

STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND
DEVELOPMENT

RE-ADVERTISEMENT
FOR
CONSTRUCTION PROPOSAL



Kevin J. Reed
4/8/08

STATE PROJECT NO. 065-30-0041
HOUMA TUNNEL MODIFICATIONS
ROUTE LA 3040
TERREBONNE PARISH

STATE PROJECT NO. 065-30-0041

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NOTICE TO CONTRACTORS (08/07)

Either sealed paper bids or electronic bids for the following project will be received by the Department of Transportation and Development (DOTD). Paper bids can be delivered to the DOTD Headquarters Administration Building, 1201 Capitol Access Road, Room 405-L, Baton Rouge, Louisiana 70802 until 8:00 a.m on **WEDNESDAY, MAY 28, 2008**. After 8:00 a.m., paper bids will be received in the Headquarters Auditorium until 10:00 a.m. Electronic bids must be submitted through www.bidx.com prior to the electronic bidding deadline. Beginning at 10:00 a.m., all bids will be publicly opened and presented in the Headquarters Auditorium. No bids will be received after 10:00 a.m. Any person requiring special accommodations shall notify DOTD at (225) 379-1111 not less than 3 business days before bid opening.

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DESCRIPTION: HOUMA TUNNEL MODIFICATIONS

ROUTE: LA 3040

PARISH: TERREBONNE

TYPE: The contractor shall provide electrical, mechanical, and structural construction services as required for all modifications which have been identified for the Houma Tunnel, and are further specified in this document. The contractor shall keep at least one pump in each pump room operational at all times.

All bidders are encouraged to visit the tunnel for a precursory inspection prior to submitting a bid.

LIMITS: State Project No. 065-30-0041: AT INTRACOASTAL WATERWAY TUNNEL

ESTIMATED COST RANGE: \$1,000,000 TO \$2,500,000

PROJECT ENGINEER: KEITH ANGELETTE, P.E.; 5056 West Main St., Houma, La 70360, (985)858-2403.

PROJECT MANAGER: KEVIN REED, P.E.; P.O. Box 94245, Baton Rouge, La 70804, (225)572-8888.

COST OF PROPOSAL FORMS: \$25.00

COST OF PLANS: \$8.50

Bids must be prepared and submitted in accordance with Section 102 of the 2006 Louisiana Standard Specifications for Roads and Bridges as amended by the project specifications, and must include all information required by the proposal.

NOTICE TO CONTRACTORS (CONTINUED)

Plans and/or proposals may be obtained in Room 101-A of the DOTD Headquarters Administration Building, 1201 Capitol Access Road in Baton Rouge, or by contacting the DOTD; Email: sharonknight@dotd.la.gov, Phone (225) 379-1111, FAX: (225) 379-1714, or by written requests sent to the Louisiana Department of Transportation and Development, Project Control Section, P. O. Box 94245, Baton Rouge, LA 70804-9245. Proposals will not be issued later than 24 hours prior to the time set for opening bids. The purchase price for plans and proposals is non-refundable. Plans and specifications may be seen at the Project Engineer's office or in Room 101-A of the DOTD's Headquarters Administration Building in Baton Rouge. Upon request, the Project Engineer will show the work.

The U. S. Department of Transportation (DOT) operates a toll free "Hotline" Monday through Friday, 8:00 a.m. to 5:00 p.m., eastern time. Anyone with knowledge of possible bid rigging, bidder collusion, or other fraudulent activities should call 1-800-424-9071. All information will be treated confidentially and caller anonymity will be respected.

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GENERAL BIDDING REQUIREMENTS (08/06): The specifications, contract and bonds governing the construction of the work are the 2006 Edition of the Louisiana Standard Specifications for Roads and Bridges, together with any supplementary specifications and special provisions attached to this proposal.

Bids shall be prepared and submitted in accordance with Section 102 of the Standard Specifications.

The plans herein referred to are the plans approved and marked with the project number, route and Parish, together with all standard or special designs that may be included in such plans. The bidder declares that the only parties interested in this proposal as principals are those named herein; that this proposal is made without collusion or combination of any kind with any other person, firm, association, or corporation, or any member or officer thereof; that careful examination has been made of the site of the proposed work, the plans, Standard Specifications, supplementary specifications and special provisions above mentioned, and the form of contract and payment, performance, and retainage bond; that the bidder agrees, if this proposal is accepted, to provide all necessary machinery, tools, apparatus and other means of construction and will do all work and furnish all material specified in the contract, in the manner and time therein prescribed and in accordance with the requirements therein set forth; and agrees to accept as full compensation therefore, the amount of the summation of the products of the quantities of work and material incorporated in the completed project, as determined by the engineer, multiplied by the respective unit prices herein bid.

It is understood by the bidder that the quantities given in this proposal are a fair approximation of the amount of work to be done and that the sum of the products of the approximate quantities multiplied by the respective unit prices bid shall constitute gross sum bid, which sum shall be used in comparison of bids and awarding of the contract.

The bidder further agrees to perform all extra and force account work that may be required on the basis provided in the specifications.

The bidder further agrees that within 15 calendar days after the contract has been transmitted to him, he will execute the contract and furnish the Department satisfactory surety bonds.

If this proposal is accepted and the bidder fails to execute the contract and furnish bonds as above provided, the proposal guaranty shall become the property of the Department; otherwise, said proposal guaranty will be returned to the bidder; all in accordance with Subsection 103.04.

DEFINITIONS AND TERMS (07/07): Subsection 101.03 of the Standard Specifications is amended as follows.

The definition for "Proposal/ Bid Guaranty" is deleted and following substituted.

Proposal/Bid Guaranty. The required security furnished with a bid. The only form of security acceptable is a Bid Bond.

BIDDING REQUIREMENTS (07/07) Section 102 of the Standard Specifications and the Supplemental Specifications thereto, is amended as follows.

Subsection 102.09, Proposal/Bid Guaranty is deleted and the following substituted.

102.09 PROPOSAL/BID GUARANTY. Each bid shall be accompanied by a proposal/bid guaranty in an amount not less than five percent of the total bid amount when the bidder's total bid amount as calculated by the Department in accordance with Subsection 103.01 is greater than \$50,000. No proposal/bid guaranty is required for projects when the bidder's total

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bid amount as calculated by the Department is \$50,000 or less. The official total bid amount for projects that include alternates is the total of the bidder's base bid and all alternates bid on and accepted by the Department. The proposal/bid guaranty submitted by the bidder shall be a bid bond made payable to the contracting agency as specified on the bid bond form provided in the construction proposal. No other form of security will be accepted.

The bid bond shall be on the "Bid Bond" form provided in the construction proposal, on a form that is materially the same in all respects to the "Bid Bond" form provided, or on an electronic form that has received Department approval prior to submission. The bid bond shall be filled in completely, shall be signed by an authorized officer, owner or partner of the bidding entity, or each entity representing a joint venture; shall be signed by the surety's agent or attorney-in-fact; and shall be accompanied by a notarized document granting general power of attorney to the surety's signer. The bid bond shall not contain any provisions that limit the face amount of the bond.

The bid bond will be written by a surety or insurance company that is in good standing and currently licensed to write surety bonds in the State of Louisiana by the Louisiana Department of Insurance and also conform to the requirements of LSA-R.S. 48:253.

All signatures required on the bid bond may be original, mechanical reproductions, facsimiles or electronic. Electronic bonds issued in conjunction with electronic bids must have written Departmental approval prior to use. The Department will make a listing of approved electronic sureties providers on the Bidx.com site.

MAINTENANCE OF TRAFFIC (08/06): Subsection 104.03 of the 2006 Standard Specifications is amended to include the following requirements.

The contractor shall provide for and maintain through and local traffic at all times and shall conduct his operations in such manner as to cause the least possible interference with traffic at junctions with roads, streets and driveways.

DETERMINATION AND EXTENSION OF CONTRACT TIME (01/04): Subsection 108.07 Determination and Extension of Contract Time is amended to include the following.

The contractor shall document for each month of scheduled construction, the occurrence of adverse weather conditions having an impact on controlling items of work. An adverse weather day is one on which rainfall or wet soil conditions will prevent construction operations from proceeding for at least 5 continuous hours of the day or 65 percent of the normal work day, whichever is greater, with the normal working force engaged in performing the controlling item of work. If the contractor submits a written request for additional contract time due to adverse weather conditions, the contractor's request will be considered only for adverse weather days in excess of the allowable number of days per month stated below. An equitable adjustment in contract time will be made at the conclusion of the project by comparing the total number of excess adverse weather days requested by the contractor to the number of adverse weather days that were included in the construction schedule but were not used. Contract time will not be reduced due to the adjustments for adverse weather. An adjustment in the contract time due to adverse weather will not be cause for an adjustment in the contract amount.

The following are anticipated adverse weather days that the contractor shall include in each month of his calendar day construction schedule.

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January	<u>11</u> days	May	<u>5</u> days	September	<u>4</u> days
February	<u>10</u> days	June	<u>6</u> days	October	<u>3</u> days
March	<u>8</u> days	July	<u>6</u> days	November	<u>5</u> days
April	<u>7</u> days	August	<u>5</u> days	December	<u>8</u> days

CONTRACT TIME (10/01): The contractor will be issued a "Conditional Notice to Proceed" as defined in Subsection 101.03. The "Conditional Notice to Proceed" will expire **NINETY (90) CALENDAR** after its issuance, whereupon a "Notice to Proceed" will become effective, unless the contractor begins regular construction at an earlier date at which time the Notice to Proceed becomes effective.

The entire contract shall be completed in all details and ready for final acceptance in accordance with Subsection 105.17(b) within **ONE HUNDRED TWENTY (120) WORKING** days after the effective date of the "Notice to Proceed".

LOUISIANA
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
SUPPLEMENTAL SPECIFICATIONS
(FOR 2006 STANDARD SPECIFICATIONS)

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**LOUISIANA
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SUPPLEMENTAL SPECIFICATIONS**

The 2006 Louisiana Standard Specifications for Roads and Bridges and supplemental specifications thereto are amended as follows.

SECTION 101 – GENERAL INFORMATION, DEFINITIONS, AND TERMS:

Subsection 101.03 – Definitions (07/07), Pages 3 – 13).

Delete the definition for “Proposal/Bid Guaranty” and substitute the following.

Proposal / Bid Guaranty. The required security furnished with a bid. The only form of security acceptable is a Bid Bond.

SECTION 102 – BIDDING REQUIREMENTS:

Subsection 102.09 – Proposal / Bid Guaranty (07/07), Page 19.

Delete the contents of this subsection and substitute the following.

PROPOSAL/BID GUARANTY. Each bid shall be accompanied by a proposal/bid guaranty in an amount not less than five percent of the total bid amount when the bidder’s total bid amount as calculated by the Department in accordance with Subsection 103.01 is greater than \$50,000. No proposal/bid guaranty is required for projects when the bidder’s total bid amount as calculated by the Department is \$50,000 or less. The official total bid amount for projects that include alternates is the total of the bidder's base bid and all alternates bid on and accepted by the Department. The proposal/bid guaranty submitted by the bidder shall be a bid bond made payable to the contracting agency as specified on the bid bond form provided in the construction proposal. No other form of security will be accepted.

The bid bond shall be on the "Bid Bond" form provided in the construction proposal, on a form that is materially the same in all respects to the "Bid Bond" form provided, or on an electronic form that has received Department approval prior to submission. The bid bond shall be filled in completely, shall be signed by an authorized officer, owner or partner of the bidding entity, or each entity representing a joint venture; shall be signed by the surety's agent or attorney-in-fact; and shall be accompanied by a notarized document granting general power of attorney to the surety's signer. The bid bond shall not contain any provisions that limit the face amount of the bond.

The bid bond will be written by a surety or insurance company that is in good standing and currently licensed to write surety bonds in the State of Louisiana by the Louisiana Department of Insurance and also conform to the requirements of LSA-R.S. 48:253.

All signatures required on the bid bond may be original, mechanical reproductions, facsimiles or electronic. Electronic bonds issued in conjunction with electronic bids must have written Departmental approval prior to use. The Department will make a listing of approved electronic sureties providers on the Bidx.com site.

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SECTION 108 – PROSECUTION AND PROGRESS:

Subsection 108.04 – Prosecution of Work (03/05) Pages 74 and 75.

Add the following sentence to the third paragraph of Heading (b).

Should the surety or the Department take over prosecution of the work, the contractor shall remain disqualified for a period of one year from the completion of the project, unless debarment proceedings are instituted.

When the Department of Transportation and Development is not the contracting agency on the project, the second paragraph under Heading (c) is deleted.

SECTION 202 – REMOVING OR RELOCATING STRUCTURES AND OBSTRUCTIONS:

Subsection 202.06 – Plugging or Relocating Existing Water Wells (03/04), Page 105.

Delete the first sentence and substitute the following.

All abandoned wells shall be plugged and sealed at the locations shown on the plans, or as directed by the engineer, in accordance with the “Water Well Rules, Regulations, and Standards, State of Louisiana.” This document is available at the Department of Transportation and Development, Water Resources Section, P. O. Box 94245, Baton Rouge, Louisiana 70804-9245. The Water Resource Section’s telephone number is (225) 274-4172.

SECTION 302 – CLASS II BASE COURSE:

Subsection 302.05 – Mixing (08/06), Pages 152 and 153.

Delete the first sentence of Subheading (b)(1), In-Place Mixing, and substitute the following.

In-place mixing shall conform to Heading (a)(1) except that the percentage of Type I portland cement required will be 6 percent by volume.

SECTION 308 – IN-PLACE CEMENT TREATED BASE COURSE:

All Subsections within Section 308 – (07/07), Pages 191 – 198.

Whenever the reference to “DOTD TR-432, Method D” is used, it shall mean “DOTD TR-432”.

SECTION 502 – SUPERPAVE ASPHALTIC CONCRETE MIXTURES:

Subsection 502.02 – Materials (08/06), Pages 210 – 213.

Delete Table 502-3, Aggregate Friction Rating under Subheading (c)(1) and substitute the following.

**Table 502-3
Aggregate Friction Rating**

Friction Rating	Allowable Usage
I	All mixtures
II	All mixtures
III	All mixtures, except travel lane wearing courses with plan ADT greater than 7000 ¹
IV	All mixtures, except travel lane wearing courses ²

¹ When plan current average daily traffic (ADT) is greater than 7000, blending of Friction Rating III aggregates and Friction Rating I and/or II aggregates will be allowed for travel lane wearing courses at the following percentages. At least 30 percent by weight (mass) of the total aggregates shall have a Friction Rating of I, or at least 50 percent by weight (mass) of the total aggregate shall have a Friction Rating of II. The frictional aggregates used to obtain the required percentages shall not have more than 10 percent passing the No. 8 (2.36 mm) sieve.

² When the average daily traffic (ADT) is less than 2500, blending of Friction Rating IV aggregates with Friction Rating I and/or II aggregates will be allowed for travel lane wearing courses at the following percentages. At least 50 percent by weight (mass) of the total aggregate in the mixture shall have a Friction Rating of I or II. The frictional aggregates used to obtain the required percentages shall not have more than 10 percent passing the No. 8 (2.36 mm) sieve.

SECTION 704 – GUARD RAIL:

Subsection 704.03 – General Construction Requirements (01/05), Pages 368 and 369.

Add the following to Heading (d), Guard Rail End Treatments.

All end treatments shall bear a label indicating the manufacturer and exact product name of the end treatment along with its assigned NCHRP 350 test level. This label shall resist weathering and shall be permanently affixed to the railing in such a way as to be readily visible.

SECTION 713 – TEMPORARY TRAFFIC CONTROL:

Subsection 713.06 – Pavement Markings (08/06), Pages 400 – 403.

Delete Table 713-1, Temporary Pavement Markings and substitute the following.

Table 713-1
Temporary Pavement Markings^{1,2}

		Two-lane Highways	Undivided Multilane Highways	Divided Multilane Highways
SHORT TERM	ADT < 1500; or ADT > 1500 and time < 3 days	Lane lines 4-foot (1.2 m) tape on 40-foot (12 m) centers; with "Do Not Pass" and "Pass With Care" signs as required		
	ADT > 1500; Time > 3 days and < 2 weeks	Lane lines 4-foot (1.2-m) tape on 40-foot (12-m) centers with no passing zone markings		
	All ADT's with time < 2 weeks		Lane lines 4-foot (1.2m) tape on 40-foot (12 m) centers; double yellow centerline	Lane lines 4-foot (1.2 m) tape on 40-foot (12 m) centers
LONG TERM	All ADT's with time > 2 weeks	Standard lane lines, no-passing zone markings, legends and symbols and when pavement width is 22 feet (6.7 m) or greater, edge lines	Standard lane lines, centerlines, edge lines, and legends and symbols	Standard lane lines, centerlines, edge lines, and legends and symbols.

¹No-passing zones shall be delineated as indicated whenever a project is open to traffic.
²On all Asphaltic Surface Treatments that are open to traffic and used as a final wearing course or as an interlayer, temporary pavement markings (tabs) on 20-foot (6 m) centers shall be used, in lieu of the 4-foot (1.2 m) tape, on 40-foot (12 m) centers.

SECTION 729 – TRAFFIC SIGNS AND DEVICES:

Subsection 729.02 – Materials (04/07), Pages 456 and 457.

Delete the contents of Heading (a), Sign and Marker Sheeting, and substitute the following.

(a) Sign and Marker Sheeting: Sheeting material for sign panels, delineators, barricades and other markers shall comply with Section 1015. All permanent signs shall meet the requirements of ASTM D 4956, Type III, except as follows:

Reflective sheeting for the permanent signs of Table 729-1 shall meet the requirements of ASTM D 4956, Type IX or Type X as modified in Subsection 1015.05.

Table 729-1

Permanent Signs for Use With Type IX or X (modified) Reflective Sheeting

Sign	MUTCD Number
Stop	R1-1
Yield	R1-2
4-Way	R1-3
All Way	R1-4
Do Not Enter	R5-1
Wrong Way	R5-1a
Chevrons	W1-8
No Passing Zone Pennants	W14-3
Type 3 Object Marker	OM-3 (Right & Left)
Type 2 Object Marker	-----
Guardrail End Decals	-----

Subsection 729.04, Fabrication of Sign Panels and Markers (04/07), Pages 458 – 460.

Delete the third paragraph of Heading (c), Sheeting Application and substitute the following.

ASTM D 4956 Type IX or X (modified) reflective sheeting shall be applied with an orientation determined by the engineer to obtain the optimum entrance angle performance. Fabricated vertical splices in ASTM D 4956 Type IX or X (modified) reflective sheeting will be allowed only when the horizontal dimension of the sign face or attached shield is in excess of the maximum manufactured width of the sheeting. Fabricated vertical splices in ASTM D 4956 Type IX or X (modified) reflective sheeting will also be allowed when the specified orientation will create excessive sheeting waste.

SECTION 804 – DRIVEN PILES:

Subsection 804.08 – Construction Requirements (04/07), Pages 548 – 554.

Delete the first sentence of Heading (a), Preboring and substitute the following.

Preboring by augering, wet-rotary drilling, or other methods used to facilitate pile driving will not be permitted unless specified in the plans or allowed by the engineer.

Delete the first sentence of Heading (b), Jetting and substitute the following.

Jetting will not be permitted unless allowed in the plans or allowed by the engineer.

SECTION 901 – PORTLAND CEMENT CONCRETE:

Subsection 901.06 – Quality Control of Concrete (08/06), Pages 726 – 731.

Add the following to the contents of Heading (b), Quality Control Tests.

