Entrelec.

5. Terminal Block, Blade Disconnect Switch:
   a. Use: Provide one for each discrete input and output field interface wire.
   b. Rated Voltage: 600V ac.
   c. Rated Current: 10 amp.
   d. Wire Size: 22 through 12 AWG.
   e. Rated Wire Size: 12 AWG.
   f. Color: Gray body, orange switch.
   g. Spacing: 0.25-inch, maximum.
   h. Manufacturer and Product: Phoenix Contact, Entrelec.

6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 6.3 amp.
   c. Wire Size: 22 through 12 AWG.
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: LED diode 24V dc.
   i. Leakage Current: 5.2 mA, maximum.
   j. Spacing: 0.32-inch, maximum.
   k. Manufacturer and Product: Phoenix Contact, Entrelec.

7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 6.3 amp.
   c. Wire Size: 22 through 12 AWG.
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
h. Indication: Neon lamp 110V ac.

i. Leakage Current: 1.8 mA, maximum.

j. Spacing: 0.32-inch, maximum.

k. Manufacturer and Product: Phoenix Contact, Entrelec.

G. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

H. Intrinsic Safety Barriers:

1. Refer to Drawings, Electrical and Mechanical drawings for any classified areas requiring rated intrinsically rated circuits.

2. Mounted in enclosure provided by Gate System Supplier with circuits included in all panel drawings and wiring diagrams.

3. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturer and Product: Turck; MTL, Inc.; Series MTL 5000.
   b. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   c. Manufacturer: Turck.

I. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
   b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.

2. Pushbutton, E-Stop, Lockable Cover, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type key release with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Compliant with global E-stop standards, including EN ISO 13850 and EN 60947-5-5. Use key release type for outdoor service.
   c. Standard size, black field, legend plates with white markings for service legend.
   d. Manufacturers and Products:
      1) Square D.
      2) Allen-Bradley.
J. Dual 24V dc Power Supply:

1. Line voltage: 85V ac to 132V ac.
2. Frequency: 47-Hz to 63-Hz.
3. Tolerance: Less than 2 percent overall.
4. Temperature: Minus 10 degrees C to 60 degrees C.
5. Dual power: Provide dual power supplies with automatic switching power supply redundancy manager between dual power supplies.
6. Features:
   a. Adjustable voltage.
   b. DC ok signal.
   c. Status indicators, Green LED.
7. Fusing: Internally fused, external 10A slow acting fusing of input required.
10. Manufacturer and Product: Phoenix Contact; Model Quint PS series.

K. Uninterruptable Power Supply 24V dc:

1. Provide an industrial DIN rail mounted system with a minimum of 15 minutes, including sizing calculations, of continuous 24V dc power in the event of power malfunction for dc loads.
2. Provide battery modules based on sizing calculations.
3. Automatic battery detection.
4. Monitor output as status to the PLC, where the UPS is mounted in a PLC control panel.
5. Cold restart function.
8. Manufacturer and Model: Phoenix Contact; Quint4-UPS.

L. Uninterruptable Power Supply 120V ac:

1. Provide an industrial DIN rail mounted system with a minimum of 20 minutes, including sizing calculations, of continuous 120V ac power in the event of power malfunction for dc loads. 120V ac unit may be used for entire panel backup power in lieu of dc UPS and ac UPS.
2. High temperature rated, user replaceable, batteries.
3. Monitor output as status to the PLC, where the UPS is mounted in a PLC control panel.
4. Protects connected loads from surges, spikes, lightning, and other power disturbances.
5. Cold start capability.
6. Automatically starts up the connected equipment upon the return of utility power.
7. Periodic automatic battery self-test ensures early detection of a battery that needs to be replaced.
8. Input Voltage 120V ac.
9. Output Voltage 120V ac.

2.12 INSTRUMENT TAG NUMBERS

A. As shown on Drawings.

2.13 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.
   1. Panel Mounted: Plastic, mounted to instrument behind panel face.
   2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:
   1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
   2. Color: White with black letters.
   3. Letter Height: 3/16 inch.
   4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2-inch high.

2.14 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.

B. Suppressor Locations:
   1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
   2. On analog pairs at each end when the pair travels outside of building.
3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressor Design:
   1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
   2. Response: 5 nanoseconds maximum.
   4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
   5. Enclosure Mounted: Encapsulated in flame retardant epoxy.

D. Suppressors on 120V ac Power Supply Connections:
   1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
   2. First-Stage Clamping Voltage: 350 volts or less.
   3. Second-Stage Clamping Voltage: 210 volts or less.
   4. Power Supplies for Continuous Operation:
      a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
      b. All Other Applications: Minimum 30 amps at 130V ac.

E. Suppressors on Analog Signal Lines:
   1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
   2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
      a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
      b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
      c. Maximum Loop Resistance: 18 ohms per conductor.
   3. Manufacturers and Products:
      a. Phoenix Contact.
      b. Circuit Components, Inc.; Din Rail SDD-400 Series for Data or Analog Signals.
      c. Joslyn; Model 1663-08.

F. Grounding: Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.
PART 3  EXECUTION

3.01  ELECTRICAL POWER AND SIGNAL WIRING

A.  Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B.  Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

C.  Use manufacturer’s recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.

D.  Do not splice or tap wiring except at device terminals or terminal blocks.

3.02  PROTECTION

A.  Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B.  During Work, periodically replace capsules in accordance with capsule manufacturer’s recommendations. Replace capsules at Substantial Completion.

C.  Installation Contractor is responsible for coordinating the startup, functional testing, and performance testing of the gate system hardware.

D.  The Gate System Supplier shall be responsible for all functional and performance testing of the Gate System Supplier Control System in its entirety. This shall include, but not limited to every gate control system feature, equipment, device, I/O point, all software functions on the PLC/HMI, all network functions, and all offsite remote functions. This shall include testing of all field wiring interfaces to the gates supplied by the Gate System Supplier.

E.  Prior to startup, all equipment shall be tested and inspected for proper alignment, quiet operation, proper connection, and satisfactory performance in conformance with requirements of this Section.
F. Functional Tests:

1. Every gate control system feature, equipment, device, I/O point, all software functions on the PLC/HMI, all network functions, and all offsite remote functions shall be fully tested from the field equipment to the control system.