The contractor shall be responsible for monitoring the components (cement, mineral and chemical admixtures, aggregates) in their mix to protect against any changes due to component variations. As component shipments arrive, the contractor shall verify slump, air content and set

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time by testing at ambient temperatures. The contractor shall make adjustments to the mix design to rectify any changes which would adversely affect constructability, concrete placement or the specifications. The contractor shall submit test results to the Department for review each day of paving. Testing to validate component consistency will be documented on the control logs. Conformance or variation in mix parameters (workability, set times, air content, etc.) shall be noted on the control logs. The contractor shall provide a copy of the proposed testing plan to the engineer for record. Acceptance of the plan does not relieve the contractor's responsibility for consistency.

Subsection 901.08 – Composition of Concrete (12/05), Pages 732 – 734.

Add the following to Heading (a).

The blended cement containing up to 50 percent of grade 100 or grade 120 ground granulated blast-furnace slag must be in compliance with Subsection 1001.04 for portland blast-furnace slag cement.

SECTION 1003 – AGGREGATES:

Subsection 1003.02 – Aggregates for Portland Cement Concrete and Mortar (07/07).

Pages 763 – 766.

Delete the contents of Heading (c), Aggregates for Types B and D Pavements, and substitute the following.

(c) Aggregates for Types B and D Pavements: For the combined aggregates for the proposed portland cement concrete pavement mix, the percent retained based on the dry weight (mass) of the total aggregates shall meet the requirements of Table 1003-1A for the type of pavement specified in the plans. Additionally, the sum of the percents retained on any two adjacent sieves so designated in the table shall be at least 12 percent of the total combined aggregates. The maximum amounts by weight (mass) of deleterious materials for the total aggregate shall be the same as shown in Subsection 1003.02(b).

Table 1003-1A
Aggregates for Types B and D Pavements

U.S. Sieve	Metric Sieve	Percent Retained of Total Combined Aggregates	
		Pavement Type	
		Type B	Type D
2 1/2 inch	63 mm	0	0
2 inch	50 mm	0	0-20
1 1/2 inch	37.5 mm	0-20	0-20
1 inch	25.0 mm	0-20	5-20
3/4 inch	19.0 mm	5-20	5-20
1/2 inch	12.5 mm	5-20	5-20
3/8 inch	9.5 mm	5-20	5-20
No. 4	4.75 mm	5-20	5-20
No. 8	2.36 mm	5-20	5-20
No. 16	1.18 mm	5-20	5-20
No. 30	600 μm	5-20	5-20
No. 50	300 μm	0-20	0-20
No. 100	150 μm	0-20	0-20
No. 200	75 μm	0-5	0-5

Note: For the sieves in the shaded areas, the sum of any two adjacent sieves shall be a minimum of 12 percent of the total combined aggregates.

Each type of aggregate to be used in the proposed mixture shall be sampled and tested individually. The percent of total combined aggregates retained shall be determined mathematically based on the proportions of the combined aggregate blend. All gradation calculations shall be based on percent of dry weight (mass).

SECTION 1005 – JOINT MATERIALS FOR PAVEMENTS AND STRUCTURES:

Subsection 1005.04 – Combination Joint Former/Sealer (11/05), Pages 782 and 783.

Delete Heading (a) and substitute the following.

(a) Description: This joint former/sealer is intended for use in simultaneously forming and sealing a weakened plane in portland cement concrete pavements.

The material shall consist of an elastomeric strip permanently bonded either mechanically or chemically at the top of each of two rigid plastic side frames and covered with a removable plastic top cap. Side frames shall be of such configuration that when the sealer is inserted into plastic concrete and vibrated, a permanent bond forms between side frames and concrete.

Delete Heading (b)(1) and substitute the following.

(1) Elastomer: The elastomer strip portion of the material shall be manufactured from vulcanized elastomeric compound using polymerized chloroprene or thermoplastic vulcanizate as the base polymer, and shall comply with the following requirements:

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<u>Property</u>	<u>ASTM Test Method</u>	<u>Requirements</u>	
		<u>Polymerized Chloroprene</u>	<u>Thermoplastic Vulcanizate</u>
Tensile Strength, kPa, Min.	D 412	12,400	7,400
Elongation at Break, % Min.	D 412	200	400
Hardness, Shore A	D 2240	65 ± 10	65 ± 10
Properties after Aging, 70 h @ 100°C	D 573		
Tensile Strength, % Loss, Max.		20	20
Elongation, % loss, Max.		25	25
Hardness, pts. increase, Max.		10	10
Ozone Resistance, 20% strain or bentloop, 300 pphm in air, 70 h @ 40°C	D 1149	no cracks	no cracks
Oil Swell, IRM 903, 70 h @ 100°C, wt change, % Max.	D 471	45	75

Delete Headings (b)(2) and (b)(3) and substitute the following:

(2) Bond of Elastomer to Plastic: The force required to shear the elastomer from the plastic shall be a minimum of 5.0 pounds per linear inch (90 g/mm) of sealer when tested in accordance with DOTD TR 636.

(3) Bond of Plastic to Cement Mortar: This bond will be evaluated and shall meet the following requirements:

The force required to separate the cement mortar from the plastic shall be a minimum of 5.0 pounds per linear inch (90 g/mm) of sealer when tested in accordance with DOTD TR 636.

SECTION 1006 – CONCRETE AND PLASTIC PIPE:

Subsection 1006.09 – Plastic Yard Drain Pipe (06/07), Page 789.

Delete the contents of Subheading (a)(3), Ribbed Polyvinyl Chloride Pipe (RPVCP) and substitute the following.

Ribbed Polyvinyl Chloride Pipe (RPVCP): Ribbed Polyvinyl Chloride Pipe shall comply with ASTM F 794, Series 46 or ASTM F 949 (46 psi).

SECTION 1013 – METALS:

Subsection 1013.09 – Steel Piles (08/06) Page 822.

Delete the title and references to “Steel Piles” in this subsection and substitute “Steel H Piles”.

SECTION 1015 – SIGNS AND PAVEMENT MARKINGS:

Subsection 1015.04 – Sign Panels (05/07), Pages 832 and 833.

Delete the contents of Heading (a), Permanent Sign Panels and substitute the following.

FOR INFORMATION ONLY

(a) Permanent Sign Panels: Flat panels shall be aluminum sheets or plates complying with ASTM B 209, Alloy 6061-T6 or Alloy 5052-H38. Extruded aluminum panels shall comply with ASTM B 221 (ASTM B 221M), Alloy 6063-T6 and after fabrication, have a flatness equal to or less than 0.031 inch per foot of length and 0.004 inch per inch of width.

Subsection 1015.05 - Reflective Sheeting (05/07), Pages 833 – 838.

Add the following to Heading (a), Permanent and Temporary Standard Sheeting.

Type X (Modified) (White, Yellow, Red) - A super high-intensity retroreflective sheeting having highest retroreflectivity characteristics at medium distances. This sheeting is typically an unmetallized microprismatic retroreflective element material. This material shall meet the requirements of ASTM D 4956 Type X except as modified below.

(1) Retroreflectivity: Minimum Coefficients of Retroreflection for Type X (Modified) White, Yellow, and Red sheeting shall be as specified in Table 1015-a.

Table 1015-a
Coefficients of Retroreflection for Type X (Modified) Sheeting¹

Observation Angle, degrees	Entrance Angle, degrees	White	Yellow	Red
0.2	-4	600	450	90
0.2	+30	300	225	45
0.5	-4	240	180	36
0.5	+30	120	90	18

¹Minimum Coefficient of Retroreflection (R_A) ($\text{cd lx}^{-1}\text{m}^{-2}$)

Heading (d), Accelerated Weathering.

Delete Table 1015-3, Accelerated Weathering Standards and substitute the following.

**Table 1015-3
Accelerated Weathering Standards¹**

Type	Retroreflectivity ²				Colorfastness ³	
	Orange		All colors, except orange		Orange	All colors, except orange
III	1 year	80 ⁴	3 years	80 ⁴	1 year	3 years
III (for drums)	1 year	80 ⁴	1 year	80 ⁴	1 year	1 year
VI	1/2 year	50 ⁵	1/2 year	50 ⁵	1/2 year	1/2 year
IX	Not used		3 years	80 ⁶	Not used	3 years
X (Fluorescent Orange)	1 year	80 ⁷	Not used		1 year	Not used
X (Modified)	Not used		3 years	80 ⁸	Not used	3 years

¹At an angle of 45° from the horizontal and facing south in accordance with ASTM G 7 at an approved test facility in Louisiana or South Florida.

²Percent retained retroreflectivity of referenced table after the outdoor test exposure time specified.

³Colors shall conform to the color specification limits of ASTM D 4956 after the outdoor test exposure time specified.

⁴ASTM D 4956, Table 8.

⁵ASTM D 4956, Table 13.

⁶ASTM D 4956, Table 3.

⁷ASTM D 4956, Table 4.

⁸DOTD Standard Specifications, Table 1015-a.

Heading (e), Performance.

Delete Table 1015-4, Reflective Sheeting Performance Standards and substitute the following.

**Table 1015-4
Reflective Sheeting Performance Standards**

Type	Retroreflectivity ¹ -- Durability ²				Colorfastness ³
	Orange		All colors, except orange		
III	3 years	80 ⁴	10 years	80 ⁴	3 years
IX	Not used		7 years	80 ⁵	3 years
X (Fluorescent. Orange)	3 years	80 ⁶	Not used		3 years
X (Modified)	Not used		7 years	80 ⁷	3 years

¹Percent retained retroreflectivity of referenced table after installation and the field exposure time specified.

²All sheeting shall maintain its structural integrity, adhesion and functionality after installation and the field exposure time specified.

³All colors shall conform to the color specification limits of ASTM D4956 after installation and the field exposure time specified.

⁴ASTM D4956, Table 8.

⁵ASTM D 4956, Table 3.

⁶ASTM D 4956, Table 4.

⁷ DOTD Standard Specifications, Table 1015-a.

Heading (g), Sheeting Guaranty.

Delete Table 1015-5, Manufacturer's Guaranty-Reflective Sheeting and substitute the following.

**Table 1015-5
Manufacturer's Guaranty-Reflective Sheeting**

Type	Manufacturer shall restore the sign face in its field location to its original effectiveness at no cost to the Department if failure occurs during the time period ¹ as specified below		Manufacturer shall replace the sheeting required to restore the sign face to its original effectiveness at no cost to the Department if failure occurs during the time period ¹ as specified below
	Orange	All colors, except orange	All colors, except orange
III	<3 years	<7 years	7-10 years
IX	Not used	<5 years	5-7 years
X (Fluorescent Orange)	<3 years	Not used	Not used
X (Modified)	Not used	< 5 years	5-7 years

¹From the date of sign installation.

Subsection 1015.11 - Preformed Plastic Pavement Marking Tape (06/07), Pages 842 – 844.

Delete the contents of this subsection and substitute the following.

1015.11 PREFORMED PLASTIC PAVEMENT MARKING TAPE.

(a) General: Preformed plastic pavement marking tape shall be approved products listed on QPL 64 and shall comply with ASTM D4505 Retroreflectivity Level I or Level II, or DOTD Intersection Grade (as specified below), except as modified herein. The marking tape shall be Class 2 or 3. The type and color shall be in accordance with the plans and the MUTCD.

(b) Thickness: All preformed plastic pavement marking tape shall have a minimum overall thickness of 0.060 inches (1.5 mm) when tested without the adhesive.

(c) Friction Resistance: The surface of the Retroreflectivity Level II preformed plastic pavement marking tape shall provide a minimum frictional resistance value of 35 British Polish Number (BPN) when tested according to ASTM E303. The surface of the Retroreflectivity Level I and DOTD Intersection Grade preformed plastic pavement marking tape shall provide a minimum frictional resistance value of 45 BPN when tested according to ASTM E303. Values for the Retroreflectivity Level I material with a raised surface pattern as defined in ASTM D4505 are calculated by averaging values taken at downweb and at a 45 degrees angle from downweb.

(d) Retroreflective Requirements: The preformed plastic pavement marking tape shall have the minimum initial specific luminance values shown in Table 1015-7 when measured in accordance with ASTM D 4061.

Table 1015-7
Specific Luminance of Preformed Plastic Tape

Type	Observation Angle, degrees	Entrance Angle, degrees	Specific Luminance (mcd/sq m/lx)	
			White	Yellow
Retroreflectivity Level I	1.05	88.76	500	300
DOTD Intersection Grade	1.05	88.76	375	250
Retroreflectivity Level II	1.05	88.76	250	175

(e) Durability Requirements: The DOTD Intersection Grade preformed plastic pavement marking tape shall show no appreciable fading, lifting or shrinkage for a least 12 months after placement when placed in accordance with the manufacturer's recommended procedures on pavement surfaces having a daily traffic count not to exceed 15,000 ADT per lane.

The Retroreflectivity Level I preformed plastic pavement marking tape shall show no appreciable fading, lifting or shrinkage for a least 4 years after placement for longitudinal lines and at least 2 years after placement for symbols and legends.

The Retroreflectivity Level I preformed plastic pavement marking tape shall also retain the following reflectance values for the time period detailed in Table 1015-8.

Table 1015-8
Retained Specific Luminance for Retroreflectivity Level I
Preformed Plastic Pavement Marking Tape

Time	Observation Angle, degrees	Entrance Angle, degrees	Specific Luminance (mcd/sq m/lx)	
			White	Yellow
1 year	1.05	88.76	400	240
4 years (2 years for symbols and legend)	1.05	88.76	100	100

(f) Plastic Pavement Marking Tape Guaranty (DOTD Intersection Grade and Retroreflectivity Level I): If the plastic pavement marking tape fails to comply with the performance and durability requirements of this subsection within 12 months for DOTD Intersection Grade and 4 years for Retroreflectivity Level I, the manufacturer shall replace the plastic pavement marking material at no cost to the Department.

SECTION 1020 – TRAFFIC SIGNALS:

Subsection 1020.01 – Traffic Signal Heads (06/07), Pages 873 – 884.

Delete the contents of Heading (a), General Requirements and substitute the following.

(a) General Requirements: Traffic signal sections, beacon sections and pedestrian signal sections shall be of the adjustable type. Materials and construction of each section shall be the same.

Signals shall be constructed for either 8 or 12-inch (200 mm or 300 mm) lens in accordance with the plans. Signal sections shall have three to five sections per face and beacon

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sections have only one section per face. Signal sections and associated brackets shall be finished inside and out with two coats of high grade dark olive green enamel, color number 14056 according to Federal Standard No. 595b with each coat independently baked. Visors shall be coated green on the outside and black on the inside. Edges shall be deburred and smooth with no sharp edges.

Subsection 1020.04 – Poles for Traffic Signal Systems (06/07), Pages 890 – 894.

Delete the sixth paragraph of Heading (a), Pedestal Support Signal Poles, and substitute the following.

Pedestals shall be finished with at least one coat of rustproofing primer, applied to a clean surface and one coat of dark olive green enamel, color number 14056 according to Federal Standard No. 595b.

ITEM S-101, REPLACE EAST PUMP ROOM DRAINAGE PUMPS AND ASSOCIATED PIPING

This item consists of removing the four existing drainage pumps, associated piping and valves (see sheets P2.0 and P2.1) and providing four new drainage pumps, bases, motors, valves, a new sump pump and all associated piping (see General Note 1 on sheet P1.0 and sheets P3.0, P3.1, P3.2 and P3.3) required to make the new pumps functional in accordance with the Plans and Specifications. The cost of the control panel is excluded from this item and shall be included in Item S-106.

MEASUREMENT AND PAYMENT: Quantities of drainage pumps, associated piping and valves shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

Replace East Pump Room Drainage Pumps and Associated Piping

ITEM S-102, PROVIDE ELECTRIC MOTOR OPERATORS FOR EAST PUMP ROOM DRY WELL VALVES

This item consists of providing a motor operator on each of the eight new gate valves located in the east pump room dry well (see Specific Notes 8-15 on sheet P3.0, Specific notes 7 & 8 on sheet P3.1, Specific Note 9 on sheet P3.2 and Specific Notes 31 and 32 on sheet P3.3), along with all associated wiring and controls in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for providing motor operators on the dry well gate valves shall be measured as a lump sum.

Payment shall be made under:

Provide Electric Motor Operators for East Pump Room Dry Well Valves

ITEM S-103, EAST PUMP ROOM STRUCTURAL IMPROVEMENTS

This item consists of adding a new hand operated trolley to the overhead trolley beam, new concrete topping to the floor slab of the dry pit to slope the slab to the existing drain sump and adding grating in the wet pit to protect the pump suction inlets in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for east pump room structural improvements shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

East Pump Room Structural Improvements

ITEM S-104, REPLACE EAST PUMP ROOM ENTRANCE DOORS

This item consists of removing and replacing the existing entrance doors and metal frames into the pump room in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for replacing the east pump room entrance doors shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:
Replace East Pump Room Entrance Doors

ITEM S-105, EAST PUMP ROOM NEW PUMP CONTROL PANEL AND LEVEL CONTROLS

This item consists of providing a new pump control panel all wiring between control panel and float switches and reactive air bell system in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for new pump control panel and level controls shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:
East Pump Room New Pump Control Panel and Level Controls

ITEM S-106, EAST PUMP ROOM ELECTRICAL WORK

In general, this item includes all electrical work inside the pump room, except for the installation of the pump control panel, in accordance with the Plans and Specifications. . This item consists of providing all electrical circuitry (conduit and wiring) between new pump control panel and pump motors, electrical circuitry (conduit and wiring) between new pump control panel and valve motors, the installation of new mini-power zone, and all branch circuit wiring between panel and lights and receptacles in pump room. It shall also include all wiring devices and lights

MEASUREMENT AND PAYMENT: Quantities for the electrical work shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:
East Pump Room Electrical Work

ITEM S-107, REPLACE MID-CHANNEL PUMP ROOM DRAINAGE PUMPS AND ASSOCIATED PIPING

This item consists of removing the two existing drainage pumps, associated piping and valves (see sheets P2.2 and P2.3) and providing two new submersible drainage pumps, valves and all associated piping (see General Note 1 on sheet P1.0 and sheets P3.4, P3.5, P3.6 and P3.7) required to make the new pumps functional in accordance with the Plans and Specifications. The cost of the control panel is excluded from this item and shall be included in Item S-S112.

MEASUREMENT AND PAYMENT: Quantities of drainage pumps, associated piping and valves shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

Replace Mid-Channel Pump Room Drainage Pumps and Associated Piping

ITEM S-108, MID-CHANNEL PUMP ROOM STRUCTURAL IMPROVEMENTS

This item consists of removing a large portion of the main floor slab, providing new structural support and adding new floor grating on the main level and providing new grating to protect the pump suction in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for mid-channel pump room structural improvements shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

Mid-Channel Pump Room Structural Improvements

ITEM S-109, REPLACE MID-CHANNEL PUMP ROOM ENTRANCE DOORS

This item consists of removing and replacing the existing entrance doors and metal frames into the pump room in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for replacing the mid-channel pump room entrance doors shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

Replace Mid-Channel Pump Room Entrance Doors

ITEM S-110, MID-CHANNEL PUMP ROOM NEW PUMP CONTROL PANEL AND LEVEL CONTROLS

This item consists of providing a new pump control panel all wiring between control panel and float switches and reactive air bell system in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for new pump control panel and level controls shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

Mid-Channel Pump Room New Pump Control Panel and Level Controls

ITEM S-111, MID-CHANNEL PUMP ROOM ELECTRICAL WORK

In general, this item includes all electrical work inside the pump room, except for the installation of the pump control panel, in accordance with the Plans and Specifications. . This item consists of providing all electrical circuitry (conduit and wiring) between new pump control panel and pump motors, electrical circuitry (conduit and wiring) between new pump control panel and valve motors, the installation of new mini-power zone, and all branch circuit wiring between panel and lights and receptacles in pump room. It shall also include all wiring devices and lights

MEASUREMENT AND PAYMENT: Quantities for the electrical work shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

Mid-Channel Pump Room Electrical Work

ITEM S-112, REPLACE WEST PUMP ROOM DRAINAGE PUMPS AND ASSOCIATED PIPING

This item consists of removing the four existing drainage pumps, associated piping and valves (see sheets P2.0 and P2.1) and providing four new drainage pumps, bases, motors, valves, a new sump pump and all associated piping (see General Note 1 on sheet P1.0 and sheets P3.8, P3.9, P3.10 and P3.11) required to make the new pumps functional in accordance with the Plans and Specifications. The cost of the control panel is excluded from this item and shall be included in Item S-119.

MEASUREMENT AND PAYMENT: Quantities of drainage pumps, associated piping and valves shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

Replace West Pump Room Drainage Pumps and Associated Piping

ITEM S-113, PROVIDE ELECTRIC MOTOR OPERATORS FOR WEST PUMP ROOM DRY WELL VALVES

This item consists of providing a motor operator on each of the eight new gate valves located in the west pump room dry well (see Specific Notes 8-15 on sheet P3.8, Specific notes 7 & 8 on sheet P3.9, Specific Note 9 on sheet P3.10 and Specific Notes 31 and 32 on sheet P3.11), along with all associated wiring and controls in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for providing motor operators on the dry well gate valves shall be measured as a lump sum.

Payment shall be made under:

Provide Electric Motor Operators for West Pump Room Dry Well Valves

ITEM S-114, WEST PUMP ROOM STRUCTURAL IMPROVEMENTS

This item consists of adding a new hand operated trolley to the overhead trolley beam, new concrete topping to the floor slab of the dry pit to slope the slab to the existing drain sump, adding grating in the wet pit to protect the pump suction inlets and providing concrete topping to the existing pump housekeeping pads in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for west pump room structural improvements shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

West Pump Room Structural Improvements

ITEM S-115, REPLACE WEST PUMP ROOM ENTRANCE DOORS

This item consists of removing and replacing the existing entrance doors and metal frames into the pump room in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for replacing the west pump room entrance doors shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

Replace West Pump Room Entrance Doors

ITEM S-116, WEST PUMP ROOM NEW PUMP CONTROL PANEL AND LEVEL CONTROLS

This item consists of providing a new pump control panel all wiring between control panel and float switches and reactive air bell system in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for new pump control panel and level controls shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:

West Pump Room New Pump Control Panel and Level Controls

ITEM S-117, WEST PUMP ROOM ELECTRICAL WORK

In general, this item includes all electrical work inside the pump room, except for the installation of the pump control panel, in accordance with the Plans and Specifications. . This item consists of providing all electrical circuitry (conduit and wiring) between new pump control panel and pump motors, electrical circuitry (conduit and wiring) between new pump control panel and valve motors, the installation of new mini-power zone, and all branch circuit wiring between panel and lights and receptacles in pump room. It shall also include all wiring devices and lights

MEASUREMENT AND PAYMENT: Quantities for the electrical work shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:
West Pump Room Electrical Work

ITEM S-118, VENTILATION BUILDING MECHANICAL WORK

This item consists of removing the existing tunnel carbon monoxide system, exhaust dampers and associated linkage, motors, etc. (see Specific Notes 1 and 2 on sheet M1.0) and replacing them with new exhaust system equipment (see Specific Notes 5-8 on sheet M1.0) in accordance with the Plans and Specifications.

MEASUREMENT AND PAYMENT: Quantities for replacing the exhaust system equipment in the ventilation building shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:
Ventilation Building Mechanical Work

ITEM S-119, VENTILATION BUILDING ELECTRIC MOTORS

This item consists of cleaning and testing the existing exhaust fan motors in accordance with the Plans and Specifications. The contractor shall provide a separate cost to have the motors rewound in the event that the tests indicate that this necessary.

MEASUREMENT AND PAYMENT: Quantities for cleaning and testing the exhaust fan motors shall be the design quantities specified on the plans and will be measured as a lump sum. The contractor shall provide a separate unit cost to have the motors rewound.

Payment shall be made under:
Ventilation Building Electric Motors

ITEM S-120, VENTILATION BUILDING ELECTRICAL SERVICE

This item consists of providing new normal electrical service feeder from utility transformer to new MCC in accordance with the Plans and Specifications. It shall include any utility charges for new utility transformer that needs to be installed for this project.

MEASUREMENT AND PAYMENT: Quantities for electrical service work shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:
Ventilation Building Electrical Service

ITEM S-121, VENTILATION BUILDING ELECTRICAL WORK

This item consists of providing all the electrical work in the ventilation building in accordance with the Plans and Specifications except for the work as covered in items S-122 and S-123 above. It shall include the new MCC and UPS and all branch circuits, devices, lights for the ventilation building. It shall also include new Zetron panel and telephone wiring.

MEASUREMENT AND PAYMENT: Quantities for electrical service work shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:
Ventilation Building Electrical Work

ITEM S-122, TUNNEL ELECTRICAL WORK

This item consists of install all new electrical conductors (both power and control) from the ventilation building to each pump room in accordance with the Plans and Specifications. It shall include the new sidewalk lights and associated branch circuitry.

MEASUREMENT AND PAYMENT: Quantities for electrical service work shall be the design quantities specified on the plans and will be measured as a lump sum.

Payment shall be made under:
Tunnel Electrical Work

SECTION 01290 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.2 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including Application for Payment forms with Continuation Sheets, Submittals Schedule and Contractor's Construction Schedule.
 2. Submit the Schedule of Values to Engineer at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
 3. Subschedules: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of payment.
- B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.
1. Identification: Include the following Project identification on the Schedule of Values:
 - a. Project name and location.
 - b. Name of Engineer.
 - c. Engineer's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 2. Submit draft of AIA Document G703 Continuation Sheets.
 3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the

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- Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
 5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
 7. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
 8. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.3 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.
- C. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
 1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
 2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

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- D. **Transmittal:** Submit 3 signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- E. **Waivers of Mechanic's Lien:** With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. **Waiver Forms:** Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- F. **Initial Application for Payment:** Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of Values.
 3. Contractor's Construction Schedule (preliminary if not final).
 4. Submittals Schedule (preliminary if not final).
 5. List of Contractor's staff assignments.
 6. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 7. Initial progress report.
 8. Report of preconstruction conference.
 9. Certificates of insurance and insurance policies.
- G. **Application for Payment at Substantial Completion:** After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

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H. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01290

SECTION 01310 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
1. Coordination Drawings.
 2. Project meetings.

1.2 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Startup and adjustment of systems.
8. Project closeout activities.

1.3 SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings for efficient installation of different components

1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
 - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Engineer for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
2. Sheet Size: At least 8-1/2 by 11 inches but no larger than 30 by 40 inches.
3. Number of Copies: Submit 5 copies of each submittal. Engineer will return 3 copies.
4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

1.4 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

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3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or at a location selected by the Owner. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner and Engineer; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for requests for interpretations (RFIs).
 - g. Procedures for testing and inspecting.
 - h. Procedures for processing Applications for Payment.
 - i. Distribution of the Contract Documents.
 - j. Submittal procedures.
 - k. Preparation of Record Documents.
 - l. Use of the premises.
 - m. Work restrictions.
 - n. Responsibility for temporary facilities and controls.
 - o. Construction waste management and recycling.
 - p. Parking availability.
 - q. Office, work, and storage areas.
 - r. Equipment deliveries and priorities.
 - s. First aid.
 - t. Security.
 - u. Progress cleaning.
 - v. Working hours.
 3. Minutes: Record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

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1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. The Contract Documents.
 - b. Options.
 - c. Related requests for interpretations (RFIs).
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Possible conflicts.
 - i. Compatibility problems.
 - j. Time schedules.
 - k. Weather limitations.
 - l. Manufacturer's written recommendations.
 - m. Warranty requirements.
 - n. Compatibility of materials.
 - o. Acceptability of substrates.
 - p. Temporary facilities and controls.
 - q. Space and access limitations.
 - r. Regulations of authorities having jurisdiction.
 - s. Testing and inspecting requirements.
 - t. Installation procedures.
 - u. Coordination with other work.
 - v. Required performance results.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at intervals as determined by Owner. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at

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- these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Access.
 - 6) Site utilization.
 - 7) Temporary facilities and controls.
 - 8) Work hours.
 - 9) Hazards and risks.
 - 10) Progress cleaning.
 - 11) Quality and work standards.
 - 12) Status of correction of deficient items.
 - 13) Field observations.
 - 14) Requests for interpretations (RFIs).
 - 15) Status of proposal requests.
 - 16) Pending changes.
 - 17) Status of Change Orders.
 - 18) Pending claims and disputes.
 - 19) Documentation of information for payment requests.
 3. Minutes: Record the meeting minutes.
 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.

Project Management and Coordination

- a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01310

SECTION 01320 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
1. Contractor's Construction Schedule.
 2. Submittals Schedule.
 3. Daily construction reports.
 4. Field condition reports.
- B. See Division 1 Section "Payment Procedures" for submitting the Schedule of Values.

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 2. Predecessor Activity: An activity that precedes another activity in the network.
 3. Successor Activity: An activity that follows another activity in the network.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Float: The measure of leeway in starting and completing an activity.
1. Float time belongs to Owner.

- E. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

1.3 SUBMITTALS

- A. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
 - 1. Scheduled date for first submittal.
 - 2. Specification Section number and title.
 - 3. Submittal category (action or informational).
 - 4. Name of subcontractor.
 - 5. Description of the Work covered.
 - 6. Scheduled date for Engineer's final release or approval.
- B. Preliminary Network Diagram: Submit two copies, large enough to show entire network for entire construction period. Show logic ties for activities.
- C. Contractor's Construction Schedule: Submit two opaque copies of initial schedule, large enough to show entire schedule for entire construction period.

1.4 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from parties involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 2. Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Final Completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Engineer.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - a. Drainage pumping units
 - b. Pump controls and control panel.
 3. Submittal Review Time: Include review and resubmittal times indicated in Division 1 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
 4. Startup and Testing Time: Include not less than 5 days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

Construction Progress Documentation

- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Uninterruptible services.
 - c. Seasonal variations.
 - d. Environmental control.
 3. Work Stages: Indicate important stages of construction for each major portion of the Work.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
1. For construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

2.4 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. Equipment at Project site.

3. Material deliveries.
 4. High and low temperatures and general weather conditions.
 5. Accidents.
 6. Stoppages, delays, shortages, and losses.
 7. Orders and requests of authorities having jurisdiction.
 8. Services connected and disconnected.
 9. Equipment or system tests and startups.
- B. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate Actual Completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01320

SECTION 01330 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. See Division 1 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule.
- C. See Division 1 Section "Quality Requirements" for submitting test and inspection reports.
- D. See Division 1 Section "Closeout Procedures" for submitting warranties.
- E. See Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
- F. See Division 1 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
- G. See Division 1 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

Submittal Procedures

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Submittals Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
- D. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Submittal number or other unique identifier, including revision identifier.
- 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06100.01).

Submittal Procedures

Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).

- i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate.
 - l. Other necessary identification.
- E. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.
- F. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
1. Additional copies submitted for maintenance manuals will be marked with action taken and will be returned.
- G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form.
- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities.

PART 2 - PRODUCTS**2.1 ACTION SUBMITTALS**

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Manufacturer's catalog cuts.
 - e. Wiring diagrams showing factory-installed wiring.
 - f. Printed performance curves.
 - g. Operational range diagrams.
 - h. Compliance with specified referenced standards.
 - i. Testing by recognized testing agency.
 4. Number of Copies: Submit 5 copies of Product Data, unless otherwise indicated. Engineer will return 3 copies. Mark up and retain one returned copy as a Project Record Document.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 40 inches.
 3. Number of Copies: Submit two opaque (bond) copies of each submittal. Engineer will return one copy.
- D. Submittals Schedule: Comply with requirements specified in Division 1 Section "Construction Progress Documentation."

Submittal Procedures

- E. Application for Payment: Comply with requirements specified in Division 1 Section "Payment Procedures."
- F. Schedule of Values: Comply with requirements specified in Division 1 Section "Payment Procedures."
- G. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.
 - 1. Number of Copies: Submit three copies of subcontractor list, unless otherwise indicated. Engineer will return two copies.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 - 1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. Engineer will not return copies.
 - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
- B. Coordination Drawings: Comply with requirements specified in Division 1 Section "Project Management and Coordination."
- C. Contractor's Construction Schedule: Comply with requirements specified in Division 1 Section "Construction Progress Documentation."
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

- G. **Manufacturer Certificates:** Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- H. **Product Certificates:** Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- I. **Material Certificates:** Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- J. **Product Test Reports:** Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- K. **Maintenance Data:** Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 1 Section "Operation and Maintenance Data."
- L. **Manufacturer's Instructions:** Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer.
- M. **Manufacturer's Field Reports:** Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
 - 1. Statement on condition of substrates and their acceptability for installation of product.
 - 2. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
- N. **Insurance Certificates and Bonds:** Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

SECTION 01400 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing is required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 2. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. See Divisions 15 and 16 Sections for specific test requirements.

1.2 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- D. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

Quality Requirements

- E. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
- F. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.3 SUBMITTALS

- A. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.4 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- E. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of

manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.5 QUALITY CONTROL

- A. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 1 Section "Submittal Procedures."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01400

SECTION 01600 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. See Division 1 Section "Closeout Procedures" for submitting warranties for Contract closeout.
- C. See Divisions 15 and 16 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.2 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1.3 SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

- a. Statement indicating why specified material or product cannot be provided.
- b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
- c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
- e. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
- f. Cost information, including a proposal of change, if any, in the Contract Sum.
- g. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
- h. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

B. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.
 - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Store cementitious products and materials on elevated platforms.
 - 5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 7. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

- B. Submittal Time: Comply with requirements in Division 1 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
- B. Product Selection Procedures:
1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
 3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
 4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
 5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
 6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements.
 7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the

Product Requirements

specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.

2.2 PRODUCT SUBSTITUTIONS

- A. Timing: Engineer will consider requests for substitution if received within 30 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.
- B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - 1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume.
 - 2. Requested substitution does not require extensive revisions to the Contract Documents.
 - 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - 4. Substitution request is fully documented and properly submitted.
 - 5. Requested substitution will not adversely affect Contractor's Construction Schedule.
 - 6. Requested substitution is compatible with other portions of the Work.
 - 7. Requested substitution has been coordinated with other portions of the Work.
 - 8. Requested substitution provides specified warranty.

2.3 COMPARABLE PRODUCTS

- A. Conditions: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied:
 - 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 - 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

3. Evidence that proposed product provides specified warranty.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01600

SECTION 01770 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Warranties.
 - 3. Final cleaning.
- B. See Division 1 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
- C. See Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
- D. See Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
- E. See Division 1 Section "Demonstration and Training" for requirements for instructing Owner's personnel.
- F. See Divisions 15 and 16 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Advise Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

Closeout Procedures

4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 5. Prepare and submit Project Record Documents, operation and maintenance manuals, damage or settlement surveys, and similar final record information.
 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 7. Complete startup testing of systems.
 8. Submit test records.
 9. Terminate and remove temporary facilities from Project site, along with construction tools, and similar elements.
 10. Complete final cleaning requirements, including touchup painting.
 11. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."
 2. Submit copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list). The copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled

requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit three copies of list. Include name and identification of each area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1.5 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Clean each surface or unit to condition expected. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, and grounds, in areas disturbed by construction activities, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Clean interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances.
 - f. Remove debris and surface dust from limited access spaces, including roofs, trenches, manholes, and similar spaces.
 - g. Sweep concrete floors broom clean.
 - h. Remove labels that are not permanent.
 - i. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

Closeout Procedures

- l) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - j. Wipe surfaces of mechanical and electrical equipment, elevator equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - k. Replace parts subject to unusual operating conditions.
 - l. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - m. Leave Project clean and ready for occupancy.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01770

SECTION 01781 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. See Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
- C. See Divisions 15 and 16 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.2 SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up Record Prints.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.

1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally.
2. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. Note related Change Orders, and Record Drawings where applicable.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, and Record Drawings where applicable.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents: Store Record Document in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

END OF SECTION 01781

SECTION 01782 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation manuals for systems, subsystems, and equipment.
 - 2. Maintenance manuals for the care and maintenance of products, systems and equipment.
- B. See Divisions 15 and 16 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.2 SUBMITTALS

- A. Manual: Submit one copy of each manual in final form at least 15 days before final inspection. Engineer will return copy with comments within 15 days after final inspection.
 - 1. Correct or modify each manual to comply with Engineer's comments. Submit 3 copies of each corrected manual within 15 days of receipt of Engineer's comments.

PART 2 - PRODUCTS

2.1 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain a title page, table of contents, and manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.

4. Date of submittal.
 5. Name, address, and telephone number of Contractor.
 6. Name and address of Engineer.
 7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements.
- B. Descriptions: Include the following:

1. Product name and model number.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include start-up, break-in, and control procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

2.3 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
1. Product name and model number.
 2. Manufacturer's name.
- D. Maintenance Procedures: Include manufacturer's written recommendations and inspection procedures, types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including maintenance instructions, drawings and diagrams for maintenance, nomenclature of parts and components, and recommended spare parts for each component part or piece of equipment:
- D. Maintenance Procedures: Include test and inspection instructions, troubleshooting guide, disassembly instructions, and adjusting instructions, and demonstration and training videotape if available, that detail essential maintenance procedures:
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

Operation and Maintenance Data

- B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
- E. Comply with Division 1 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01782

SECTION 01820 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training videotapes.
- B. See Divisions 15 and 16 Sections for specific requirements for demonstration and training for products in those Sections.

1.2 SUBMITTALS

- A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, and length of instruction time.
- B. Demonstration and Training Videotapes: Submit two copies within seven days of end of each training module.

1.3 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 1 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
- B. Coordinate content of training modules with content of operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Training Modules: For each module, include instruction for the following:
1. Documentation: Review operations, and maintenance manuals; Project Record Documents; identification systems.
 2. Operations: Include startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; and required sequences for electric or electronic systems.
 3. Adjustments: Include alignments and checking, noise, vibration, and efficiency adjustments.
 4. Troubleshooting: Include diagnostic instructions and test and inspection procedures.
 5. Maintenance: Include inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
 6. Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- B. Scheduling: Provide instruction at mutually agreed on times.
1. Schedule training with Owner, with at least seven days' advance notice.

3.2 DEMONSTRATION AND TRAINING VIDEOTAPES

- A. General: Engage a qualified photographer to record demonstration and training videotapes. Record each training module separately.
- B. Videotape Format: Provide high-quality VHS color videotape in full-size cassettes.

END OF SECTION 01820

SECTION 15000 - MECHANICAL GENERAL REQUIREMENTS



PART 1 - GENERAL

1.1 SCOPE

- A. This section, as well as the Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 - General Sections included in Division 15 Specifications are for mechanical and related work particular to the Modifications for the Pump Rooms located in the Intracoastal Water Way Tunnel in Houma, LA.. Coordinate with plans and other specifications sections.

1.2 RELATED DOCUMENTS

- SECTION 15000 - MECHANICAL - GENERAL REQUIREMENTS
- SECTION 15050 - BASIC MATERIALS AND METHODS
- SECTION 15060 - HANGERS AND SUPPORTS
- SECTION 15075 - MECHANICAL IDENTIFICATION
- SECTION 15110 - VALVES
- SECTION 15160 - STORM DRAINAGE PIPING
- SECTION 15447 - TUNNEL CENTRIFUGAL DRAINAGE PUMPS
- SECTION 15448 - TUNNEL SUBMERSIBLE CENTRIFUGAL DRAINAGE PUMPS
- SECTION 15820 - BACKDRAFT DAMPERS
- SECTION 15900 - CARBON MONOXIDE MONITORING SYSTEM

1.3 WORK INCLUDED

- A. The work covered by this Division of the Specifications consists of furnishing all plant, labor, equipment, supervision, appliances, and materials, and in performing all operations in connection with the pumping and piping mechanical systems, complete, and in strict accordance with this Division of the Specifications and the applicable drawings.