2. The gates shall be fully tested including the following functions:
   b. Remote automatic control.
   c. Level setpoint (Group 1 and Group 2 Gates) and flow setpoint (Flume Entrance Gates) adjustment and PID control to maintain the associated control setpoint.
   d. Validate all remote monitoring status and alarm signals.

3. Documentation of all control system functional tests shall be provided by the Gate System Supplier to the Owner’s representative for approval. If test results are unsatisfactory, the Gate System Supplier Contractor must remedy the cause of test failure, and retest.

G. Performance Tests: In coordination with Owner and the Gate System Supplier, the gates and the entire Gate System Supplier Control System shall be jointly tested through the full operating range and meet all operating requirements as defined by the final Pneumatic Crest Gate Controls and Waveshaper Gate Controls.

3.03 GATE SYSTEM SUPPLIER’S SERVICES

A. Gate System Supplier PLC and HMI representatives shall be present at the Site, as required, to complete all functional and performance testing of the entire Gate System Supplier Control System.

B. Gate System Supplier PLC and HMI representative shall provide following control system operations training:

1. System Operations:
   a. Duration: Four-hour training session onsite after performance testing has been successfully completed, but prior to startup and operations.
   b. Sessions: Three sessions of the 4-hour training.
   c. Contents: Train Owner on complete operation of the entire Gate Supplier Control System.
2. System Offsite Remote Access:
   a. Duration: Two-hour training session onsite after performance testing has been successfully completed but prior to startup and operations.
   b. Sessions: Two sessions of the 4-hour training.
   c. Contents: Train Owner on complete remote logon process and procedure.

3.04 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are part of this Specification.

1. Pneumatic Crest Gate Controls.
2. Waveshaper Gate Controls.

END OF SECTION
PNEUMATIC CREST GATE CONTROLS

1.01 GENERAL

A. The following control narrative is the basis for the Pneumatic Gate Controls. This control narrative shall be edited, as required by equipment submittals, Gate Supplier coordination, and the Applications Software Workshops input. This control narrative shall be considered final after an approved submittal following the Applications Software Workshops. Provide all applications software, as required, for a complete dam operations and control system as per Dam Operations and Control, hereinafter.

1. References:
   a. Section 35 20 25, Pneumatic Gate System.
   b. Section 35 20 30, Waveshapers™ and Gates.
   c. Section 40 99 90, Package System Controls.
      1) Supplement Pneumatic Crest Gate Controls.
      2) Supplement WaveShaper Gate Controls.

1.02 SYSTEMS OVERVIEW

A. Overview of Compressed Air Control Panel PLC Applications Software:

1. Provide all applications software, including all configuration for all system devices including PLCs, HMI, Switches, Firewall, all network devices, and all other system components that require configuration.

2. Provide Applications Software:
   a. Based on the Approved Final Control Narratives:
      1) Pneumatic Crest Gate Controls.
      2) WaveShapers Gate Controls.
   b. Complete software configurations for Compressed Air Control Panel include:
      1) PLC.
      2) HMI.
      3) Win911.
      4) Offsite Remote Login: Communication with Camera System.
      5) Network communications.
      6) Alarms: Warnings/alarms shall be programmed in the system to alert for malfunctions, errors, or identifiable problems with the equipment, sensors, or questionable operations activities. Input ranges, differences in measurements or calculated parameters should be input into the system, but changeable by the operator.
3. Completed network configuration and communications required for operations of the entire system. Shall include, but not limited to:
   a. Network configuration shall include, but not limited to:
      1) Switches.
      2) Firewall.
      3) All other network devices requiring configuration.
   b. Network Communications:
      1) Device status.
      2) Communications to Offsite Remote Logon: Remote login shall be via the cell modem in the Compressed Air Control Panel and then ghost from the Compressed Air Control Panel to the Hydraulic System Control Panel.
      3) Communications to iPad.
      4) Win911.
   c. All PLC-to-PLC required communications to form a complete Dam Operations and Control, hereinafter. Shall include, but not limited to:
      1) Produce-consume logic to pass specific data.
      2) Specific tags shall include but not limited to:
         a) Critical alarms.
         b) Dam level.
         c) Flume level.
         d) PLC status.
         e) Device status.
         f) All other status as required for a complete dam operations and control system as per Dam Operations and Control, hereinafter.

B. Dam Operations and Control:

1. Overview of Dam Operations and Controls:
   a. Operations and control of the Dam Gates, and the Recreational Flume and the Big Water features shall result in a new operational function for the Dam.
   b. The normal operation of the dam gates is intended to be accomplished through automated control. However, ongoing monitoring of the gate operating system shall be required along with determining the appropriate response to any alarms, or system failure.
   c. In addition to the recreational and public access interests, gate operation shall also need to include consideration of sediment movement, egg passage, and the higher flow conditions in excess of the 12,000 cfs flows normally experienced as the result of hydropower generation and Keystone Lake level management for
flood storage releases. Gate operation shall be controlled by the automated control system based upon maintaining a target lake level. This automated control can be over ridden at any time and manually operating the gates. This mode of operation may be preferred during high river flow conditions to open specific full-height gate for the purpose of selective sediment sluicing from different areas. The specific gate operation shall be determined and optimized over the initial years of operation through experience. Full-height gate operation shall also be specifically done to accommodate egg passage downstream during the spring spawning season.

2. Overview of Dam Facility Operations:
   a. The Zink Dam modifications include both fixed dam modification and addition of new gates along most of the length of the dam. The facilities improvements are intended for the purpose managing the flow extremes in the river to the benefit of the recreational opportunities, while not interfering with flood flow releases from Keystone.
   
   b. Flow in this reach of the Arkansas River is unique and very different from those flows that existed before the construction of Keystone Dam. Flow can range from nonexistent during drought periods to flood flow releases, managed by the USACE, that fill the entire channel because of the expansive size of the Keystone drainage area upstream on the Arkansas River. In addition to these weather-related flows, there are flows related to hydropower generation which is managed by Southwest Power Administration (SWPA). These upstream conditions create a wide range of flows within the river. The Zink Dam PLC applications software and operations HMI shall be developed to control and operate so as to accommodate any flow in the river. Historical records document the flow extremes and unpredictability of the timing of such flows. This historical flow information shall be used in developing the initial operational protocol for gate operation along with other operational goals and in predicting of various operational conditions.
   
   c. Real-time flow release data is available from Keystone Dam as well as from a USGS-managed flow gauging station located on the 11th Street bridge approximately 2 miles upstream of the Zink Dam. Releases from Keystone typically have a river travel time of 8 hours to 9 hours before reaching the Zink Dam location.
   
   d. There must be flow in the river for either the Recreational Flume or future “Big Water” features to function and operate. The river flow is only detained within Zink Lake. The flows that enter Zink Lake will simultaneously flow over the dam and the recreational
features, or through the recreational features and out of the lake. Accordingly, Zink Lake does not store water in the conventional sense as typical dams and lake systems. The source of all flow entering Zink Lake includes:

1) Releases from Keystone Dam:
   a) Hydropower generation flows (6,000 cfs to 12,000 cfs).
   b) Flood releases from drainage area upstream of Keystone (over 300,000 cfs).