1.4 COORDINATION OF WORK

- A. General: Refer to the Division 1 sections for general coordination requirements applicable to the entire work. It is recognized that the contract documents are diagrammatic in showing certain physical relationships which must be established within the mechanical work, and

in its interface with other work, including electrical work, and that such establishment is the exclusive responsibility of the Contractor.

- B. Advise other trades of openings required in their work for the subsequent move-in of large equipment.
- C. Submit coordination drawings prior to purchase-fabrication-installation of any of the elements involved in the coordination.
- D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- E. Verify all dimensions by field measurements.
- F. Arrange for openings in building components to allow for installation.
- G. Coordinate the installation of required supporting devices and sleeves to be set in concrete and other structural components, as they are constructed.
- H. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring specific positioning in the installation areas.
- I. Coordinate the cutting and patching of building components to accommodate the installation of equipment and materials. Comply with Division 1.
- J. Install equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
- K. Contractor shall visit the site before bidding to familiarize himself with conditions under which he will have to perform his Contract.

1.5 EXISTING CONDITIONS

- A. Contractor shall field verify existing conditions and notify engineer in writing of any discrepancies prior to commencing with new work.
- B. All existing piping and materials not to be reused and becoming surplus or abandoned shall be removed from the premises and shall be property of the Contractor, unless otherwise noted.

1.6 INTERRUPTION OF SERVICES

- A. All work shall be accomplished at a time most convenient to the Owner and so that the interruption of service shall be minimum and only for changeover. Where this is impractical, the Contractor shall provide temporary drainage pumps, power, etc. to maintain the ability to pump runoff water at all times.
- B. No service shall be interrupted or changeover begun until the time and duration of service interruption have been agreed to, in writing, signed by the Owner's Representative, the Engineer, and the Contractor.
- C. Temporary connections, or temporary rerouting to serve existing facilities will be required as the work progresses. Make due allowances in bid.
- D. The Contractor shall provide a plan outlining how the Pump Station will be kept in operations continuously during the replacement of the pumps and associated piping. This plan must be approved in writing by the owner prior to commencing work on the Station.

1.7 CODES AND STANDARDS

- A. Workmanship, material and equipment shall be in accordance with Specifications and Drawings, and in some instances the requirements exceed those required by codes and standards. Where not exceeded, the codes and standards shall be considered as absolute minimum requirements.

1.8 ELECTRICAL WORK

- A. Refer to Division 16 for all electrical work as it pertains to work specified in this section.

1.9 WORKMANSHIP

- A. Install all materials and components of the work in accordance with instructions of manufacturer following the best modern construction practices and conforming with the Contract Documents. Workmanship shall be first class, in both function and appearance, and shall be performed by experienced workmen skilled in the type of work.

1.10 DRAWINGS

- A. Contract Drawings and details are shown to limit and explain structural conditions, requirements, and manner of erecting work. Drawings are intended to convey the scope of work and indicate general arrangements of equipment and piping and sizes and locations of equipment and outlets. Trades shall follow these drawings in laying out their work, check existing field conditions to familiarize themselves with all conditions affecting their work and shall verify spaces in which their work will be installed.
- B. It may be necessary to shift pipes or equipment, but all such changes must be referred to the Engineer for approval. Where rearrangement of piping or equipment is required, Contractor shall prepare and submit approval drawings of the proposed arrangement.
- C. Where the Contractor is not certain about the method of installation, he shall ask for details. Lack of details, not requested, will not be an excuse for improper installation, and any such work must be corrected.

1.11 SHOP DRAWINGS AND DATA TO BE SUBMITTED

- A. Submit adequate engineering data on each piece of equipment to allow a careful check of compliance with the technical requirements of the Contract documents. Clearly indicate on submitted data the manufacturer's name, piece number, equipment capacity, and other applicable technical data. Refer to individual sections for specific requirements.
- B. Corrections or comments made on shop drawings during the review do not relieve the Contractor from compliance with requirements of the Contract Documents, Plans and Specifications. Shop Drawings will be checked for general conformance with the design concept of the project and general compliance with information given in the contract documents. Review of Shop Drawings shall not relieve the Contractor from responsibility for confirming and correlating all quantities and dimensions, coordinating work with that of all other trades, and performing work in a safe and satisfactory manner. Review of shop drawings shall not permit any deviation from Plans and Specifications. Shop Drawings must be accompanied by signed statement from Contractor, stating that he has reviewed the submittal and checked it for compliance.
- C. Shop Drawings: Submit 1/2 inch minimum scale coordinated shop drawings relating to the mechanical systems, showing clearances and relationship to structural members, piping, lights and ceilings. Shop drawings must be submitted and reviewed before any ductwork is constructed or installed.

- D. Contractor shall provide products as specified if submittals for review of materials are not received within thirty (30) days after award of the Contract.
- E. Any item not specified herein but submitted as a substitute for the specified item shall be accompanied by manufacturers's documentation starting/illustrating the following applicable information in addition to the specific information requested in other sections.
 - 1. Dimensions/weight.
 - 2. Electrical ratings-voltage, amperage, short circuit capability, etc.
 - 3. Construction - gauge of steel/aluminum, paint finish/application method, color, NEMA type, etc.
 - 4. Warranty.

1.12 INSTRUCTIONS AND EQUIPMENT START UP SERVICE

- A. Contractor shall furnish the services of factory authorized start up personnel and competent instructors who will check alignments of equipment, perform required start up test and give full instruction to designated personnel in the adjustment, operation, and maintenance, including pertinent safety requirements of the equipment or system specified. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation.

1.13 OPERATING AND MAINTENANCE MANUALS

- A. Bind in looseleaf binders with the words, "Operating and Maintenance Manual" and the project identification imprinted on the cover. Prepare three complete sets of records for the Owner, with table of contents, index, and tabbed section dividers.
- B. During the construction period, accumulate the following for inclusion in the Operating and Maintenance Manuals:
 - 1. Pumps.
 - 2. Wiring and control diagrams.
 - 3. Shop Drawings.
 - 4. Operating instructions for:
 - a. Pumping systems and controls.
 - b. Motor actuated valves and controls.
 - 5. Recommended maintenance procedures.

- D. Submit the manuals for approval at approximately 75 percent job completion. Each manual shall consist of:
1. Complete description of each item of equipment and apparatus furnished and installed - including ratings, capacities, and characteristics.
 2. Fully detailed parts list, including all numbered parts of each item of equipment and apparatus furnished and installed.
 3. Manufacturer's printed instructions describing operation, servicing, maintenance and repair of each item of equipment and apparatus.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications, adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from physical and water/moisture damage.
- C. Coordinate deliveries of materials and equipment to minimize construction site congestion.

1.15 GUARANTEES

- A. Contractor shall guarantee all materials, workmanship, and equipment furnished under Division 15 for a period of one (1) year after the date of final acceptance or beneficial use by the Owner, whichever date is the earliest.

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS

- A. Manufacturer's names and catalog numbers are scheduled or specified for the purpose of establishing standard of design, quality, appearance, performance and serviceability, and not to limit competition. Scheduled products (as may be modified by detailed Specifications) are those selected as the basis for system design with respect to physical size and space arrangements, required capacity and performance characteristics, and the product quality intended. Since the final equipment furnished may vary in size, connection points, etc., the Contractor shall verify all final pipe connections (types, sizes and locations), and make final adjustments as necessary, to suit equipment furnished.

- B. The Drawings indicate specified products physically arranged in the spaces, as catalogued by Specific manufacturers, generally as listed in the equipment schedules.
- C. Listed "Acceptable Manufacturers" are those considered capable of manufacturing products conforming to detailed Specifications, and as such, are invited to compete on an equal basis provided the offering is comparable in every respect to scheduled or specified products and actually conforms to the detailed Specifications and schedule requirements. Listing herein as "acceptable manufacturers" does not imply "accepted," "approved," "prior approval," or any other such connotation.

2.2 AUXILIARY STRUCTURAL SUPPORTS

- A. Provide auxiliary structural supports as necessary to support mechanical systems from the building structure. Supporting members shall be metal strut framing or standard structural shapes, designed to support imposed loads with a working stress no greater than 25 percent of ultimate stress values of the members, and articulation with the building structure without exceeding structural limitations at the point of attachment to the building structure.

2.3 SPECIAL TOOLS

- A. Furnish a set of special tools and devices required for the proper maintenance of the major pieces of equipment and install on adequate tool board. This shall include only tools which cannot normally be purchased "over-the-counter" at hardware stores.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Protect equipment and materials from physical damage, water damage and deterioration after it is delivered to the project, and during the installation.
- B. The equipment shall be kept clean. Motors and electrical devices shall be covered with suitable materials to prevent dirt, dust or moisture accumulation within the equipment or control panels. Machinery and devices shall be properly oiled and maintained to prevent rusting and deterioration.
- C. Repair scratches, mars, or paint deterioration.

3.2 MATERIAL DAMAGE

- A. The Contractor shall immediately report in writing to the owner and Engineer any incident involving equipment or material damage including rain water damage, pipe leaks, physical damage, etc.
- B. At a minimum the report shall include the areas and extent of damage and proposed resolution.
- C. Water damaged materials shall be replaced with new materials without exception.

3.3 PAINTING AND FINISHING AND CLEANING

- A. Surfaces shall be left clean, debris shall be removed and equipment shall be furnished in factory applied coat finish.
- B. Piping and equipment: Clean exterior of piping and equipment, removing rust, plaster and dirt by wire brushing. Remove grease, oil, and similar materials by wiping with clean rags and suitable solvents. Provide one coat of primer, followed by two coats of premium enamel or epoxy finish paint to all pipe and fittings. Finish color shall be selected by the owner.
- C. Supports and anchors: Supports and anchors shall be hot dipped galvanized steel with cold galvanized welds.
- D. Motors, pumps and other items with factory finish. Remove grease and oil and leave surfaces clean and polished.

END OF SECTION 15000

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Sleeves.
3. Grout.
4. Mechanical demolition.
5. Equipment installation requirements common to equipment sections.
6. Concrete grout.

1.2 SUBMITTALS

A. Product Data: For the following

1. Pipe and fittings.

B. Welding certificates.

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately

modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and fittings with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Protect pipe from weather during storage to prevent corrosion and scale build-up.

1.5 COORDINATION

- A. Arrange for pipe spaces, core drilling and openings in building structure during progress of construction, to allow for mechanical installations. Contractor is responsible for providing required penetrations in existing structure to accommodate piping.
- B. Coordinate installation of required supporting devices and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated. Full-Face type for flat-face, Class 125, flanges and narrow-face type for raised face, Class 250, flanges.
- C. Welding Filler Metals: Comply with AWS D10.12.

2.3 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish and remove mechanical systems, equipment and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- C. If pipe or equipment to remain is damaged, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping to permit valve servicing.

- E. Install piping at indicated slopes or elevations.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Seal all penetrations of walls and floors with non-shrink grout.
- J. Verify final equipment locations prior to roughing-in.
- K. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- L. Expansion and Contraction of Piping:
 - 1. Allowance shall be made throughout for expansion and contraction of pipe. Refer to the drawings for details.
 - 2. All pipe shall be so installed that it may contract or expand freely without damage to any other work or injury to itself. Any swing joints, expansion joints, or bends necessary shall be installed whether shown or not.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

3.6 PAINTING

- A. Paint all pipe and fittings as described in Part 2 of these specifications. Painting shall be performed in accordance with manufacturer's recommendations.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to existing concrete base according to structural drawing requirements and equipment manufacturer's written instructions.

Basic Mechanical Materials and Methods

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install supports and anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.8 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on existing slabs and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 15050

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of pipe hanger and support system component.

1.3 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.
 - c. Michigan Hanger Co., Inc.

2. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.

2.3 MISCELLANEOUS MATERIALS

- A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- C. Grout: ASTM C 1107, Grade B, factory-mixed and packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 2. Properties: Non-staining, non-corrosive, and non-gaseous.
 3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 1. Pipe Stanchion (MSS Type 37): For suspension of non-insulated stationary pipes, NPS 6 to NPS 12.
 2. Channel-Strut System: For support of pipes, NPS 1 to NPS 4, with stainless steel channels, pipe clamps and wall fasteners.
- D. Vertical-Piping Clamps: As detailed on the drawings, unless otherwise specified in piping system Specification Sections.
- E. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Concrete Drilled Anchors: Equal to "Hilti" model HY 150 injection adhesive anchor for attachment to suspend pipe hangers from concrete ceiling or floor anchorage for pipe stands.

3.2 INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports and attachments as required to properly support piping from building structure.
- B. Install building attachments to concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges and at changes in direction of piping.
- C. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- E. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor. Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

- A. Cut, drill and fit miscellaneous metal fabrications for pipe and equipment supports. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded. Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, methods used in correcting welding work and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.
 5. Hot dip galvanized assemblies after fabrication, where required by Drawing details.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up - Galvanized Surfaces: Clean welds, bolted connections and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15060

SECTION 15075 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Valve tags.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliance.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.

2.2 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.
 - 1. Material: 0.032-inch- thick brass .
 - 2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

PART 3 - EXECUTION

3.1 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 - 1. Pumps and similar motor-driven units.

3.2 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves.
- B. Valve-Tag Application Schedule: Tag valves according to size and shape with captions similar to those indicated in the following:
 - 1. Valve-Tag Size and Shape:
 - a. 1-1/2 inches, round.
 - 2. Function:
 - a. Function or name of valve (GV-1, GV-2, etc.).
 - 3. Color:
 - a. Valve Tag - RED; Lettering - White.

3.3 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.
- B. Clean faces of mechanical identification .

END OF SECTION 15075

SECTION 15110 - VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Bronze ball valves.
 - 2. Gray-iron swing type, spring and lever check valves.
 - 3. Cast-iron, duo-disc, OS&Y gate valves with motor operators.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for building services piping valves.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and Smaller: Threaded ends.
- C. Ferrous Valves NPS 2-1/2 and Larger: Flanged ends.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Handwheel: For valves that are specified as non-rising stem type.
 - 2. Motor Operated: For valves that are specified as outside screw and yoke type.
- G. Valve Flanges: ASME B16.1 for cast-iron valves and ASME B16.5 for steel valves.
- H. Threaded Ends: With threads according to ASME B1.20.1.

2.3 BRONZE BALL VALVES

- A. Available Manufacturers:
 - 1. Hammond Valve Co.
 - 2. Milwaukee Valve Co.
 - 3. Red-White valve Corp.
- B. All ball valves and their components shall be designed for a minimum working pressure of 600 PSI WOG and conform to MSS-SP-110. All non-metallic components and elastomers shall be suitable for 250 degrees F minimum continuous operating temperature, or not less than 50 degrees F above the operating temperature of the system, whichever is higher. All mating surfaces of closure faces shall be of bronze or Type 300 series or 17-4PH stainless steel, or elastomer, approved for the particular service, and materials must be compatible to prevent poisoning of contact surfaces of different materials (electrolytic action). Each valve shall be provided with a handle which shall be secured to the stem or chained to the valve body.

- C. Ball valves shall be used on lines 2 inches and smaller. Valves shall have bronze bodies with chrome-plated balls, threaded ends, and shall conform to MSS SP-110. Valves shall be 3-piece bolt-through body.

2.4 GRAY-IRON SWING TYPE, SPRING AND LEVER CHECK VALVES

A. Available Manufacturers:

- 1. Mueller Co.
- 2. Grinnell Co.

- B. Flanged ends, spring and lever operated with rubber disc facing, meeting ANSI/AWWA C508 Standards and ANSI B16.1 flanged end dimensions and drilling, iron body, bronze mounted with O-ring stuffing box, adjustable spring tension to control opening and closing of clapper, lever and spring shall have the option of being installed on either side of the valve. Valves shall be suitable for horizontal and vertical installation.

2.5 CAST-IRON GATE VALVES

A. Available Manufacturers:

1. Type I, Cast-Iron, Rising-Stem Gate Valves:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Div.
- c. McWane Inc.; Clow/Kennedy Valve Div.

- B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

- C. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and double disc.

2.6 MOTOR OPERATED VALVE ACTUATORS

- A. Gate valves GV-1, GV-2, GV-3, GV-4, GV-7, GV-8, GV-9 and GV-10 shall be provided with "Flowserve" Limitorque Series MX actuators coupled to valves using series B320 bevel gear operators.

- B. The actuator shall consist of a three-phase electric motor, worm gear reduction, absolute position encoder, electronic torque sensor, reversing motor contactor, electronic control,

- protection, and monitoring package, manual override handwheel, valve interface brushing, 32-character LCD, and local control switches all contained in an enclosure that is sealed to NEMA 4, 4X, 6, IP68, and XP. Actuator design life shall be one million drive sleeve turns.
- C. The power transmission shall be completely bearing-supported, and consist of a hardened alloy steel worm and bronze alloy worm gear, oil-bath lubricated using a synthetic oil designed specifically for extreme pressure gear transmission service.
 - D. The motor shall be 3-phase/60-cycle with Class F insulation, and a thermistor embedded within the motor windings to prevent damage due to overload. The motor shall be easily removed through the use of a plug-in connector and shaft coupling.
 - E. Valve position shall be sensed by a 15-bit, optical, absolute position encoder. Open and closed positions shall be stored in permanent, nonvolatile memory. The encoder shall measure valve position at all times, including both motor and hand-wheel operation, with or without 3-phase power present, and without the use of a battery.
 - F. An electronic torque sensor shall be included. The torque limit shall be adjusted from 40-100% of rating in 1% increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a "Jammed Valve" protection feature, with automatic retry sequence, shall be incorporated to de-energize the motor if no movement occurs.
 - G. The control module shall include power and logic circuit boards, control transformer, and protection fuses, all mounted to a steel plate and attached in the control compartment with captive screws. The module shall be easily removed through the use of plug-in connectors. The module shall also include a reversing contactor, local control switches, 32-character LCD, and LED indicators. All internal wiring shall be flame-resistant, rated 105 degrees Celsius, and UL listed.
 - H. The LCD module shall use solid-state Hall-effect devices for local communication and configuration. The use of reed switches for this purpose on the LCD module is prohibited.
 - I. The reversing contactor shall be mechanically interlocked to prevent simultaneous energizing of the open and close coils. The control module shall also include an auto reversal delay to inhibit high current surges caused by rapid motor reversals. The control transformer shall include vacuum-impregnated coils and dual primary fuses. A phase correction circuit shall be included to correct motor rotation faults caused by incorrect site wiring. The phase correction circuit shall also detect the loss of a phase and disable operation to prevent motor damage.

- J. Remote control shall be configured as 4 wires for open-stop-close control. Terminals must also be provided for ESD (Emergency Shutdown) and Inhibit Movement commands. The ESD signal shall override any existing signal (except LOCAL, STOP, and INHIBIT) and send the valve to its configured emergency position. The ESD shall be configured to override LOCAL, STOP, and/or INHIBIT. Remote control functions shall be powered by the actuator's internal supply of 110 VAC or 24 VDC. The internal supplies shall be protected against overcurrent and short circuit faults.
- K. Terminals shall be included to connect the electronic controls package, including display, to a back-up 24VDC power source.
- L. A dedicated circuit to prevent undesired valve operation in the event of an internal circuit fault or erratic command signal shall be included. An open or short-circuit in the internal circuit board logic shall not energize the motor contactor, nor shall a single fused control relay contact fail to de-energize the motor contactor. The command inputs shall be optically coupled and require a pulse width of at least 250 ms to 350 ms to turn on or off. In the event of an internal circuit fault, an alarm shall be signaled by tripping the Monitor Relay and through LCD indication.
- M. A padlockable LOCAL-STOP-REMOTE switch and an OPEN-CLOSE switch shall be included for local valve actuator control. The control switches shall not penetrate the controls cover and shall be designed to electrically isolate the actuator's internal components from the external environment. The OPEN-CLOSE switch shall be configured for maintained or push-to-run (inching) control.
- N. Four latched contacts shall be provided for remote indication of valve position, configured as 1-N/O and 1-N/C for both the open and closed positions. The contacts shall be configured to represent any other actuator status; mid-travel position, switched to local, overtorque, motor overtemperature, manual operation, switched to remote, switched to stop, valve moving, close torque switch, open torque switch, hardware failure, ESD active, inhibit active, or valve jammed.
- O. A monitor relay shall be included and shall trip when the actuator is not available for remote operation. Both N/O and N/C contacts shall be included, rated 250 VAC/30 VDC, 5 amps. The yellow LED shall blink when the monitor relay is active.
- P. A 32-character, Liquid Crystal Display (LCD) shall be included to display valve position as a percent of open, 0-100%, and current actuator status. "STATUS OK" shall be displayed for an operable actuator. If the actuator is not operable, the appropriate alarm shall be displayed. The alarm shall be continuously displayed until the actuator is operable. Red, green, and yellow LEDs shall be included for close, open, stopped, and moving indication.

- Q. All calibration shall be possible without removing any covers and without the use of any special tools. All calibration shall be performed by answering "YES" and "NO" questions displayed on the LCD. "YES" is signaled by using the OPEN switch and "NO" by using the CLOSE switch, as indicated adjacent to the switches. A configurable password option shall be available to prevent unauthorized changes.
- R. All customer connections shall be located in a terminal chamber that is separately sealed from all other actuator components. Site wiring shall not expose actuator components to the environment. The internal sealing within the terminal chamber is suitable for the NEMA 4, 6, and IP68. The chamber shall include screw-type terminals, 3 power and 50 control, for site connections. Three conduit entries, available as: (2) - 1.25" NPT and (1) - 1.5 NPT shall be located in the terminal chamber.
- S. The actuator shall be coated with a polymer powder coat. The coating system shall be suitable for an ASTM B117 salt spray test of 1500 hours. External fasteners shall be highstrength carbon steel, zinc plated, chromate-hexavalent coated, and then top coated with a highstrength, high-endurance polymer. The fasteners shall be suitable for an ASTM B117 salt spray test of 500 hours.
- T. A handwheel and declutch lever shall be provided for manual operation. The handwheel shall not rotate during electric operation nor can a seized motor prevent manual operation. Changing from motor to manual operation is accomplished by engaging the declutch lever. Energizing the motor shall return the actuator to motor operation. The declutch lever is padlockable in the motor position.
- U. The actuator shall include a removable bushing to mate with the valve shift.
- V. Diagnostic facilities shall be included to accumulate and report the performance of the motor, encoder, contactor, cycle time, handwheel operations, actuator ID, and output turns. In addition, a torque profile of the reference baseline valve stroke and the last valve stroke shall be included. All diagnostic information shall be displayed on the LCD.
- W. Every actuator shall be factory tested to verify: rated output torque, output speed, handwheel operation, local control, control power supply, valve jammed function, all customer inputs and outputs, motor current, motor thermistor, LCD and LED operation, direction of rotation, microprocessor checks, and position-sensor checks. A report confirming successful completion of testing shall be included with the actuator.
- X. All actuator designs shall have been tested to demonstrate electromagnetic compatibility with the following:
1. EFT Immunity; EN 50082-2
 2. Conducted Immunity; EN 50082-2

3. Conducted Immunity; Mains (power)
Harmonic Distortion per MIL-STD-461,
Method Conducted Emissions; EN 55011
 4. Radiated Emissions; EN 55011
 5. ESD Immunity; EN 50082-2
 6. Radiated Immunity; EN 50082-2
 7. Radiated Immunity; 1-2 Ghz per IEC 801-3
 8. CS01 & CS02
 9. Surge Immunity; IEC 1000-4-5 & ANSI/IEEE C62.41 to 4 KV
 10. Magnetic Field Immunity; IEC 1000-4-8
- Y. The actuator shall be tagged with CE mark per compliance with directives 89/336/EEC and 89/392/EEC.

2.7 AUXILIARY CONTROL STATION

- A. An auxiliary control station shall be provided in a separate enclosure for control of the actuator. The enclosure shall meet the same requirements as the actuator and shall be suitable for either surface mounting or stanchion mounting. The control station shall include three buttons (OPEN-STOP-CLOSE) and two lights for position indication (RED for OPEN and GREEN for CLOSED). The control station shall also include a three-position selector switch (LOCAL-OFF-REMOTE). The selector switch shall be padlockable in each position. The enclosure shall have two conduit entries for control wiring.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
1. Shutoff Service: Gate valves.
 2. Pump Discharge: Gate and check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Storm Drainage Piping: Use the following types of valves:

1. Swing Type, Spring and Lever Check Valves, NPS 4 and Larger: Class 125, gray iron.
2. Gate Valves, NPS 4 and Larger: Type I, Class 125, NRS or OS&Y as indicated on drawings, bronze-mounted cast iron.
3. Bronze Ball Valves, NPS 1 and NPS 2: 600 PSI WOG, 3 piece body, threaded ends.

D. Select valves with the following end connections:

1. For Steel Piping, NPS 2 and Smaller: Threaded ends.
2. For Steel Piping, NPS 4 to NPS 12: Flanged ends.

3.2 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: In horizontal position with hinge pin level or vertical position as indicated on the Drawings.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 15110

SECTION 15160 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following storm drainage piping inside the building:

- 1. Pipe and fittings.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:

- 1. Storm Drainage, Force-Main Piping: 150 psig.

1.4 SUBMITTALS

- A. Product Data: For pipe, fittings and couplings.

- B. Shop Drawings:

- 1. Refer to Section 15000 and 15050.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting and joining materials.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
- B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
- C. Pressure Fittings:
1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
 2. Cast-Iron Flanges: ASME B16.1, Class 125.

2.4 DUCTILE-IRON PIPE AND FITTINGS

- A. Ductile-Iron Pipe and Fittings: Flanged ends.
1. Gaskets: AWWA C111, rubber.
- B. Flanges: ASME 16.1, Class 125, cast iron.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Section 15000 for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges shall be used on aboveground pressure piping, unless otherwise indicated.
- B. Storm drainage drain lines NPS 1 and NPS 2 shall be the following:
 - 1. Galvanized steel pipe, pressure fittings, and threaded joints.
- C. Storm drainage force mains NPS 4 and larger shall be the following:
 - 1. Steel or cast iron pipe, cast iron pressure fittings and flanged joints.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- C. Install force mains at elevations to match existing systems that are being removed and replaced.
- D. Do not enclose, cover, or put piping into operation until it is inspected and approved by Engineer and authorities having jurisdiction.

3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 15 Section "Valves."
- B. Shutoff Valves: Install shutoff valve on each drainage pump suction and discharge.

1. Install OS&Y motorized gate valve.
- C. Check Valves: Install swing check valve as indicated on the Drawings.
 1. Install swing type, spring and lever check valve.
- D. Drain Valves: Install shutoff valve as indicated on the drawings.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports."
- B. Install supports according to Division 15 Section "Hangers and Supports."
- C. Support vertical piping at base.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify Engineer and authorities having jurisdiction at least 72 hours before inspection must be made. Perform tests specified below in presence of Engineer and authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by Engineer and authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If Engineer or authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- D. Test force-main piping according to procedures of Engineer and authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 150 psig. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15160

SECTION 15447 TUNNEL CENTRIFUGAL DRAINAGE PUMPS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor and materials required to install, put into operation, and field test the non-clog centrifugal pumps at the East and West Tunnel Pump Stations, as shown on the Drawings and as specified.

1.2 RELATED WORK

- A. Valves and piping are included in Division 15.
- E. Electrical equipment shall match the requirements of Division 16.

1.3 SUBMITTALS

- A. Submit to the Engineer for approval, as provided in Division 1, the following:
 1. Manufacturer's certified rating curves showing pump characteristics of head, brake horsepower, discharge, efficiency, and required net positive suction head. Catalog sheets showing a family of curves will not be acceptable.
 2. Literature and drawings describing the equipment in sufficient detail, including parts list and materials and details of construction, to indicate full compliance with these specifications.
 3. Certified dimensional drawings of each item of equipment and auxiliary apparatus to be furnished.
 4. Schematic electrical wiring diagrams and other data as required for completion of each pump installation.

1.4 SYSTEM DESCRIPTION

- A. Pumps shall be installed in the West pump room as shown on the Drawings. Design criteria are as follows:

1. Number of Pumps	Pumps 1, 2 & 3
2. Configuration	As shown on Drawings
3. Process Fluid	Runoff
4. Design Capacity	1250 gpm at 45-ft. TDH
5. Min. Efficiency @Design	80%

- | | |
|-----------------------------|------------------------|
| 6. Max. NPSHR @ Run out | 23 feet |
| 7. Min. Efficiency @Run out | 70% |
| 8. Minimum Run out | 2000 gpm at 28-ft. TDH |
| 9. Shutoff Head | 65-ft. |
| 10. Motor Horsepower | 25 HP |
| 11. Electrical Requirements | 480 V, 3 Phase |
| 12. Minimum Solid Size | 3-inch sphere |
| 13. Pump Discharge Size | 6 inches |
| 14. Maximum Speed | 1185 rpm |

B. Pumps shall be installed in the East and West pump rooms as shown on the drawings. Design criteria are as follows:

- | | |
|-----------------------------|-----------------------|
| 1. Number of Pumps | Pumps 4 & 7 |
| 2. Configuration | As shown on drawings |
| 3. Process Fluid | Runoff |
| 4. Design Capacity | 200 gpm at 45-ft. TDH |
| 5. Min. Efficiency@ Design | 49% |
| 6. Max NPSHR @ Run out | 20 feet |
| 7. Min Efficiency @ Run out | 60% |
| 8. Minimum Run out | 900 gpm at 20-ft. TDH |
| 9. Shutoff Head | 50-ft. |
| 10. Motor Horsepower | 7.5 HP |
| 11. Electrical Requirements | 480 V, 3 Phase |
| 12. Minimum Solid Size | 3 inch sphere |
| 13. Pump Discharge Size | 4 inches |
| 14. Maximum Speed | 1185 rpm |

C. Pumps shall be installed in the East pump room as shown on the drawings. Design criteria are as follows:

- | | |
|-----------------------------|------------------------|
| 1. Number of Pumps | Pumps 8, 9 & 10 |
| 2. Configuration | As shown on drawings |
| 3. Process Fluid | Runoff |
| 4. Design Capacity | 800 gpm at 40-ft. TDH |
| 5. Min. Efficiency@ Design | 71% |
| 6. Max NPSHR @ Run out | 22 feet |
| 7. Min Efficiency @ Run out | 62% |
| 8. Minimum Run out | 1800 gpm at 18-ft. TDH |
| 9. Shutoff Head | 51-ft. |
| 10. Motor Horsepower | 15 HP |
| 11. Electrical Requirements | 480 V, 3 Phase |
| 12. Minimum Solid Size | 3 inch sphere |
| 13. Pump Discharge Size | 6 inches |
| 14. Maximum Speed | 1185 rpm |

1.5 QUALITY ASSURANCE

- A. The pumps shall be furnished by a manufacturer who is fully experienced for a minimum of five years, reputable and qualified in the manufacture of the pumps to be furnished. The pumps shall be designed, constructed, delivered, and installed in accordance with the best practices and methods. The pumps shall be as manufactured by Hydromatic, Fairbanks

Morse, Hayward Gordon, or prior approved equal.

- B. Should equipment which differs from these Specifications be offered and determined to be the equal of that specified, such equipment shall be acceptable only on the basis that any revision in the design and construction of the structure, piping, or appurtenant equipment be made at no additional cost to the Owner.
- C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc, required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.
- D. All pumps shall be rated for 24-hour continuous duty.
- E. Complete sets of operating and maintenance instructions shall be furnished in accordance with Section Division 1.
- F. A manufacturer's factory representative who has complete knowledge of proper startup, installation, and operation and maintenance of pumps shall be provided as noted below.

TABLE OF MANUFACTURER'S REPRESENTATIVES' DUTIES

Services Provided By Factory Representative	Minimum ⁽¹⁾ No. of Trips	Minimum Time ⁽¹⁾ On Site (8 hr. working days)
1. Supervise Installation	1	1 day
2. Inspect and Approve Installation ⁽²⁾	1 ⁽³⁾	1 day
3. Supervise Testing	1 ⁽⁴⁾	1 day
4. Instruct Engineer and Owner's Representatives in proper startup and operations and maintenance	1 ⁽⁵⁾	1 day
⁽¹⁾ The manufacturer's factory representative shall be present at frequent enough intervals to ensure proper installation and testing of the equipment as specified in Section 01665.		
⁽²⁾ The manufacturer's representative shall provide to the Engineer a written certification that the pumps have been installed in accordance with the manufacturer's recommendations and Section 01665.		
⁽³⁾ May be done directly following completion of item 1 if acceptable to the Engineer.		
⁽⁴⁾ May be done directly following completion of Item 2 if acceptable to the Engineer.		
⁽⁵⁾ This instruction may be given following completion of Item 3 provided that the test is successful and the operation and maintenance manuals have been approved.		

PART 2 PRODUCTS

2.1 PUMPS

A. Impellers

The impeller shall be balanced non-clogging type made of close-grained cast iron conforming to ASTM A48 Class 30. The impeller for the Pumps shall be of one piece, single suction, Two-Blade, radial flow design with well-rounded leading vanes and then tapered toward the trailing edge for a circular flow pattern. The waterways through the impeller will have extremely smooth contours, devoid of sharp corners so as to prevent rags or stringy, fibrous material from catching or clogging. The clearance between the full diameter impeller outside diameter and cutwater shall be capable of passing a 3.0" sphere for both services. The impeller is to be balanced and secured to the shaft by means of a bolt, washer, and key. The arrangement shall be such that the impeller cannot be loosened from torque in either forward or reverse rotation. Wiper vanes on the back impeller shroud are not allowed.

B. Volute/Casing

The volute shall be matched to the impeller and made of close-grained cast iron conforming to ASTM A48 Class 30. The volute is to be of one-piece circular constant flow, equalizing pressure design with smooth fluid passages large enough to pass any size solid that can pass through the impeller. The volute shall be side flanged tangential discharge and capable of rotation in 45° increments to accommodate piping orientation. Diffusion vanes are not permitted. The volute shall be furnished with large cleanout openings located at the impeller centerline, to allow access to the impeller. Volute priming, drain, and 1/2" minimum gauge connections shall be provided. Flanges shall be 125 lbs. flat-faced flanges per ANSI drilling. The casing shall be designed to permit the removal of the rotating assembly without disturbing the suction or discharge piping. The casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff head, whichever is greater.

C. Front head

The front head shall be made of close-grained cast iron conforming to ASTM A48 Class 30. The front head shall be cast separately to the volute and connected to the suction piping.

D. Blackhead

A separately cast close-grained cast iron blackhead with large access openings and integral sealing box conforming to ASTM A48 Class 30 shall be provided. The sealing box shall be designed for use with mechanical seal. The sealing box shall be furnished with a 1/4" injection and vent tap for a clear water or grease connection to a water seal ring to prevent air from entering the pump through the sealing box. A 1/4" minimum sealing box drain tap shall be provided. Sealing box leakage will be collected by the packing box drain trough and pipe directly to drain, eliminating any drainage to the floor.

E. Frame

The bearing frame shall be close-grained cast iron conforming to ASTM A48 Class 30 and of heavy, rugged design for carrying the bearings and machined for accurate and permanent bearing alignment completely enclosing the shaft between the bearings. The bearing housing shall be of dust proof design incorporating lip type grease seals in contact with the shaft to prevent the entrance of contaminants. Jacking bolts for external impeller adjustment are required. Zerk type grease fittings for bearing lubrication shall be supplied at the bearing housings.

F. Shaft Assembly

Minimum shaft diameter

Pump Application	1, 2, 3, 8, 9, & 10	4 & 7
Pump Model	6"-B5423	4"-B5423
1. At impeller	1.75"	1.75"
2. At sleeve	2.125"	2.125"
3. At thrust bearing	2.756"	2.756"
4. At radial bearing	2.559"	2.559"
5. Between bearings	3.25"	3.25"
6. Center to Center of bearings	11.00"	11.00"

The pump shaft shall be high-strength alloy steel with a minimum 100,000 PDI tensile strength and 75,000 PSI yield strength of sufficient diameter to carry the maximum loads imposed and to prevent vibration and fatigue. The shaft shall be accurately machined along its entire length and precision ground at bearing locations. Keyways shall be provided at both ends. A renewable straight shaft sleeve, positive adhesive sealed to prevent leakage between the shaft and the sleeve, shall protect the shaft through the sealing box area. The shaft sleeve shall be stainless steel with a Brinell hardness of 190-241.

The minimum distance between the radial and thrust bearings shall be greater than the cantilever distance between the inboard (radial) bearing and the centerline of the impeller.

Radial (inboard) bearings shall be grease lubricated double row spherical roller bearings designed to carry the hydraulic radial loads encountered in the service conditions. Thrust (outboard) bearings shall be an angular contact ball bearings designed to carry the pump hydraulic axial and dead load thrust. Bearing shall be designed for a nominal L10 life of 100,000 hrs. Per AFBMA at best efficiency point.

G. Fits and Hardware

Tunnel Centrifugal Drainage Pumps

The volute casing, front head, blackhead, and frame shall be manufactured with concentric shoulder fits to assure accurate alignment. All machine bolts, nuts, and cap screws shall be of the hex head type and will not require the use of any special tools.

H. Pump shall be provided with impeller and volute axial type wear rings. Impeller wear ring shall be 300-350 BHN 400 series stainless. Casing wear ring shall be 410-484 BHN 400 series stainless.

I. Minimum Pump Weight – Pumps 1, 2, 3, 8, 9 & 10 – 490 Lbs. Pumps 4 & 7 - 420 lbs.

J. The suction head shall be fitted with a suction flange as shown on the drawings, constructed of cast iron, ASTM A48, Class 30 or 35. Pumps shall be mounted on a structural steel base plate designed to accommodate the pump and motor.

L. Each pump shall be provided with glycerin-filled suction and discharge pressure gauges with a 1/4-in NPT inlet and 4.5-in dials. A 316 stainless steel, oil filled, diaphragm with a 1/2-in NPT inlet and 1/4-in flushing tap, with T-cock, shall be installed on each gauge. The suction gauges shall be of the compound type to indicate both vacuum and pressure and be graduated to read 15-psi positive pressures and 30-in mercury negative pressures. The discharge gauges shall be graduated from 0 to 60 psi. The pressure gauges shall be equal to Figure 1980 Solfrunt standard gauges, Model 150000-4 series, manufactured by Amtek, U.S. Gauge Division. The diaphragm seals shall be equal to Model MGSG0103102 seals manufactured by Amtek, Mansfield & Green Division. The gauges shall be connected to the pump suction and discharge. All fittings and cocks shall be 316 Stainless Steel.

M. The pump and its driving equipment shall be designed and constructed to successfully withstand a maximum turbinng speed of the unit resulting from backflow through the pump of 100 percent of the design operating speed.

N. The natural frequency of the assembled pump and its supporting structure shall be at least 25 percent higher than the maximum pump speed

O. The combination pump and driver base shall be a heavy-duty fabricated structural steel open channel base with large access openings to facilitate grouting. An all-metal shaft guard completely enclosing the flexible coupling shall be provided. Bent form bases are not allowed.