2) Hydrologic drainage downstream of Keystone but upstream of Zink Dam.

3) Other miscellaneous facility discharges that are insignificant in quantity.

e. In the absence of any of these sources the river flow is essentially zero.

3. Overall Dam Operations and Control Strategy:
   a. The controls and operations interfaces shall both anticipate, and accommodate, the myriad of flow conditions along with the desired used of the recreational features that are available. The primary anticipated conditions include:
      1) Use of available flow to operate the Recreational Flume
      2) Maintaining the increased Zink Lake elevation of 620.0 feet.
      3) Passing of flood flows.
      4) Gate operation to maximize opportunities for sediment and fish egg passage downstream.
      5) Future use of available flow to operate the WaveShaper “Big Water” features.
         a) Note – the PLC and HMI shall include all programming for the future WaveShaper “Big Water” features.

b. Facility management to achieve these operations will require real-time decisions by operations staff while others shall be automated. An overall operation control philosophy is presented in the following paragraphs.

1) The gate areas are grouped as follows:
   a) Group 1 Gates: All gates within the future WaveShaper Area (These include Entrance Gates to the WaveShapers and ten individually operated 3-foot gates on either side of the Entrance Gates.)
   b) Group 2 Gates: All gates outside the future WaveShaper Area (including 3-foot and 10-foot gates).
   c) Recreational Flume Entrance Gates.
2) Until the WaveShaper area is developed, the 3-foot gates in the future WaveShaper area shall be operated similarly to the other 3-foot gate sections with all panels in a section operating in tandem. The WaveShaper Entrance gates shall not be routinely operated to maintain water surface elevation, but shall be opened when needed to pass flood flows.

3) The most predictable flow in the river corresponds to hydropower generation releases from operation of hydropower generation units at Keystone. The timing and duration of these hydropower releases varies and are not predictable. This variability along with the travel time from Keystone and the “hydraulic routing” effect result in a continuously changing flow condition. Following a hydropower generation release the flow will reach Tulsa and begin to increase the water elevation in Zink Lake. As this occurs, all 3-foot crest gates shall automatically adjust to release flow to maintain the 620.0 lake elevation set point. The following Table, Flow Capacity of Gate Sections at Three Different Positions, illustrates flow capacities of individual gate sections, as well as cumulative flow capacity of gate sections operated together at three different gate positions.

<table>
<thead>
<tr>
<th>Gate Section Length (ft)</th>
<th>Flow per Gate Section and Cumulative Gate Sections at Three Positions (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/2 open</td>
</tr>
<tr>
<td>3-1 50</td>
<td>304</td>
</tr>
<tr>
<td>3-2 50</td>
<td>304</td>
</tr>
<tr>
<td>3-3 50</td>
<td>304</td>
</tr>
<tr>
<td>3-4 50</td>
<td>304</td>
</tr>
<tr>
<td>3-5 76</td>
<td>463</td>
</tr>
<tr>
<td>3-6 52</td>
<td>317</td>
</tr>
<tr>
<td>3-7 36</td>
<td>219</td>
</tr>
<tr>
<td>Subtotal 3’ Gates 364</td>
<td>2,216</td>
</tr>
<tr>
<td>10-1 104</td>
<td>3,854</td>
</tr>
<tr>
<td>10-2 104</td>
<td>3,854</td>
</tr>
<tr>
<td>10-3 104</td>
<td>3,854</td>
</tr>
</tbody>
</table>
Flow Capacity of Gate Sections at Three Different Locations

<table>
<thead>
<tr>
<th>Gate Section</th>
<th>Length (ft)</th>
<th>Flow per Gate Section and Cumulative Gate Sections at Three Positions (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gate Section</td>
<td>1/2 open</td>
</tr>
<tr>
<td>10-4</td>
<td>104</td>
<td>3,854</td>
</tr>
<tr>
<td>Subtotal 10' Gates</td>
<td>416</td>
<td>15,417</td>
</tr>
<tr>
<td>6-1</td>
<td>70</td>
<td>Not Used</td>
</tr>
<tr>
<td>7-1</td>
<td>30</td>
<td>Not Used</td>
</tr>
<tr>
<td>Subtotal WaveShaper Entrance</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Overall Total</td>
<td>880</td>
<td>17,633</td>
</tr>
</tbody>
</table>

*The gate section naming convention is nominal gate height and relative location from west bank to east bank.

4) As shown in the Table, a 6,000 cfs power generation flow could be accommodated with all 3-foot crest gates open, or with a 104-foot section of 10-foot gate between 1/2 and 3/4 open. A 12,000 cfs power generation flow can be accommodated with a 104-foot section of 10-foot gate fully open and the 3-foot crest gates 1/2 open.