P. The motors shall operate under 3/60/460 Volt power supply variations per NEMA MG1-14. Motors shall be NEMA Design B or A with torque and starting current in accordance with NEMA MG1-12. The motors will be capable of withstanding up to 10 starts per hour. Motors shall have copper windings. Motors to include a minimum of two normally closed automatic reset thermostats connected in series and embedded in adjoining phases. Each completed and assembled motor shall receive a routine factory test per IEEE and NEMA MG1-12 in accordance with IEEE Standard 112. Tests shall include but not limited to: No

load current, No load speed, Locked rotor current, Winding resistance, High Potential, Bearing/Vibration check.

2.2 PUMP DRIVE SYSTEM

- A. Each solids handling pump shall be driven by a TEFC motor. The motor nameplate horsepower rating shall not be exceeded by the brake horsepower requirements of the specified head and capacity requirements.

2.3 ACCESSORIES, APPURTENANCES, TOOLS AND SPARE PARTS

- A. Contractor shall provide seal water piping as shown on the Contract Drawings. Seal water shall consist of a 50-micron filter; pressure reducing valve, shut-off valve, solenoid valve, and needle valve.
- B. All exposed metal, except stainless steel or unless otherwise specified herein, shall be primed and finish painted to meet manufacturer's recommendations.
- C. Special tools shall be provided if required for operation and maintenance of the equipment.
- D. All spare parts listed in the manufacturer's recommended spare parts list, including at least the following minimum inventory:
 - 1. One set of packing for each pump furnished.
 - 2. One set of gaskets, O-rings, grommets, and other sealing devices for each pump furnished.
 - 3. A supply of all required lubricants, sufficient for one year's normal operation.

PART 3 EXECUTION

3.1 SHOP TESTING

- A. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. Tests and test reports shall be made in conformity with recommendations of the Hydraulic Institute Standards and in accordance with Section 01665.
- B. Copies of the test logs, a description of the test piping, equipment and setup, and a test procedure shall accompany certified test performance curves. The curves shall include

head, bhp, and efficiency.

- C. Certified copies of a report covering each test, and capacity, power, and efficiency curves based on shop test results, shall be prepared by the pump manufacturer and delivered to the Engineer not less than 10 days prior to shipment of the equipment from the factory. If performance tests are not conducted on the motor, certified test reports of an identical motor shall be included.

3.2 INSTALLATION

- A. Installation of the pumps shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.
- B. Anchor bolts shall be set by the Contractor in accordance with the manufacturer's recommendations.

3.3 INSPECTION AND TESTING

- A. After all pumps have been completely installed, the Contractor shall conduct in the presence of the Engineer, and plant operator such tests as are necessary to indicate that pump discharge conforms to the Specifications. Field test shall be performed on all pumps furnished under this Section. The Contractor shall supply all electric power, labor, water, and auxiliary equipment required to complete the field test.
- B. If the pump performance does not meet the specifications, corrective measures shall be taken or the pumps shall be removed and replaced with pumps, which satisfy the conditions, specified, at no additional expense to the Owner.
- C. All labor, power, materials, equipment and appurtenances required for testing shall be furnished by the Contractor at no additional cost to the Owner.

END OF SECTION

SECTION 15448 - TUNNEL SUBMERSIBLE DRAINAGE PUMPS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The vendor shall furnish equipment and incidentals required to provide 2 vortex non-clog explosion-proof submersible centrifugal sewage pumps as specified herein.
- B. The vendor shall supply a control panel, which contains all necessary components for proper starting and operation of the pumps. This panel shall also provide a circuit that monitors the seal sensors in the pump.
- C. Pumps shall be equipped with stainless steel nameplate stating the unit is accepted for use in NEC Class 1, division 1, group C, D, hazardous locations with third party, (Factory Mutual,) approval.

1.2 OPERATING CONDITIONS

- A. Each pump shall be rated 7.5 H.P., 480 volts, 3 phase, 60 hertz, 1150 R. P. M (MAX). The unit shall produce 300 gpm at 30 ft TDH. The pump shall be capable of handling a 3.25" spherical solid. The pump shall be non-overloading throughout the entire range of operation without employing service factor.
- B. The pump shall also be capable of operating fully submersed with out damage. The pump motor shall reserve a minimum service factor of 1.15.
- C. The performance curve submitted for approval shall state in addition to head and capacity performance, the pump motor RPM, solid handling capacity, and reflect motor service factor.

PART 2 - PRODUCTS

2.1 PUMPS

- A. The pump shall be a centrifugal, non-clog, solids handling, submersible, wastewater type, model S4IVX as manufactured by Hydromatic Pump or prior approved. The pump volute, motor and seal housing shall be high quality gray cast iron, ASTM A-48, Class 30. The pump discharge shall be fitted with a 4" standard ASA 125-lb. flange, faced and drilled. The pump discharge flange shall have drilled holes, slotted flanges shall not be allowed.

- B All external mating parts shall be machined and Buna N Rubber O-ring sealed on a beveled edge. Gaskets shall not be acceptable. All fasteners exposed to the pumped liquids shall be 300 series stainless steel.

2.2 ELECTRICAL POWER CORD

- A. Electrical power cord shall be STW-A, water resistant 600V, 60°C., UL and CSA approved and applied dependent on amp draw for size.
- B. The pump shall be triple protected with a compression fitting and an epoxy potted areas at the power cord entry to the pump. A separation between the junction box area of the pump and the motor by a stator lead sealing gland or terminal board shall not be acceptable.
- C. The power cable entry into the cord cap assembly shall first be made with a compression fitting. Each individual lead shall be stripped down to bare wire at staggered intervals, and each strand shall be individually separated. This area of the cord cap shall then be filled with an epoxy compound potting which will prevent water contamination to gain entry even in the event of wicking or capillary attraction.
- D. The power cord leads shall then be connected to the motor leads with extra heavy connectors having brass inserts with a screwed wire to wire connection, rather than a terminal board that allows for possible leaks.
- E. The connection box wiring shall be separated from the motor housing wiring by stripping each lead down to bare wire, at staggered intervals, and separating each strand. This area shall be filled with an epoxy compound potting. Fiberglass terminal boards which are subject to heat fatigue and cracking, and which may lead to possible leaks shall not be acceptable.
- F. The cord cap assembly where bolted to the connection box assembly and the connection box assembly where bolted to the motor housing shall each be sealed with a Buna N Rubber O-ring on a beveled edge to assure proper sealing.

2.3 MOTOR

- A. The stator, rotor and bearings shall be mounted in a sealed submersible type housing. The stator windings shall have Class F insulation, (155°C or 311°F), and a dielectric oil filled motor, NEMA B design. Further protection shall be provided by on winding thermal sensors. Because air-filled motors do not dissipate heat as efficiently as oil-filled motors, they shall not be acceptable.

Tunnel Submersible Drainage Pumps

- B. The pump and motor shall be specifically designed so that they may be operated partially or completely submerged in the liquid being pumped. The pump shall employ the use of cooling water jackets or cooling fins as needed.
- C. Stators shall be securely held in place with a removable end ring and threaded fasteners so they may be easily removed in the field without the use of heat or a press. Stators held by a heat shrink fit shall not be acceptable. Stators must be capable of being repaired or rewound by local motor service station. Units, which require service only by the factory, shall not be acceptable. No special tools shall be required for pump and motor disassembly.
- D. Pump shall be equipped with heat sensors. The heat sensor(s) (one on single phase, two on three phase) shall be a low resistance; bi-metal disc that is temperature sensitive. It shall be mounted directly on the stator windings and sized to open at 120°C and automatically reset at 30-35°C differential. The sensors shall be connected in series with motor starter coil so that the pump cease operation when an over-temperature condition is sensed. The starter shall be equipped with 3 leg overload relay with heaters sized for the pump's full load amps. The pump shall cease operation when the overload is tripped. The overload shall be manually reset.

2.4 BEARINGS AND SHAFT

- A. An upper radial bearing and a lower thrust bearing shall be required. These shall be heavy-duty single row ball bearings, which are permanently lubricated by the dielectric oil, which fills the motor housing. Double row, sealed grease packed bearings shall not be acceptable. Bearings, which require lubrication according to a prescribed schedule, shall not be acceptable. The upper radial bearing shall have a minimum B-10 life at the specified condition of 40,000 hours and the lower thrust bearing shall have a minimum B-10 life at the specified condition of 40,000 hours. Bearings shall be locally available.
- B. The shaft shall be machined from a solid 400 series stainless steel forging and is a large diameter design with minimum overhang to reduce shaft deflection and prolong bearing life.

2.5 SEALS

- A. The pump shall have two mechanical seals, mounted in tandem, with an oil chamber between the seals. John Crane Type 21, BF1C1, seals shall be used with the rotating seal faces being carbon and the stationary seal faces to be ceramic. The lower seal shall be replaceable without disassembly of the seal chamber and without the use of special tools. Pump-out vanes shall be present on the backside of the impeller to keep contaminants out

Tunnel Submersible Drainage Pumps

of the seal area. Units, which require the use of foreign manufactured seals, shall not be acceptable. Seals shall be locally available.

- B. The pump shall be equipped with a seal leak detection probe and warning system. This shall be designed to alert maintenance personnel of lower seal failure without having to take the unit out of service for inspection or requiring access for checking seal chamber oil level and consistency.
- C. There shall be an electric probe or seal failure sensor installed in the seal chamber between the two tandem mechanical seals. If the lower seal fails, contaminants which enter the seal chamber shall be detected by the sensor and send a signal to operate the specified warning device.
- D. Units equipped with opposed mechanical seals shall not be acceptable.

2.6 IMPELLER

- A. Impeller shall be of the vortex multi-vane non-clogging design and have pump-out vanes on the backside of the impeller to prevent grit and other materials from collecting in the seal area. Totally enclosed or semi-open impellers shall not be allowed. Impeller shall not require coating. Because most impeller coatings do not remain beyond the very early life of the impeller, efficiency and other performance data submitted shall be based on performance with an un-coated impeller. Attempts to improve efficiency by coating impeller shall not be acceptable. The impeller shall be manufactured from ASTM A-48, Class 30 material.
- B. Impellers shall be dynamically balanced. The tolerance values shall be listed below according to the International Standard Organization grade 6.3 for rotors in rigid frames.

RPM	Tolerance
1150	.026 in. - oz./lb. of impeller weight.

- C. The impeller shall be threaded to the shaft. A300 series stainless steel washer and impeller bolt shall be used to fasten the impeller to the shaft. Straight end shafts for attachment of the impeller shall not be acceptable.

2.7 CASING

- A. The casing shall be of the end suction volute type having sufficient strength and thickness to withstand all stress and strain from service at full operating pressure and load. The casing shall be of the centerline discharge type. The design shall be such that the pumps will be automatically connected to the discharge piping when lowered

into position with the guide rails. The casing shall be accurately machined and bored for register fits with the suction and casing covers.

2.8 GUIDE RAIL STATION

A General

1. The MTM rail system shall include 2 submersible non-clog sewage pumps, discharge elbow, connecting flange assembly, guide connector, upper guide bracket, lifting cable, float mounting bracket and stainless steel guide rails.
2. Refer to separate specifications for control equipment.

B Discharge Base Elbow.

1. The discharge elbow designed to mount directly to the sump floor shall be supplied for each pump. It shall have a standard 125-pound flange faced and drilled on the outlet side, with a machined mating inlet connection. The design shall be such that the pump to discharge connection is made without the need for any nuts, bolts or gaskets. The base elbow shall also anchor and align the two, 2" stainless steel guide rails.
2. A cast iron connecting flange/rail bracket shall be mounted on each pump discharge. It shall have a machined mating flange, which matches the base elbow discharge connection. Dealing of this discharge connection shall be accomplished by a simple linear downward motion of the pump culminating with the entire weight of the pumping unit supported entirely by the base elbow.

C Upper Guide Bracket.

1. The stainless steel upper guide bracket shall align and support the two guide rails at the top of the sump. It shall bolt directly to the hatch frame and incorporate an expandable rubber grommet for secure rail installation.
2. Each pumping unit shall be provided with a 316 Stainless steel lifting cable, and be of sufficient length to extend from the pump to the top of the wet-well. The access frame shall provide a hook to attach the cable when not in use. The lifting cable shall be sized to the pump weight.

D Float mounting bracket

1. A Stainless steel float-mounting bracket shall be provided with strain relief that support and hold the level control cords. Continuous cords are to run from pumps and level controls to a control panel shall be provided.

E Guide rail

1. The dual rail guide design keeps the pump in proper alignment with the stationary discharge piping. These rails shall be 2" stainless steel pipe which bolt directly to the base elbow and to the access frame at the top of the wet-well by a Stainless steel upper guide rail bracket.

PART 3 - EXECUTION

3.1 PAINTING

- A. The pump shall be painted after assembly, and testing, with a dark green water reducible air dry enamel. The paint shall be applied in one coat covering all exterior surfaces. The pump shall be air dried after testing and before painting.

3.2 SERVICEABILITY

- A. The complete rotating assembly shall be capable of being removed from the volute without disturbing the suction piping, discharge piping, and volute. The motor housing, seal housing with seal plate and impeller still attached to the shaft shall be capable of being lifted out of the volute case from the top as one assembly.

3.3 TESTING

- A. Commercial testing shall be required and include the following:
 - 1. The pump shall be visually inspected to confirm that it is built in accordance with the specification as to HP, voltage, phase and hertz.
 - 2. The stator motor leads shall be tested for integrity using a megohm meter at the highest setting.
 - 3. Pump shall be allowed to run dry to check for proper rotation.
 - 3. Discharge piping shall be attached; the pump submerged in water and amp readings shall be taken in each leg to check for an imbalanced stator winding. If there is a significant difference in readings, the stator windings shall be checked with a bridge to determine if an unbalanced resistance exists. If so, the stator shall be replaced.
 - 4. The pump shall be removed from the water, megohm meter tested again, dried and the motor housing filled with dielectric oil.

3.4 INSTALLATION

- A. Installation of the pumps shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings.
- C. Anchor bolts shall be set by the Contractor in accordance with the manufacturer's recommendations.

3.3 INSPECTION AND TESTING

- A. After the pumps have been completely installed, the Contractor shall conduct in the presence of the Engineer, and plant operator such tests as are necessary to indicate that pump discharge conforms to the Specifications. Field test shall be performed on all pumps furnished under this Section. The Contractor shall supply all electric power, labor, water, and auxiliary equipment required to complete the field test.
- B. If the pump performance does not meet the specifications, corrective measures shall be taken or the pumps shall be removed and replaced with pumps, which satisfy the conditions, specified, at no additional expense to the Owner.
- C. All labor, power, materials, equipment and appurtenances required for testing shall be furnished by the Contractor at no additional cost to the Owner.

END OF SECTION

SECTION 15820 - BACKDRAFT DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Mounting frame details and dimensions.

1.3 QUALITY ASSURANCE

A. Comply with SMACNA "HVAC duct Standards"

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 BACKDRAFT DAMPERS

- A. Manufacturers:
 1. Nailor.
 2. Greenheck.
 3. Ruskin Company.
- B. Description: Industrial duty, high performance, multiple-blade, parallel action gravity counter balanced, with blades of maximum width, with neoprene sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure. Nailor model 1390CB or equal.
- C. Frame: 16 gauge thick, galvanized sheet steel, with rear (bottom) mounting flange with pre-drilled 1/4" bolt holes on maximum 12" centers. Provide welded frame or corner gussets.
- D. Blades: .07" thick aluminum sheet.
- E. Blade Seals: Neoprene.
- F. Blade Axles: 1/2" diameter plated steel.
- G. Tie Bars and Brackets: plated steel.
- H. Counter Balance: Adjustable internal counterbalance.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Provide accessories of materials suited to damper materials; use galvanized-steel accessories and hardware.
- C. Install backdraft dampers as shown on plans. Provide a continuous gasket or silicone seal around all mechanical joints and seams to minimize leakage.

3.2 ADJUSTING

- A. Adjust counterbalance setting to maintain full open position when fan is operating.

END OF SECTION 15820

SECTION 15900 - CARBON MONOXIDE MONITORING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes carbon monoxide monitoring systems and components, including CO sensors, stand alone monitors and control outputs for exhaust fan control.
- B. All wiring between the monitor and sensors shall be provided and installed by Division 15 contractor.

1.2 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Schematic control diagrams showing sensors, alarms, and control outputs.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
 - 3. Details of control panel faces, including controls, instruments, and labeling.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who is an approved installer of the CO monitoring system manufacturer for both installation and maintenance of units required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 COORDINATION

- A. Coordinate location of sensors with plans and room details before installation.
- B. Coordinate equipment with Division 16 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Vulcain.

2.2 MONITORING PANEL

- A. Panel shall be stand alone monitoring and control panel capable of network configuration to monitor (4) carbon monoxide sensors and activating one binary output for control and one binary output for alarm. Panel shall be equipped with integral or external visual strobe alarm for alarm condition. Panel shall be equipped with LCD or LED user interface panel navigable by simple menu driven options. Panel shall display all sensor levels and outputs. Activation set points shall be adjustable via the user interface panel. Vulcain Model VA301CDS or approved equal.
- B. Housing: Factory cast aluminum cabinet with suitable brackets for wall mounting, located as shown on plans.
- C. Power: 24 VAC. Provide and install all necessary transformers, wiring and grounds necessary to connect to 120 VAC power provided by Division 16. Inputs: (4) networked or analog input carbon monoxide sensors.

- D. Outputs: (2) binary outputs. Provide necessary isolation relays and contacts to interface with Division 16.
- E. Visual Alarm: Provide integral or external visual strobe alarm for alarm conditions with automatic reset.

2.3 SENSORS

- A. Electronic Sensors: Vibration and corrosion resistant; for wall mounting. Vulcain model VA201Q1CO or equal.
 - 1. Carbon Monoxide sensors as follows:
 - a. Accuracy: Plus or minus 3% at calibration point.
 - b. Range: 0-500 ppm.
 - c. Ambient Conditions: 10-90% RH non-condensing, -4 -122 deg F.
 - d. Power: 24 VAC. Provide and install all necessary transformers, wiring and grounds necessary to connect to 120 VAC power provided by Division 16.
 - e. Accessories: Provide all options and accessories required for communicating with monitoring panel.

2.4 SEQUENCE OF OPERATION

- A. Carbon monoxide sensor shall provide control over both exhaust fans' high speed operation. The exhaust fans shall continuously operate in low speed when enabled by the operator. Upon any carbon monoxide detector registering 150 ppm or higher the high speed winding shall be engaged on both fans. The fans shall operate in high speed until all carbon monoxide sensors register 50 ppm or lower. Upon any carbon dioxide sensor registering 250 ppm, the unit shall alarm and close the normally open contacts connected to the remote monitoring system. The alarm shall automatically be disabled when all sensors register 250 ppm or lower.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment level and plumb.

- B. Install labels and nameplates to identify control components. Labels shall be permanently affixed to components or anchored to wall adjacent to component. Tape type labels are not acceptable.
- C. Install all wiring in raceways according to Division 16.
- D. Install piping adjacent to machine to allow service and maintenance.
- E. Ground equipment.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 - 3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- B. Replace damaged or malfunctioning controls and equipment.
 - 1. Start, test, and adjust control systems.
 - 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION 15900

SECTION 16010 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL



1.1 SCOPE

- A. This specification is for electrical and related work particular to LA DOTD Intracoastal Waterway Tunnel, in Houma, LA. Coordinate with other plans and specifications sections.

1.2 RELATED DOCUMENTS

- A. The general provisions of the Contract, including Contract Requirements, and other Division 1 Specification sections, apply to this Section. Sections included in DIVISION 16 of the Project Manual are as follows:

SECTION 16010 - ELECTRICAL GENERAL PROVISIONS
 SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS
 SECTION 16060 - GROUNDING AND BONDING
 SECTION 16075 - ELECTRICAL IDENTIFICATION
 SECTION 16120 - CONDUCTORS AND CABLES
 SECTION 16130 - RACEWAYS AND BOXES
 SECTION 16140 - WIRING DEVICES
 SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS
 SECTION 16415 - TRANSFER SWITCHES
 SECTION 16442 - PANELBOARDS
 SECTION 16443 - MOTOR CONTROL CENTER
 SECTION 16461 - DRY-TYPE TRANSFORMERS (600V AND LESS)
 SECTION 16491 - FUSES
 SECTION 16511 - INTERIOR LIGHTING
 SECTION 16650 - PUMP CONTROL PANELS

1.3 DESCRIPTION OF WORK

- A. This Section specifies several categories of provisions for electrical work, including: (1) Certain adaptive expansions of requirements specified in DIVISION 1, (2) General performance requirements within the electrical systems as a whole, and (3) General work to be performed as electrical work because of its close association.
- B. This Project Manual and accompanying Drawings are intended to describe complete workable systems of the various types. Items of materials, work, or equipment not mentioned but normally necessary for the proper execution of this work, shall be provided as if specifically called for, at no additional cost to the Owner.

1.4 SUMMARY OF ELECTRICAL WORK

A. Drawings:

1. Refer to the Electrical Drawings for graphic representations, schedules and notations showing electrical work.
2. The Drawings show approximate locations only of feeders, branch circuits, outlets, etc., except where specific routing or dimensions are indicated. The Architect reserves the right to make reasonable changes in locations indicated before roughing-in without additional cost to the Owner.
3. Because of the small scale of the Drawings, it is not possible to indicate all of the offsets, fittings, and accessories required. The Contractor shall investigate the structural and finish conditions affecting his work and shall arrange such work accordingly, furnishing fittings, bends, junction boxes, pull boxes, access panels, and accessories required to meet such conditions.

B. Project Manual:

1. Refer to the DIVISION 16 Sections for the primary technical Sections of electrical work.
2. General Outline: This section of the Project Manual covers furnishing materials, equipment, constant competent supervision, special tools, test equipment, technicians, and labor necessary for installation of a complete working electrical system, all as indicated on the plans of in this Project Manual.

C. Scope:

1. Under this part of the contract, electrical facilities will be constructed in the area of the LA DOTD Houma Tunnel in Houma, LA. A new service entrance will be established
2. Provide an alternate price to run new conduits instead of reusing existing conduits. It is the project's intention to reuse existing conduit systems where possible, but where existing conduits are deemed unusable then we will have the contractor provide new exposed conduits to replace the existing conduits in slab or in walls as required. See list below:
 - a. Provide new 4" rigid steel conduits routed from generator to new ATS. Conduits shall be routed exposed across basement ceiling and stubbed up at new ATS.
 - b. Provide new 3/4" rigid steel conduits for new receptacle circuitry in Ventilation building.
 - c. Provide two 3" and one 2.5" rigid steel conduit from new MCC to existing pullbox P4 in basement and one new 1.25" conduit from Zetron alarm panel to existing pullbox P4. In addition provide box extension of existing pullbox P4 in order for these new conduits to enter the box. The new box extension shall be stainless steel and shall be approximately 7'-4" long x 3'-2" wide x 12" deep. Provide new cover plate.

Electrical General Provisions

- d. Provide new 3/4" rigid steel conduit in tunnel for new surface mounted sidewalk lights.
- e. Provide a price per linear foot of new 4" rigid steel conduit to be routed along existing tunnel wall.
- 3. Phasing of the project is critical. The tunnel will be operating throughout the construction period.
- 4. The work shall include but not necessarily be limited to the following:
 - a. Power distribution systems - feeder & branch circuits, panels, wiring, transformers, devices, etc.
 - b. Installation of motors which are not an integral part of equipment furnished under other Divisions.
 - c. Power wiring and connections of mechanical equipment.
 - d. Service systems.
 - e. Grounding systems.
 - f. Raceway systems.
 - g. Lighting systems-fixtures/lamps/auxiliaries wiring/connections/etc.
 - h. Pump Control Panel
 - i. All required sleeves, thimbles, anchors, hangers, bolts, miscellaneous structural steel, cutting, etc., for the complete installation of the electrical systems serving the building.
 - j. Temporary electrical services for construction.

1.5 COORDINATION OF ELECTRICAL WORK

- A. General: Refer to the DIVISION 1 sections for general coordination requirements applicable to the entire work. It is recognized that the contract documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Contractor.
- B. Arrange electrical work in a neat, well organized manner with exposed conduit and similar services running parallel with primary lines of the building construction, and with a minimum of 8'-0" overhead clearance or as directed by the Architect.
- C. Advise other trades of openings required in their work for the subsequent move-in of large units of electrical work (equipment).
- D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- E. Refer to equipment Sections in Divisions 2 through 15 for rough-in requirements.
- F. Verify all dimensions by field measurements.
- G. Arrange for chases, slots, and openings in other building components to allow for electrical installations.

Electrical General Provisions

- H. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- I. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- J. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
- K. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.
- L. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- M. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
- N. Coordinate connection of electrical systems with exterior underground utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.6 TEMPORARY ELECTRICITY

- A. Furnish and install all necessary temporary power, metering, lighting or wiring that is required to insure quality workmanship everywhere.
- B. Furnish and install area distribution boxes with ground fault protection so located that the individual trades may use their own construction-type extension cords to obtain proper power and artificial lighting at all points where required by inspectors and for safety.
- C. Provide a temporary feeder from existing MCC to north tunnel lighting panel. This panel must stay along with the south tunnel lighting panel must stay operational at all times.
- D. Provide a temporary connection to serve the east pump room transformer. This serves the east pump room lighting panel which in turn serves east approach roadway lights.

1.7 QUALITY ASSURANCE, STANDARDS

- A. General: In addition to standards specified in individual work sections, the following standards are imposed, as applicable to the work in each instance:
 - 1. NFPA 70, National Electrical Code

Electrical General Provisions

The electrical installation shall conform to the requirements of the latest edition of the National Electrical Code (NEC-NFPA 70).

2. NEMA/ANSI/ASTM
Electrical material shall be built and tested in accordance with the applicable standards of the National Electrical Manufacturer's Association (NEMA); the American National Standards Institute (ANSI); and the American Society of Testing and Materials (ASTM).
3. Underwriters' Laboratories (UL)
Electrical materials shall be new and unused and shall be listed, inspected, approved and labeled by Underwriters' Laboratories, Inc., where such labeling service is available.
4. NFPA-101, Life Safety Code
OSHA Code of Federal Regulations (for construction practices)
Applicable state and local codes/ordinances.

1.8 DEMOLITION

- A. Remove existing utility service #1 first. This service serves existing MCC sections S1 and sections 1 thru 9. Remove all feeders and branch circuits served out of these sections. Existing conduits in slab and in tunnel walls shall remain and cleaned of debris. Remove all existing exposed conduits in ventilation building. These sections of the MCC serve the following loads:

1. Tunnel Ventilation Fan #1
2. Tunnel Lighting Panel -North
3. Damper Motor #1
4. Pumps 7 and 10 in east pump room
5. Transformer in east pump room
6. Pump 6 in mid-channel pump room
7. Pumps 1 and 2 in west pump room
8. Air Duct Lights
9. Sidewalk Lights

- B. Once new electrical service and new MCC is installed and all feeders run to pump rooms control panels, then remove existing utility service #2. This service serves existing MCC sections 10 thru 17. Remove all feeders and branch circuits served out of these sections. Existing conduits in slab and in tunnel walls shall remain and cleaned of debris. Remove all existing exposed conduits in ventilation building. These sections of the MCC serve the following loads:

1. Tunnel Ventilation Fan #2
2. Tunnel Lighting Panel -South
3. Damper Motor #2
4. Pumps 8 and 9 in east pump room
5. Transformer in west pump room
6. Pump 5 in mid-channel pump room
7. Pumps 3 and 4 in west pump room

- C. Remove all existing feeders between generator and existing MCC.
- D. In the ventilation building -remove all existing light fixtures, electrical panels, transformers, receptacles, disconnect switches, exposed conduit and wiring except as noted in plans. Do not remove tunnel light panels and controls in basement.
- E. In pump rooms remove all existing lights, receptacles, panels, transformers, disconnect switches, pump control wiring and power wiring. Existing wiring out to roadway fixtures shall remain.
- F. Existing telephone service cable to remain.

1.9 ELECTRICAL SUBMITTALS:

- A. Refer to the Division 1 Section 01630 for submittal definitions, requirements, and procedures.
- B. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect will not be processed.

1.10 SUBSTITUTIONS/PRIOR APPROVALS

- A. Substitutions/Prior Approvals shall be submitted in accordance with Section 01630 and provisions thereof.
- B. Only firms regularly engaged in manufacture of electrical products of types required, whose products have been in satisfactory use in similar service for not less than 3 years, shall be utilized.
- C. Any item not specified herein but submitted for approval as a substitute for the specified item shall be accompanied by manufacturer's documentation stating/illustrating the following applicable information in addition to the specific information requested in other sections:
 - 1. Dimensions/weight.
 - 2. Electrical ratings-voltage, amperage, short circuit capability, etc.
 - 3. Construction - gauge of steel/aluminum, paint finish/application method, color, NEMA type, etc.
 - 4. Warranty.
 - 5. Local manufacturer's representative or nearest stocking distributor.
 - 6. Length of time the product has been available to the public.
- D. Shop Drawings: Submit completion descriptive and dimensional data on the following materials which Contractor proposes to use:
 - 1. Pump Control Panel
 - 2. Lighting Fixtures

3. Motor Control Center
4. Panelboards
5. UPS
6. Transformers
7. Fuses
8. Lamps
9. Wiring Devices
10. Motor Controls
11. Lighting Controls
12. Conductors
13. Fire Stop Materials

E. Corrections or comments made on shop drawings during the review do not relieve the Contractor from compliance with requirements of the Contract Documents, Plans and Project Manual. Shop Drawings will be checked for general conformance with the design concept of the project and general compliance with information given in the contract documents. Review of Shop Drawings shall not relieve the Contractor from responsibility for confirming and correlating all quantities and dimensions, coordinating work with that of all other trades, and performing work in a safe and satisfactory manner. Review of shop drawings shall not permit any deviation from Plans and Project Manual. Shop Drawings must be accompanied by signed statement from contractor, stating that he has reviewed the submittal and checked it for compliance.

F. See Section 01330, for number of copies of shop drawings and product data to be submitted.

1.11 DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications, adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion.

1.12 RECORD DOCUMENTS:

- A. Refer to the Division 1 Section 01781 for requirements.

1.13 OPERATION AND MAINTENANCE DATA:

- A. Refer to the Division 1 Section 01782 for procedures and requirements for preparation and submittal of maintenance manuals.

1.14 WARRANTIES:

- A. Refer to the Division 1 Section 01770 for procedures and submittal requirements for warranties. Refer to individual equipment Sections for warranty requirements.

1.15 CLEANING

- A. Refer to the Division 1 Section 01770 for general requirements for final cleaning.
- B. Clean and restore to original finish all equipment prior to final acceptance.

1.16 GUARANTEE:

- A. The work installed shall be kept in perfect working order for one year from date of substantial completion. Guarantee shall be based upon defective materials and/or workmanship. Furnish free of cost to the Owner materials and labor necessary to comply with this guarantee.

1.17 WIRING FOR EQUIPMENT BY OTHERS:

- A. Electrical service for all equipment furnished under this Project manual shall be roughed-in and connected under this Section. It is the responsibility of the Contractor to obtain correct roughing-in dimensions and requirements for this equipment.
- B. Under other DIVISIONS, unless otherwise noted, equipment will be furnished such as: motors and magnetic motor starters (except when part of motor control centers). Connection/interconnection of that equipment shall be part of DIVISION 16000 and shall comply with other DIVISION 16000 Basic Material and Methods Sections.
- C. Apparatus required for controls and firestats will be furnished as specified under DIVISION 15 - Mechanical Work. Control wiring shall be furnished and installed as work under DIVISION 15 - Mechanical.

1.18 TESTS AND BALANCING

- A. The contractor shall conduct operating tests to demonstrate that the electrical systems are installed and will operate properly and in accordance with the requirements of this Project Manual. Tests shall be performed in the presence of the Architect's representative. The Contractor shall furnish instruments and personnel required for such tests.
- B. Contractor shall perform tests in the presence of the Architect to show that the power and lighting loads are equally divided among phases of feeders serving each piece of equipment and each panelboard.

Electrical General Provisions

- C. Any work and materials tested and found varying from the requirements of the Drawings and Project Manual shall be replaced by the Contractor without additional cost to the Owner.
- D. This requirement is in addition to specific tests such as high-potential tests, meggar test, phasing tests, generator testing, etc. which may be called for in other sections.

1.19 WORKMANSHIP

- A. Install all materials and electrical components of the work in accordance with instructions of manufacturer following the best modern construction practices and conforming with the Contract Documents. Workmanship shall be first class, in both function and appearance, whether finally concealed or exposed and shall be performed by experienced workmen skilled in the type of work. As practicable, the lines of all components of the system shall be perpendicular or parallel. In general, workmanship shall conform to guidelines set forth in N.E.C.A. manuals.

1.20 MOUNTING HEIGHTS

- A. Unless otherwise noted on the Drawings or required by the Architect, the following mounting heights shall apply.
- B. Upon approval of the Architect, mounting heights may be adjusted.
- C. Heights of Outlets - all heights measured from finish floor to bottom of device.

1. Wall Switches	44"
2. Receptacle Outlet (General)	16"
3. Special Purpose Outlet	within 12" (12 inches) of intended use
4. Telephone Outlet	16"
- D. Heights of Disconnect Switches, Protective Devices, Controllers, etc.
- E. The mounting height of disconnect switches, circuit breakers, motor controllers, push button stations, and other similar devices and equipment will vary depending upon location and whether individually or group mounted. For convenience and safety operating levers, handles or buttons shall be mounted no more than 80 inches above the finish floor line.
- F. Panelboards shall be located so that the highest overcurrent protective device is a maximum of 72" above the floor.

1.21 SAFETY

- A. It shall be the Contractor's responsibility to do all things necessary in the pursuit of the installation or testing to provide safe conditions in which to work.

Basic Electrical Materials And Methods

- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."

PART 2 - PRODUCTS**2.1 SUPPORTING DEVICES**

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- C. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- D. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- E. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- F. Expansion Anchors: Carbon-steel wedge or sleeve type.
- G. Toggle Bolts: All-steel springhead type.

1.22 FIRESTOPPING

- A. Firestopping of all openings in fire-rated floors, walls, and ceilings accommodating penetrating items such as cables, bus ducts, wireways, conduits, etc. shall be required as part of DIVISION 16000 work. Provide Firestop installation as required to meet ratings equal to the floor or wall being penetrated. See Section 07270
- B. Fire stop materials shall be manufactured for that purpose and shall be installed in accordance with the manufacturer's recommendation in order to provide a U.L. listed fire stop at all openings equal to or exceeding the rated floor, wall or ceiling.
- C. Plastic sleeves/pipe shall not be used within the building when penetrating a fire-resistant-rated wall, ceiling, partition, or floor.

END OF SECTION 16010

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Concrete equipment bases.
 - 3. Cutting and patching for electrical construction.
 - 4. Touchup painting.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

H. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."

B. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

2.3 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. For floors-on-grade, support all raceways under slab from stainless steel 1/2" rod every four (4) feet.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar

hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts.
 - 5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
 - 6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
 - 7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 8. Light Steel: Sheet-metal screws.
 - 9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

- A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.5 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

3.6 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.7 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Supporting devices for electrical components.
 - 2. Concrete bases.
 - 3. Cutting and patching for electrical construction.
 - 4. Touchup painting.

3.9 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.10 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 16050

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Data: For the following:
 - 1. Ground rods.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1. Comply with UL 467.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:

- a. Apache Grounding/Erico Inc.
- b. Chance/Hubbell.
- c. Copperweld Corp.
- d. Erico Inc.; Electrical Products Group.
- e. Ideal Industries, Inc.
- f. ILSCO.
- g. Kearney/Cooper Power Systems.
- h. Korns: C. C. Korns Co.; Division of Robroy Industries.
- i. Lightning Master Corp.
- j. O-Z/Gedney Co.; a business of the EGS Electrical Group.
- k. Raco, Inc.; Division of Hubbell.
- l. Robbins Lightning, Inc.
- m. Salisbury: W. H. Salisbury & Co.
- n. Superior Grounding Systems, Inc.
- o. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."

B. Equipment Grounding Conductors: Insulated with green-colored insulation.

C. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.

2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.
- F. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches (300 mm) above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- E. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6.4-by-50-by-300-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
 - 1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A .
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - a. Equipment Rated 500 kVA and Less: 10 ohms.
 4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 16060

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.SUMMARY
- B. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage .
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.

- C. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- D. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- E. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- F. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.
- G. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.
- H. Brass or Aluminum Tags: 2 by 2 by 0.05-inch metal tags with stamped legend, punched for fastener.
- I. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.
 - 1. Not less than 6 inches wide by 4 mils thick (152 mm wide by 0.102 mm thick).
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend indicating type of underground line.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- C. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Formulated for the type of surface and intended use.
 - 1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
 - 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
 - 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
 - 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 - 1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- G. Color-Coding of Secondary Phase Conductors: Use the following colors for service, feeder and branch-circuit phase conductors:

1. 208/120-V Conductors:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 2. 480/277-V Conductors:
 - a. Phase A: Yellow.
 - b. Phase B: Brown.
 - c. Phase C: Orange.
 3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- H. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
1. Legend: 1/4-inch- steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 2. Tag Fasteners: Nylon cable ties.
 3. Band Fasteners: Integral ears.
- I. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.

Electrical Identification

3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- J. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- K. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- high lettering on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Electrical switchgear and switchboards.
 4. Emergency system boxes and enclosures.
 5. Disconnect switches.
 6. Enclosed circuit breakers.
 7. Power transfer equipment.
 8. Contactors.
 9. Control devices.
 10. Transformers.

END OF SECTION 16075

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Available Manufacturers:

1. Alcan Aluminum Corporation; Alcan Cable Div.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 5 or 7; stranded conductor .

D. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5 or 7.

2.3 CONNECTORS AND SPLICES

A. Available Manufacturers:

1. AFC Cable Systems, Inc.
2. AMF Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway .
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- H. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- I. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

- E. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."
- F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- G. Identify and color-code conductors and cables according to Division 16 Section Electrical Identification."

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.4 FIELD QUALITY CONTROL

- 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
- 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

END OF SECTION 16120

SECTION 16130 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 7 Section "Through-Penetration Firestop Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 2. Division 16 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
 - 3. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. LFNC: Liquidtight flexible nonmetallic conduit.
- F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Available Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Anarnet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.

6. LTV Steel Tubular Products Company.
7. Manhattan/CDT/Cole-Flex.
8. O-Z Gedney; Unit of General Signal.
9. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. EMT and Fittings: ANSI C80.3.

1. Fittings: Set-screw or compression type.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers:

1. American International.
2. ElecSYS, Inc.
3. Electri-Flex Co.
4. Lamson & Sessions; Carlon Electrical Products.
5. Manhattan/CDT/Cole-Flex.
6. RACO; Division of Hubbell, Inc.
7. Spiralduct, Inc./AFC Cable Systems, Inc.
8. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

D. LFNC: UL 1660.

2.4 METAL WIREWAYS

A. Available Manufacturers:

1. Hoffman.
2. Square D.

- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Screw-cover type
- F. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. Emerson/General Signal; Appleton Electric Company.
 3. Erickson Electrical Equipment Co.
 4. Hoffman.
 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 6. O-Z/Gedney; Unit of General Signal.
 7. RACO; Division of Hubbell, Inc.
 8. Robroy Industries, Inc.; Enclosure Division.
 9. Scott Fetzer Co.; Adalet-PLM Division.
 10. Spring City Electrical Manufacturing Co.
 11. Thomas & Betts Corporation.
 12. Walker Systems, Inc.; Wiremold Company (The).
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

- F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- G. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors:
 - 1. Exposed: Rigid steel.
 - 2. Concealed: Rigid steel.
 - 3. Underground, Single Run: RNC.
 - 4. Underground, Grouped: RNC.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 3R
- B. Indoors:
 - 1. Exposed: Rigid steel.
 - 2. Concealed: Rigid steel.