4. Gate Operation Prior to Future WaveShaper Completion:
   a. Under normal, non-flood conditions, all of the 3-foot crest gates and the 10-foot full height gates (both Group 1 and Group 2) shall be set to an AUTOMATIC mode to adjust position so that the Zink Lake level elevation of 620.0 feet plus or minus 0.2 feet is maintained. For this condition the entrance gates to the future WaveShaper features shall not be utilized to maintain lake level; these gates shall remain closed and shall only open if needed to pass flood flows.
   b. If there is sufficient river flow to operate recreational flume the flume entrance gates shall be manually opened and their position set based upon the desired hydraulic conditions for the specific recreational need. If the river flow drops below that required for the recreational features in operation, gates shall automatically begin to close to assure that the lake level is maintained. There shall be the ability to manually override any of the automated functions if needed. There will be many occasions when the river has no flow and all gates shall be in their FULL UP or CLOSED position.
c. Prior to gates opening, alarm/beacon located on the east and west banks shall activate. A beacon shall flash and a horn shall sound to warn of the impending water flow downstream of the dam.

d. A typical sequence shall be for the crest gates to gradually open to maintain lake level until they reach a preset position between half and fully open. Then, a 104-foot section of full height gates shall lower to allow an equivalent flow to pass, and the crest gates shall close. If flow continues to increase, lake elevation shall be maintained by continuing to open the 104-foot section of full height gates until fully open, at which point the crest gates shall begin to open and modulate to maintain level. As river flow subsides, the process shall be reversed, and the gates shall gradually close to maintain the 620.0 elevation.

e. To ensure equal wear on gate components, and provide sluicing at different sections of the river, a different section of full height gates shall be deployed at each subsequent flow release. Selection of which full-height gates shall be the first to open shall be selectable in the automatic mode so that different full-height gate sections can be intentionally opened for flushing of sediment buildup behind the dam.

f. Operation of additional full height gates shall be required during flood storage releases including periods during spring spawning conditions which will accommodate fish egg passage downstream. As river flow decreases, the gates shall begin to close automatically to maintain the level in Zink Lake.

5. Gate Operation Prior to Future WaveShaper Completion:

a. Under normal, non-flood conditions, the rate of flow through the Group 1 Gates is anticipated to be 0 when the WaveShaper area is not in operation, or as much as 3,050 cfs if the 70-foot WaveShaper is operating. The Recreational Flume will account for an additional 0 to 500 cfs of flow.

b. The Group 2 Gates shall always be in an AUTOMATIC mode to adjust position so that the Zink Lake level elevation of 620.0 feet plus or minus 0.2 feet is maintained regardless of whether the recreational features are in use. If there is sufficient river flow to operate any of the recreational features, those gates (Group 1 and flume entrance gates) shall be manually opened and their position set based upon the desired hydraulic conditions for the specific recreational need. If the river flow drops below that required for the recreational features in operation, and Group 2 gates are fully closed, the Group 1 gates shall automatically begin to close to assure that the lake level is maintained. There shall be the ability to manually override any of the automated functions if needed.
There will be many occasions when the river has no flow and all gates shall be in their full up or CLOSED position.

1.03 PNEUMATIC GATE DESCRIPTION

A. Gates: Refer to Section 35 20 25, Pneumatic Gate System.

B. Overview Pneumatic Gate Controls and Operational Requirements:
   1. Refer to Paragraph Dam Operations and Control hereinbefore:
      b. All controls hereinafter shall conform to the overall Dam Operations and Control in Section 40 99 90, Package Control Systems, Supplement Pneumatic Crest Gate Controls.

C. Operational Modes:
   1. All gates shall be capable of both MANUAL and AUTOMATIC controls as set by Operators.
   2. Flow Calculation: The total flow rate in the river shall be calculated by the PLC based upon the water surface elevation in the pool upstream of the dam, the position of each of the gates in the main dam, and the flow rate in the Flume.

D. Sensors:
   1. One or two inclinometers are included on the gates.
   2. Inclinometers, shall be used to monitor the shall determine the gate elevations, detect errors in individual sensors, and detect warping of the various panels.
   3. Sensing of the water surface upstream of the dam shall be via redundant level sensors and used to control the dam gates, and future Big Water WaveShapers. This system has redundant level sensors and shall be passed via PLC-to-PLC communications to the Hydraulic System Control Panel PLC.

E. Notifications and Alarm Warnings:
   1. General:
      a. All notifications and alarm warnings reporting shall be made via text message to a defined list of recipients via HMI and Win911.
      b. Which alarms are communicated via Win911 shall be finalized during the Applications Workshop.
      c. Critical Alarm Warnings shall also notify a second group via text message, sound alarms requiring operator actions.
d. Warnings and notifications shall provide as much relevant information as possible such as time of occurrence, which panel and Gate is impacted, and the degree of any differential measurement (if applicable).
   1) The system shall eliminate the occurrence of false warnings and notifications due to transient hydraulic conditions and other sources of frequent false alarms.

e. Specific notifications suggested below. It is recommended that the category of each announcement be changeable by the operator.
   1) May be Desirable to Adjust Flow: During operational hours when the non-diverted flow rate (i.e., flow going through or over the gates and crests in the main dam) is at or above a set percentage (adjustable) flow rate in the Flume - unless the total flow rate in the Flume is greater than a set (adjustable) flow rate.
   2) Caution: Flow estimates or duplicate inclinometers are nearing the input warning status alert.
   3) Automated Closure: When an automatic closure procedure is initiated.

f. Specific alarm warnings shall include, but not limited to:
   1) Pending Flow: Prior to gates opening, alarm/beacon located on the east and west banks shall activate. A beacon shall flash and a horn shall sound to warn of the impending water flow downstream of the dam.
   2) Malfunction: When there are any detectable malfunctions. These should include but not be limited to:
      a) Warping of any of the panels of the Gates, actuations of the compressed air system that impact inclination of the crest panels, and movements that would damage any component of the system.
      b) Differences in duplicative sensor readings.
      c) Movement of the Gates (all pneumatically actuated) when adjustment is not made manually or by the automatic mode.
      d) Lack of movement or extended delay of movement of panels in meeting the inclination requested when operating in the Manual or Automatic modes.

1.04 INDIVIDUAL PNEUMATIC GATE CONTROL REQUIREMENTS

A. This Paragraph, in its entirety including all functions and lists, shall be finalized and conformed with equipment submittals, Paragraph Dam Operations and Control, and Applications Software Workshop input.
B. Gate control shall include LOCAL, REMOTE AUTOMATIC, and REMOTE MANUAL operating modes.

C. LOCAL/OFF/REMOTE (LOR) switch for the crest gate shall be located in the Compressed Air Control Panel, or the Valve Panel. It shall be monitored by the Compressed Air Control Panel PLC to determine the gate operating mode. If a switch is placed in the OFF position, the gate will not move and will not respond to local or remote commands. If a switch is in the Local position it shall be operated at the switch location, primarily intended for maintenance, troubleshooting, or other testing functions. Normally, the LOR switch shall always be in Remote such that all controls shall be by the PLC, with operations interface at the HMI.

1. When valve is in Remote, the HMI shall have an independent operator settable AUTOMATIC and MANUAL Mode for each gate.

2. AUTOMATIC Mode:
   a. The PLC shall be capable of incremental raising and lowering gates automatically to maintain the associated Level Setpoint as required by Paragraph Dam Operations and Control.
   b. The duration of the valve operations shall be calculated by a PID loop using the associated level signal and operator adjustable setpoint. As described within the operations narratives the level setpoint shall be 620 feet of water level.
   c. The setpoints shall be adjustable from the Compressed Air Control Panel HMI.

3. MANUAL Mode:
   a. Operators shall be able to override the automatic control of each gate from the Compressed Air Control Panel and place the gate controls in MANUAL mode.
   b. The PLC shall provide the capability for the operator to manually raise or lower each gate to intermediate positions.

D. Compressed Air Control Panel:

1. The Pneumatic Crest Gate, Compressed Air Control Panel shall include, but not be limited to, the following:
   a. PLC for local and remote gate control as described herein.
   b. Human Machine Interface (HMI) touch panel.
   c. Ethernet network switch.
   d. Control Selectors: ESTOP switch.
   e. External Interface:
      1) Pneumatic Crest Gate, Compressed Air Control Panel:
         a) Dry Contact Command Signals.
         b) MANUAL mode selection and gate commands.
c) AUTOMATIC mode selection and gate commands.
d) RAISE command.
e) LOWER command.

2. HMI:
   a. Indication shall include, but not be limited to, the following:
   b. Gate 0 percent to 100 percent position indicator.
      1) Compressed Air pressure indicator.
      2) Supply pressure indicator.
      3) REMOTE mode indicator.
      4) LOCAL mode indicator.
      5) Air Compressor RUNNING indicator.
      6) Air Compressor RUNTIME hours.
      7) Air Compressor number of STARTS.
      8) Calculated flow.
      9) Zink Lake level.
      10) Level Proportional-Integral-Derivative (PID) control loop:
          a) PID MANUAL/AUTO mode selection and status indication.
          b) PID Output (0 to 100 percent):
             1) Current value indication.
             2) Operator settable when PID is in MANUAL mode.
          c) PID Level Setpoint:
             1) Current value indication.
             2) Operator settable when PID is in AUTO mode.
          d) PID current level process variable indication.
          e) PID Tuning:
             1) Loop tuning PID entry.
             2) Loop tuning PID current value indication.
   c. Control Functions:
      1) Each gate AUTO/MANUAL mode select.
      2) PID AUTO/MANUAL mode select.
      3) Supply Air Pressure HIGH alarm setpoint.
      4) Supply Air Pressure LOW alarm setpoint.
      5) Zink Lake HIGH HIGH Level alarm setpoint.
      6) Zink Lake HIGH LEVEL alarm setpoint.
   d. Alarms:
      1) All individual gate alarms
      2) Flume PLC critical alarms, including but not limited to:
         a) E-Stop switch.
         b) HIGH HIGH flow.
         c) Loss of PLC-to-PLC communications.
         d) Other alarms as defined hereinbefore, or during Applications Software Workshop.
3) LOW Supply Pressure.
4) HIGH Supply Pressure.
5) Zink Lake HIGH HIGH Level.
6) Zink Lake HIGH Level.
7) UPS on battery.
8) UPS low battery.
9) Utility power failure.
10) PLC power supply failure.
11) Analog input signal out of range alarm for each analog input.
12) HMI to PLC communication failure.
13) PLC to PLC communication failure.

e. Security: HMI shall include three levels of security.
1) View Only: No login required. Full navigation to all graphics available without login. No control function changes allowed.
2) Operator: Username and Password required to adjust setpoints or to change control modes.
3) System Engineer: Username and Password required to adjust PID tuning parameters and to change graphics.

f. History:
1) All analog values including measured, calculated, setpoints, and tuning parameters shall be stored in history once per second.
2) Provide minimum of 9 months of hard disk data storage. After 9 months, oldest data shall be overwritten to ensure hard disk space is not completely filled.
3) Provide written procedure for backing up historical data to USB drive for transfer to offsite storage.

g. HMI Graphics:
1) Menu navigation buttons shall be visible from all other graphics.
2) Overview graphic shall provide status of entire system.
3) Compressed air system graphics shall provide individual compressed air system status and controls interface.
4) Individual gate control popup graphics shall provide individual gate control interface.
5) Alarm banner shall be visible from all other graphics.
6) Alarm summary table graphic shall include the following:
   a) Alarm description and tag.
   b) Current active unacknowledged alarms.
   c) Current active acknowledged alarms.
   d) Time and date stamp of all alarms.
7) Alarm history table graphic shall include the following:
   a) Alarm description and tag.
   b) Time and date stamp of alarm.
   c) Time and date stamp of alarm return to normal.
   d) Time and date stamp of operator acknowledgement of alarm.
   e) Provide a minimum of 500 historical alarm entries. Oldest alarm data shall be overwritten to ensure hard disk space is not completely filled.

8) Trending graphic(s) shall include the following:
   a) Operator selection of historical tags to be displayed.
   b) Display up to 10 tags per trend graphic.
   c) Adjustable time and amplitude ranges.
1.01 GENERAL

A. The following control narrative is the basis for the WaveShaper Gate Controls. This control narrative shall be edited, as required by equipment submittals, Gate Supplier coordination, and the Applications Software Workshops input. This control narrative shall be considered final after an approved submittal following the Applications Software Workshops. Provide all applications software, as required, for a complete dam operations and control system as per Dam Operations and Control, hereinafter.

1. References:
   a. Section 35 20 25, Pneumatic Gate System.
   b. Section 35 20 30, WaveShapers™ and Gates.
   c. Section 40 99 90, Package System Controls:
      1) Supplement Pneumatic Crest Gate Controls.
      2) Supplement WaveShaper Gate Controls.

1.02 SYSTEMS OVERVIEW

A. Overview of Hydraulic System Control Panel PLC Applications Software:

   1. Provide all applications software, including all configuration for all system devices including PLCs, HMI, Switches, Firewall, all network devices, and all other system components that require configuration.

   2. Provide Applications Software:
      a. Based on the Approved Final Control Narratives:
         1) Pneumatic Crest Gate Controls.
         2) WaveShaper Gate Controls.
      b. Complete software configurations for Compressed Air Control Panel include:
         1) PLC.
         2) HMI.
         3) Offsite Remote Login: Communication with Camera System.
         4) Network communications.
         5) Alarms: Warnings/alarms shall be programmed in the system to alert for malfunctions, errors, or identifiable problems with the equipment, sensors, or questionable operations activities. Input ranges, differences in measurements or calculated parameters should be input into the system, but changeable by the operator.
ZINK DAM IMPROVEMENTS
GATE PREPURCHASE

3. Completed network configuration and communications required for operations of the entire system. Shall include, but not limited to:
   a. Network configuration shall include, but not limited to:
      1) Switches.
      2) Firewall.
      3) All other network devices requiring configuration.
   b. Network Communications:
      1) Device status.
      2) Communications to Offsite Remote Logon: Remote login shall be via the cell modem in the Compressed Air Control Panel and then ghost from the Compressed Air Control Panel to the Hydraulic System Control Panel.
      3) Communications to iPad.
   c. All PLC-to-PLC required communications to form a complete Dam Operations and Control, hereinafter. Shall include, but not limited to:
      1) Produce-consume logic to pass specific data.
      2) Specific tags shall include but not limited to:
         a) Critical alarms.
         b) Dam level.
         c) Flume level.
         d) PLC status.
         e) Device status.
         f) All other status as required by Dam Operations and Control.

B. Dam Operations and Controls: Refer to Section 40 99 90, Package Control Systems, Supplement Pneumatic Crest Gate Controls.

1.03 WAVESHAPER GATE DESCRIPTION

A. Gates shall consist of composite panels with elastomeric hinges anchored to concrete and elastomeric hinges between composite panels where shown on Drawings. There are two types of WaveShapers in the project – Entrance Gates w/ WaveShaper and WaveShapers. Entrance Gate with WaveShapers control both the upstream water levels and the downstream waves with an upstream crest/pneumatic gate panel that is hinged to both the concrete and to one of the downstream panels that comprise the WaveShaper gate. WaveShapers only control the formation of waves downstream with panels hinged to the concrete. Crest gate panels shall be actuated with a pneumatic system and be fully compatible with the hydraulic system actuating the WaveShaper gates. Actuators for WaveShaper gates shall include hydraulic cylinders mounted between the hinged gate panels and the concrete foundations. The elastomeric hinges and actuators shall allow the Gates to
operate through a range from fully raised to fully lowered and as otherwise shown on Drawings.

B. WaveShaper Gate Controls and Operational Requirements Overview:

1. Refer to Section 40 99 90, Package Control Systems, Supplement Pneumatic Crest Gate Controls, Paragraph Dam Operations and Control:
   b. All controls hereinafter shall conform to the overall Dam Operations and Control in Section 40 99 90, Package Control Systems, Supplement Pneumatic Crest Gate Controls.

2. Flow Rates: Design Flow for Flume:
   a. Aesthetic Flow Rate: Adjustable between 10 cfs to 50 cfs.
   b. Operational Flow Rate: Each Entrance WaveShaper adjustable by operator between minimum and maximum operational flow rates.
   c. Minimum Operational Flow Rate: Adjustable with an initial setting of 50 cfs.
   d. Maximum Operational Flow Rate: Adjustable with initial setting at 300 cfs.

3. The flow rate in the flume shall be controlled by the position (crest elevations) of the two Entrance WaveShapers.

4. The flow rate (cfs) for each of the Entrance WaveShapers is intended to be manually set by the operator. Once set, each Entrance WaveShaper shall modulate to maintain the set flow rate.

5. The two panels downstream of the Crest Panel for each of the Entrance Gates and all the panels of the two WaveShapers (Drops 3 and 4) downstream of the Entrance WaveShapers are hydraulically actuated and shall be adjusted to control the shape of the hydraulic (jump) features forming downstream of the WaveShapers.

6. In the AUTOMATED mode, automatic adjustment via the hydraulic system of all WaveShapers throughout the Flume shall be based upon the flow rate, estimated downstream water surface elevation in some cases, and input curves for each of the panels of each WaveShaper. Inclinometers shall provide feedback as to the position of each panel of each WaveShaper. While in AUTOMATED mode, the operator shall also be able to manually adjust WaveShapers (at either the Hydraulic System Control Panel HMI or with the Operator iPad while standing at the entrance gates).

7. The Flume shall be capable of automated operations when it is manually initiated by the operator.

8. Design of the Flume WaveShapers and appurtenances are shown on Drawings and Section 35 20 30, WaveShapers™ and Gates.
C. Operational Modes:

1. All panels of all the WaveShapers shall be able to be adjusted in the following modes:
   a. All gates shall be capable of both MANUAL and AUTOMATIC controls as set by Operators.
   b. Manual Operations Mode:
      1) Allows adjustment of each of the WaveShapers at the HMI.
      2) Automated control shall be utilized during the Automatic Closure Procedure.
      3) When there is a change in flow rate of an adjustable set value (50 cfs as an initial setting), or more, and the WaveShaper panels are set to positions outside the input rating curve for the new flow rate, all WaveShaper panels shall automatically (override manual setting) and adjust for the new flow rate, regardless of their current manual setting. After the new target flow rate is met, the operator can switch back to manual mode to manually adjust the panels.
   
   c. Automatic Operations Mode:
      1) The AUTOMATIC mode is intended to be initiated by the operator at the HMI. In addition, the operator will also set the target flow rate for each of the Entrance WaveShapers. These flow rates will be automatically maintained by the control system by adjusting the Crest Panel of each of the Entrance WaveShapers. This system shall be integrated with the operations of the larger full height and crest gates of the main dam in the river. The operating system will allow for the operator to easily set and change the flow rate for each of the Entrance WaveShapers.
      2) The WaveShapers in the AUTOMATIC mode shall adjust automatically based upon the flow rate and an input rating curve for each of the panels of each of the WaveShapers. An adjustable dead band for each panel shall be input at the HMI to avoid frequent movement of the panels. For example, the panels of the WaveShaper at Drop 3 will adjust to an inclination based upon the flow rate in the flume and the input curve for each panel (i.e., panel inclination verses flow rate).
      3) In addition, the WaveShaper panels downstream of the Crest Panels of the Entrance WaveShapers and Drop 4 shall also be adjusted based upon downstream water surface level sensors and the flow rate in the Arkansas River, respectively. The inclination of the panels of each Entrance WaveShaper shall be based upon the flow rate through the...
individual Entrance WaveShaper and the downstream water surface elevation (measured and estimated as described above.) The panels of the WaveShaper at Drop 4 shall be based solely upon the flow rate in the Flume at total river flows less than Impacting River Flow Rate - initially set at 12,000 cfs. At total river flows above the Impacting River Flow Rate, an additional decrease of the inclination of each of the panels will be applied based upon an input curve (i.e., degrees of inclination vs. total river flow rate).

4) During Automatic Operation Mode:
   a) The operator shall be able to manually adjust the position of all WaveShaper panels without suspending automatic operations mode or automated closure functions.
   b) The flow in the flume should be maintained at the set flow rate until:
      (1) The total target flow rate is adjusted by the operator.
      (2) The upstream water surface elevations in the pool upstream of the dam drops below an input elevation.
      (3) The automated shutdown procedure is manually or automatically initiated.
      (4) The emergency shutdown procedure is manually initiated.

d. Remote Manual Operations Shutdown:
   1) This is a complete system shutdown via Offsite Remote Logon, regardless of whether any gate is in MANUAL Operations Mode or AUTOMATIC Operations Mode.
   2) This shutdown shall initiate a complete initiation of a safe system shutdown.

2. Flow Rate and Measurement:
   a. Two Entrance Gates with WaveShapers (Entrance WaveShapers) to the Flume shall have the option to be either automated to control the flow into the flume, or manually set the gate position. In MANUAL, the system shall provide the current flow rate for information to the operators. The first/most upstream panel or Crest Panel of each of the Entrance WaveShapers are pneumatically operated using the Obermeyer system. The angle of these Crest Panels shall be continually measured by two inclinometers on each of these most upstream panels and shall be converted by the system to a crest elevation of each of the Entrance WaveShapers. The resulting crest elevation hydraulically determines the flow rate passed by each of the Entrance
WaveShapers and when added they shall provide the total flow in the flume.

b. The total flow rate in the flume shall be calculated by the PLC using the elevations of both crests of the Entrance Wave Shapers, upstream water surface elevation provided by the upstream sensors, and input rating curves. The flow rate in the flume shall also be calculated in the PLC by using a water surface sensor in the pool immediately downstream of the Entrance Wave Shapers and an input rating curve. This flowrate shall be continually checked (reflecting flow stabilization) using these two methods.

c. The total flow rate in the river shall be calculated by the PLC based upon the water surface elevation in the pool upstream of the dam, the position of each of the gates in the main dam, and the flow rate in the flume.

D. Sensors:

1. One or two inclinometers are included on all panels of all WaveShapers.
2. Summary:
   a. Entrance Gates: 12 inclinometers total (two per four hydraulic gates and two per two pneumatic gates).
   b. Drops #3 and #4: Eight inclinometers total (one per side gate and two for center gate).
3. Inclinometers, located on both sides of each panel (twelve total), shall be used to monitor the inclination of all three panels of each Entrance Wave Shaper, determine the WaveShaper lip elevations, detect errors in individual sensors, and detect warping of the various panels.
4. Sensing of the water surface upstream of the Entrance Wave Shapers shall be accomplished by the sensors and system controlling the in-river main dam gates and future Big Water Wave Shapers. This system has redundant level sensors and shall be passed via PLC-to-PLC communications.
5. A water surface level sensor in the pool immediately downstream of the Entrance Wave Shapers is used to determine and provide the flowrate in the flume. The crest of Drop #2 located downstream of the pool has a fixed rating curve that shall be programmed into the system. Flow rates estimated by the measured pool level and the rating curve shall be calibrated during tuning.

E. Notifications and Alarm Warnings:

1. General:
   a. All notifications and alarm warnings reporting shall be made via text message to a defined list of recipients via HMI and Win911.
b. Which alarms are communicated via Win911 shall be finalized during the Applications Workshop.

c. Critical Alarm Warnings shall also notify a second group via text message, sound alarms requiring operator actions.

d. Warnings and notifications shall provide as much relevant information as possible such as time of occurrence, which panel and WaveShaper is impacted, and the degree of any differential measurement (if applicable).

1) The system shall eliminate the occurrence of false warnings and notifications due to transient hydraulic conditions and other sources of frequent false alarms.

e. Specific notifications suggested below. It is recommended that the category of each announcement be changeable by the operator.

1) Pending Flow: Prior to gates opening, alarm/beacon located on the east and west banks shall activate. A beacon shall flash and a horn shall sound to warn of the impending water flow downstream of the dam.

2) May be Desirable to Adjust Flow: During operational hours when the non-diverted flow rate (i.e., flow going through or over the gates and crests in the main dam) is at or above a set percentage (adjustable) flow rate in the Flume - unless the total flow rate in the Flume is greater than a set (adjustable) flow rate.

3) Caution: Flow estimates or duplicate inclinometers are nearing the input warning status alert.

4) Automated Closure: When an automatic closure procedure is initiated.

a) Automated under normal conditions (Normal Automated Closure) of the Entrance WaveShapers shall be initiated in certain conditions, such as the time of day, high flow in the river, upstream pool elevation approaching minimum set elevation, or manually through the remote-control system.

b) The WaveShapers located throughout the Recreational Flume shall raise sequentially from downstream to upstream to an input set inclination.

c) The crest/pneumatic panels of the Entrance WaveShaper shall raise to a set low-flow rate.

d) The time for Normal Automated Closure shall be adjustable between 5 minutes and 15 minutes.

e) Emergency closure shall be initiated by the operator either remotely, from the HMI, or by two panel mounted E-Stop switches.
f) The time for emergency closure should be adjustable between 2 minutes and 15 minutes and completely shut off the flow in the flume.

f. Specific alarm warnings shall include, but not limited to:

1) Emergency Closure: When an emergency closure has been initiated.

2) Malfunction: When there are any detectable malfunctions. These should include but not be limited to:
   a) Warping of any of the panels of the WaveShapers, actuations of the hydraulic system that impact inclination of the crest panels, and movements that would damage any component of the system.
   b) Differences in duplicative sensor readings.
   c) When the estimated flow in the Entrance WaveShapers is different (within an input percentage) than that indicated by the downstream water level sensor. (provisions for flow to stabilize should be made.)
   d) Movement of the WaveShapers (all hydraulically actuated panels) when adjustment is not made manually or by the AUTOMATIC mode.
   e) Lack of movement or extended delay of movement of panels in meeting the inclination requested when operating in the MANUAL or AUTOMATIC modes.
   f) Gate Positioned Outside of Desired Limits: When the flow changes in the system by an adjustable set value (30 cfs as an initial setting) or more and the panels of the WaveShaper gates are positioned outside of the input curve in AUTOMATIC mode.

1.04 INDIVIDUAL WAVESHAPER AND PNEUMATIC GATE CONTROL REQUIREMENTS

A. This Paragraph, in its entirety including all functions and lists, shall be finalized and conformed with equipment submittals, Paragraph Dam Operations and Control, and Applications Software Workshop input.

B. Gate control shall include LOCAL, REMOTE AUTOMATIC, and REMOTE MANUAL operating modes.

C. LOCAL/OFF/REMOTE (LOR) switch for the WaveShaper gate shall be located in the Hydraulic System Control Panel, or the Valve Panel. It shall be monitored by the Hydraulic System Control Panel PLC to determine the gate operating mode. If a switch is placed in the OFF position, the gate shall not
move and shall not respond to local or remote commands. If a switch is in the LOCAL position it shall be operated at the switch location, primarily intended for maintenance, troubleshooting, or other testing functions. Normally, the LOR switch shall always be in REMOTE such that all controls shall be by the PLC, with operations interface at the HMI.

1. When valve is in REMOTE, the HMI shall have an independent operator settable AUTOMATIC and MANUAL Mode for each gate.

2. AUTOMATIC Mode:
   a. The PLC shall be capable of incremental raising and lowering gates automatically to maintain the associated Flow Setpoint as described in hereinbefore.
   b. The duration of the valve operations shall be calculated by a PID loop using the associated level signal and operator adjustable setpoint. As described within the operations narratives the level setpoint shall be 620 feet of water level.
   c. The setpoints shall be adjustable from the Hydraulic System Control Panel HMI.

3. Manual Mode:
   a. Operators shall be able to override the automatic control of each gate from the Hydraulic System Control Panel and place the gate controls in MANUAL mode.
   b. The PLC shall provide the capability for the operator to manually raise or lower each gate to intermediate positions.

D. Hydraulic System Control Panel:

1. The WaveShaper Gates, Hydraulic System Control Panel shall include, but not be limited to, the following:
   a. PLC for local and remote gate control as described herein.
   b. Human Machine Interface (HMI) touch panel.
   c. Ethernet network switch.
   d. Control Selectors: ESTOP switch.
   e. External Interface:
      1) Pneumatic Crest Gate, Compressed Air Control Panel:
         a) Dry Contact Command Signals.
         b) MANUAL mode selection and gate commands.
         c) AUTOMATIC mode selection and gate commands.
         d) RAISE command.
         e) LOWER command.

2. HMI:
   a. Indication shall include, but not be limited to, the following:
      1) Gate 0 percent to 100 percent position indicator.
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GATE PREPURCHASE

2) All hydraulic system and individual gate status, control and alarms.
3) REMOTE mode indicator.
4) LOCAL mode indicator.
5) Calculated flows.
6) Zink Lake level.
7) Flume level.
8) Flume Flow Proportional-Integral-Derivative (PID) control loop:
   a) PID MANUAL/AUTO mode selection and status indication.
   b) PID output (0 to 100 percent).
      (1) Current value indication.
      (2) Operator settable when PID is in MANUAL mode.
   c) PID Flow Setpoint:
      (1) Current value indication.
      (2) Operator settable when PID is in AUTO mode.
   d) PID current level process variable indication.
   e) PID Tuning:
      (1) Loop tuning PID entry.
      (2) Loop tuning PID current value indication.

b. Control Functions:
1) Each gate AUTO/MANUAL mode select.
2) PID AUTO/MANUAL mode select.
3) Flume HIGH HIGH flow alarm setpoint.
4) Flume HIGH flow alarm setpoint.

c. Alarms:
1) All individual gate alarms.
2) Flume E-Stop switch.
3) Flume HIGH HIGH flow.
4) HIGH flow.
5) UPS on battery.
6) UPS low battery.
7) Utility power failure.
8) PLC power supply failure.
9) Analog input signal out of range alarm for each analog input.
10) HMI to PLC communication failure.
11) PLC to PLC communication failure.

d. Security: HMI shall include three levels of security.
1) View Only: No login required. Full navigation to all graphics available without login. No control function changes allowed.
2) Operator: Username and Password required to adjust setpoints or to change control modes.

3) System Engineer: Username and Password required to adjust PID tuning parameters and to change graphics.

e. History:
1) All analog values including measured, calculated, setpoints, and tuning parameters shall be stored in history once per second.
2) Provide minimum of 9 months of hard disk data storage. After 9 months, oldest data shall be overwritten to ensure hard disk space is not completely filled.
3) Provide written procedure for backing up historical data to USB drive for transfer to offsite storage.

f. HMI Graphics:
1) Menu navigation buttons shall be visible from all other graphics.
2) Overview graphic shall provide status of entire system.
3) Hydraulic system graphics shall provide individual hydraulic system status and controls interface.
4) Individual gate control popup graphics shall provide individual gate control interface.
5) Alarm banner shall be visible from all other graphics.
6) Alarm summary table graphic shall include the following:
   a) Alarm description and tag.
   b) Current active unacknowledged alarms.
   c) Current active acknowledged alarms.
   d) Time and date stamp of all alarms.
7) Alarm history table graphic shall include the following:
   a) Alarm description and tag.
   b) Time and date stamp of alarm.
   c) Time and date stamp of alarm return to normal.
   d) Time and date stamp of operator acknowledgement of alarm.
   e) Provide a minimum of 500 historical alarm entries. Oldest alarm data shall be overwritten to ensure hard disk space is not completely filled.
8) Trending graphic(s) shall include the following:
   a) Operator selection of historical tags to be displayed
   b) Display up to 10 tags per trend graphic.
   c) Adjustable time and amplitude ranges.
DRAWINGS