Raceways And Boxes

3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.
5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel .

C. Minimum Raceway Size: ½-inch trade size

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.
 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 2. Space raceways laterally to prevent voids in concrete.
 3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 4. Change from nonmetallic tubing to rigid steel conduit, or IMC before rising above the floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
1. Run parallel or banked raceways together on common supports.
 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors.
- K. Tighten set screws of threadless fittings with suitable tools.
- L. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.

- O. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- P. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- Q. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- R. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- S. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 16130

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
 - 2. Single- and double-pole snap switches and dimmer switches.
 - 3. Device wall plates.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Wiring Devices:
 - a. Bryant Electric, Inc./Hubbell Subsidiary.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Mfg. Company Inc.
 - d. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 RECEPTACLES

- A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- B. Straight-Blade and Locking Receptacles: Specification -Duty grade.
- C. GFCI Receptacles: Straight blade, non-feed-through type, specification grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- deep outlet box without an adapter.

2.3 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.4 SWITCHES

- A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- B. Snap Switches: Specification grade, quiet type.
- C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
 - 1. Switch: 20 A, 120/277-V ac.
 - 2. Receptacle: NEMA WD 6, Configuration 5-15R.

2.5 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Smooth, high-impact thermoplastic
 - 3. Material for Unfinished Spaces: Galvanized steel
 - 4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

2.6 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Round, solid brass with satin finish.

- D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.7 FINISHES

- A. Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect , unless otherwise indicated or required by NFPA 70.
 - 2. Wiring Devices Connected to Emergency Power System: Red .

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.
- C. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
- D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- E. Remove wall plates and protect devices and assemblies during painting.
- F. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 16 Section Electrical Identification.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 16140

SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers.
4. Molded-case switches.
5. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

Enclosed Switches and Circuit Breakers

1. Enclosure types and details for types other than NEMA 250, Type 1.
 2. Current and voltage ratings.
 3. Short-circuit current rating.
 4. UL listing for series rating of installed devices.
 5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports including the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Manufacturer's field service report.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
 1. Eaton Corporation; Cutler-Hammer Products.
 2. General Electric Co.; Electrical Distribution & Control Division.
 3. Siemens Energy & Automation, Inc.
 4. Square D/Group Schneider.
- B. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.

2.4 ENCLOSURES

A. NEMA AE 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Other Wet or Damp Indoor Locations: Type 4X, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 16 Section "Electrical Identification."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Test mounting and anchorage devices according to requirements in Division 16 Section "Electrical Supports and Seismic Restraints."
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 16410

SECTION 16415 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switch.

1.3 SUBMITTALS

- A. Product Data: Include ratings and dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- B. Wiring Diagrams: Detail wiring for transfer switches and differentiate between manufacturer-installed and field-installed wiring. Show both power and control wiring.
- C. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for load ratings and short-circuit closing and withstand ratings applicable to units for Project.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- E. Field Test Reports: Indicate and interpret test and inspection results for compliance with performance requirements.
- F. Maintenance Data: For each type of product to include in maintenance manuals specified in Division 1. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain automatic transfer switch, bypass/isolation switch, nonautomatic transfer switch, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction.
- C. Comply with NEMA ICS 1.
- D. Comply with NFPA 70.
- E. Comply with NFPA 110.
- F. Comply with UL 1008, unless requirements of these Specifications are stricter.
- G. Comply with NFPA 99.

PART 2 - PRODUCTS

2.1 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
- C. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

- F. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6; UL 508, unless otherwise indicated.
- G. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
 - 1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- H. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- I. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

2.2 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Signal-before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- D. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled, unless both sources are live.
- E. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

2.3 AUTOMATIC TRANSFER-SWITCH FEATURES

- A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
- B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
- C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
- D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes; factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
- E. Test Switch: Simulates normal-source failure.
- F. Switch-Position Pilot Lights: Indicate source to which load is connected.
- G. Source-Available Indicating Lights: Supervise sources via transfer-switch, normal- and emergency-source sensing circuits.
 - 1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - 2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
- H. Unassigned Auxiliary Contacts: Two normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
- I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
- J. Engine Starting Contacts: One isolated, normally closed and one isolated, normally open, rated 10 A at 32-V dc minimum.
- K. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle

at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 2. Push-button programming control with digital display of settings.
 3. Integral battery operation of time switch when normal control power is not available.
- L. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes; factory set for five minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.

2.4 FINISHES

- A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.5 SOURCE QUALITY CONTROL

- A. Factory Test Components, Assembled Switches, and Associated Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Four-Pole Switches: Where four-pole switches are indicated, install neutral switching.

3.2 INSTALLATION

- A. Identify components according to Division 16 Section "Electrical Identification."
- B. Floor-Mounted Switch: Level and anchor unit to floor.

3.3 CONNECTIONS

- A. Ground equipment as indicated and as required by NFPA 70.

3.4 FIELD QUALITY CONTROL

- A. Testing: Test transfer-switch products by operating them in all modes. Perform tests recommended by manufacturer under the supervision of manufacturer's factory-authorized service representative. Correct deficiencies and report results in writing. Record adjustable relay settings.

3.5 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain transfer switches and related equipment as specified below:
 - 1. Coordinate this training with that for generator equipment.
 - 2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 - 3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
 - 4. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 - 5. Schedule training with Owner, through Architect, with at least seven days' advance notice.
 - 6. Provide a minimum of four hours of instruction.

END OF SECTION 16415

SECTION 16442 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Protection Div.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D.

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints."
- B. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1.
1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.
 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
7. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
8. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

C. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
- B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.
- C. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- C. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box.
- E. Install overcurrent protective devices and controllers.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."

- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 16442

SECTION 16443 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes motor-control centers for use on ac circuits rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 16 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
 - 2. Division 16 Section "Transient Voltage Suppression" for low-voltage power, control, and communication surge suppressors.

1.3 SUBMITTALS

- A. Product Data: For each type of controller and each type of motor-control center. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each motor-control center.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current ratings of buses and installed units.
 - d. Vertical and horizontal bus capacities.
 - e. UL listing for series rating of overcurrent protective devices in combination controllers.

- f. Features, characteristics, ratings, and factory settings of each motor-control center unit.
2. Wiring Diagrams: Power, signal, and control wiring for class and type of motor-control center. Provide schematic wiring diagram for each type of controller.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around motor-control centers where pipe and ducts are prohibited. Show motor-control center layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For motor-control centers, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 1. Routine maintenance requirements for motor-control centers and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Source Limitations: Obtain motor-control centers and controllers of a single type through one source from a single manufacturer.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.
- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for motor-control centers, including clearances between motor-control centers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver motor-control centers in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Handle motor-control centers according to the following:
 - 1. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
 - 2. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Indicate method of providing temporary electrical service.
 - 3. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of motor-control centers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place" Concrete."
- C. Coordinate features of motor-control centers, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each motor-control center, each controller, and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Company; GE Industrial Systems.
 - 3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
 - 4. Siemens/Furnas Controls.
 - 5. Square D.

2.2 MOTOR-CONTROL CENTERS

- A. Wiring: NEMA ICS 3, Class I, Type B.
- B. Enclosures: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 - 1. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
 - 2. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in motor-control center; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

3. Wiring Spaces: Wiring channel in each vertical section for vertical and horizontal wiring to each unit compartment; supports to hold wiring in place.
- C. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

2.3 BUSES

- A. Material: Plated hard-drawn copper, 98 percent conductivity.
- B. Ampacity Ratings: As indicated for horizontal and vertical main buses.
- C. Neutral Buses: Full size.
- D. Equipment Ground Bus: Noninsulated, horizontal configuration; adequate for equipment ground conductors; bonded to enclosure.
- E. Horizontal Bus Arrangement: Main phase, neutral and ground buses extended with same capacity the entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections or equivalent.
- F. Short-Circuit Withstand Rating: Same as short-circuit current rating of section.

2.4 FUNCTIONAL FEATURES

- A. Description: Modular arrangement of controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center.
- B. Controller Units: Combination controller units of types and with features, ratings, and circuit assignments indicated.
 1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 2. Provide units with short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center section.
 3. Equip units in Type B and Type C motor-control centers with pull-apart terminal strips or drawout terminal boards for external control connections.
 4. Controller Disconnecting Means: Factory-assembled combination disconnect and controller.

- a. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
- C. Overcurrent Protective Devices: Individual feeder-tap units through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
- D. Spaces and Blank Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
- E. Spare Units: Type, sizes, and ratings indicated; installed in compartments indicated "spare."

2.5 ACROSS-THE-LINE CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with toggle action and overload element.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
 - 1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
 - 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
 - 3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

2.6 MULTISPEED CONTROLLERS

- A. Multispeed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
 - 1. Compelling relay to ensure that motor will start only at low speed.

2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.7 FEEDER OVERCURRENT PROTECTION

- A. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 1. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.8 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 2. Switch-selectable digital display of the following:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three-Phase Real Power: Plus or minus 2 percent.
 - e. Three-Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- F. Phase-Failure and Undervoltage Relays for Bypass Controllers: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.9 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested, motor-control centers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive motor-control centers for compliance with requirements, installation tolerances, and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. Anchor each motor-control center assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with motor-control center mounting surface.
- B. Install motor-control centers on concrete bases.
- C. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- D. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."

3.4 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 16 Section "Electrical Supports and Seismic Restraints," and concrete materials and installation requirements are specified in Division 3.

3.5 IDENTIFICATION

- A. Identify motor-control center, motor-control center components, and control wiring according to Division 16 Section "Electrical Identification."
- B. Operating Instructions: Frame printed operating instructions for motor-control centers, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of motor-control centers.

3.6 CONTROL WIRING INSTALLATION

- A. Install wiring between motor-control devices according to Division 16 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."

3.8 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each motor-control center element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. To assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 - 3. Adjusting and setting electronic trip feeder breakers so that they are fully coordinated with circuit breakers in the Tesco Pump Control Panel.
 - 4. Report results in writing.
- C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except for optional tests, stated in NETA ATS "Motor Control Centers." Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain components of motor-control centers including solid-state controllers. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 16443

SECTION 16461 - DRY-TYPE TRANSFORMERS (600 V AND LESS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.

1.3 SUBMITTALS

- A. Product Data Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Wiring and connection diagrams.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C 57.12.91.
- C. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and form work requirements are specified in Division 3.
- B. Coordinate installation of wall-mounting and structure-hanging supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cutler-Hammer.
 - 2. GE Electrical Distribution & Control.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Groupe Schneider NA.

2.2 MATERIALS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices, except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
- D. Enclosure: Ventilated, drip-proof, NEMA 250, Type 2.
- E. Enclosure: Ventilated, raintight, NEMA 250, Type 3R.
- F. Enclosure: Totally enclosed, nonventilated, with lifting eyes, NEMA 250, Type 3R.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- G. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for "Indoor Corrosion Protection."
 - 1. Finish Color: ANSI 61 gray.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- J. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- K. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
 - 1. 9 kVA and Less: 40 dBA
 - 2. 30 to 50 kVA: 45 dBA
 - 3. 51 to 150 kVA: 50 dBA

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls and floors for suitable mounting conditions where transformers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Install floor-mounting transformers level on concrete bases. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

END OF SECTION 16461

SECTION 16491 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor-control centers; and spare fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Provide fuses from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (4.4 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Quantity equal to 10% percent of each fuse type and size, but not fewer than one of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.; Bussmann Div.
2. General Electric Co.; Wiring Devices Div.
3. Gould Shawmut.
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch- (1.27-mm-) thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (40-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Main Service: Class L, time delay or Class RK1, time delay.
- B. Main Feeders: Class L, time delay or Class RK1, time delay.
- C. Motor Branch Circuits: Class RK5, time delay.
- D. Other Branch Circuits: Class RK5, time delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 16491

SECTION 16511 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Interior lighting fixtures with lamps and ballasts.
2. Lighting fixtures mounted on exterior building surfaces.

- B. Related Sections include the following:

1. Division 16 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
2. Division 16 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
- B. CRI: Color rendering index.
- C. CU: Coefficient of utilization.
- D. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:
1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.

- E. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of fixture, including dimensions and verification of indicated parameters.
 - 2. Fluorescent and high-intensity-discharge ballasts.
 - 3. Lamps.
- B. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.
- C. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

- B. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: One year from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10% of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Where products are specified in the fixture schedule on the drawings, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 FIXTURES AND COMPONENTS, GENERAL

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is scheduled.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 FLUORESCENT LAMP BALLASTS

- A. Description: Include the following features, unless otherwise indicated:

1. Designed for type and quantity of lamps indicated at full light output except for emergency lamps powered by in-fixture battery-packs.
 2. Externally fused with slow-blow type rated between 2.65 and 3.0 times the line current.
- B. Electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:
1. Operate lamps in instant start mode.
 2. Operate multiple lamps as parallel circuit, operating remaining lamp(s) at full light output upon failure of other lamp(s) connected to the same ballast.
 3. Individual ballasts specifically designed and UL Listed are to operate one, two, three, or four lamps as scheduled on the drawings.
 4. Operate the lamps at rated lumen output and life specified by lamp manufacturers.
 5. Operate lamps at a frequency higher than 20 kHz.
 6. Operate a rated circuit voltage (120 or 277 VAC) at a input frequency of 60 Hz, and tolerate +/- 10% voltage variation without damage to the ballast, and maintain light output at +/- 10% voltage variation.
 7. Comply with EMI and RFI limits set by the FCC (CRF 47 Part 18) for non-consumer applications and not interfere with normal electrical equipment.
 8. Power factor shall be not less than 0.95.
 9. Total harmonic distortion shall be less than 20%.
 10. Lamp Crest Factor shall be 0.7 or less.
 11. Ballast Factor shall be greater than 0.85.
 12. Sound rating shall be "A".
 13. Withstand transients shall be as specified by ANSI C.62.41 for location category A.
 14. Shall comply with applicable ANSI standards.
 15. Shall be CBM certified.
 16. Shall be provided with three (3) year parts and labor warranty.
- C. Ballasts for compact lamps in recessed fixtures shall have the following features, unless otherwise indicated:
1. Type: Electronic .
 2. Power Factor: 90 percent, minimum.
 3. Flicker: Less than 5 percent.
 4. Lamp Current Crest Factor: Less than 1.7 .
 5. Electronic Ballast Operating Frequency: 20 kHz or higher.
 6. Lamp end-of-life detection and shutdown circuit.
 7. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
 8. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

- D. Ballasts for compact lamps in nonrecessed fixtures shall include the following features, unless otherwise indicated:
1. Power Factor: 90 percent, minimum.
 2. Ballast Coil Temperature: 65 deg C, maximum.
 3. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
 4. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.4 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

- A. General: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated.
1. Type: Constant-wattage autotransformer or regulating high-power-factor type.
 2. Minimum Starting Temperature: Minus 22 deg F minus 30 deg C for single-lamp ballasts.
 3. Normal Ambient Operating Temperature: 104 deg F 40 deg C.
 4. Open-circuit operation that will not reduce average life.
- B. Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.
- C. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

2.5 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.
- B. T8 rapid-start low-mercury lamps, rated 32 W maximum, 2850 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- C. T8 rapid-start low-mercury lamps, rated 25 W maximum, 2125 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

- D. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches 610 mm, 1325 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- E. Compact Fluorescent Lamps: CRI 80 (minimum), color temperature 3500 , average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated
 - 1. T4, Double-Twin Tube: Rated 13 W, 900 initial lumens (minimum).
 - 2. T4, Double-Twin Tube: Rated 18 W, 1200 initial lumens (minimum).
 - 3. T4, Double-Twin Tube: Rated 26 W, 1800 initial lumens (minimum).
 - 4. T4, Triple Tube: Rated 18W, 1200 initial lumens (minimum).
 - 5. T4, Triple Tube: Rated 26W, 1800 initial lumens (minimum).
 - 6. T4, Triple Tube: Rated 32W, 2400 initial lumens (minimum).
 - 7. T4, Triple Tube: Rated 42W, 3200 initial lumens (minimum).

2.6 HIGH-INTENSITY-DISCHARGE LAMPS

- A. Metal-Halide Lamps: ANSI C78.1372, wattage and burning position as scheduled, CRI 65 (minimum), and color temperature 4000 .

2.7 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 16 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage (2.68 mm) .
- E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm) .
- F. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

- H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.8 FINISHES

- A. Fixtures: Manufacturers' standard, unless otherwise indicated.
 - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 - 2. Metallic Finish: Corrosion resistant.

2.9 SOURCE QUALITY CONTROL

- A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Suspended Fixture Support: As follows:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Continuous Rows: Suspend from cable.
- C. Adjust aimable fixtures to provide required light intensities.

3.2 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Verify normal operation of each fixture after installation.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- D. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

END OF SECTION 16511

SECTION 16650 - PUMP CONTROL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Fourplex Pump Control Panel
 - 2. Duplex Pump Control Panel

1.3 DEFINITIONS

- A. PC: Programmable Pump Controller.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.

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- d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For duplex and fourplex pump control panels and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:
 1. Manufacturer's written instructions for testing , adjusting and programming the triplex pump control panel.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain Duplex and Fourplex Control Panels from one manufacturer.
- B. Pump Control Panel shall have U.L. 508 listing.
- C. Comply with NFPA 70.

1.6 WARRANTY

- A. The components in all of the Pump control panels shall carry a full one (1) year replacement warranty.
- B. Programmable pump controller shall carry a ten (10) year replacement warranty. This warranty shall be available in writing directly from the manufacturer before bid acceptance. The warranty shall provide for direct on-site replacement of the entire PC, complete with the original program and configuration. The replacement controller shall be available within 24 hours, without requiring that the original unit first be removed and returned to the factory.

1.7 EXTRA MATERIALS

- A. The pump control panel manufacturer shall furnish a complete set of recommended spare parts necessary for the first five (5) years of operation, which shall include at least the following:
 1. relay for each type required, mounted in the pump control panel

2. spare set of N.O. contacts on each motor Starter
 3. spare 20A circuit breaker mounted in the pump control panel
 4. contactor coil and one set of power contacts for each size used.
- B. Loose spare parts shall be properly bound and labeled for easy identifications without opening the packaging and suitability protected for long storage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Duplex and Fourplex Pump Control Panel:
 - a. Tesco Controls Inc.
 - b. Healy Ruff

2.2 PUMP CONTROL PANEL

- A. Furnish and install all equipment as shown on drawings in an indoor pump control panel with U.L. 508 listing. Panel enclosure shall be constructed of 12 gauge, 316 stainless steel doors shall be equipped with 316 stainless steel polished handle with 3-point roller bearing latches and hasps for owner padlocks. Door shall open to greater than 90 degrees. All interior mounting hardware shall be stainless steel. Exterior color shall be painted as noted on the project drawings. The painting process shall include five stages of metal preparation using dip tanks as follows:
1. Alkaline cleaner,
 2. 2) Clear water rinse,
 3. 3) Iron phosphate application,
 4. 4) Clear water rinse, and
 5. 5) Inhibitive rinse to seal phosphated surfaces. Finish shall be polyester dry powder, electrostatically applied and baked on at 380 degrees Fahrenheit.
- B. The enclosure shall be compartmentalized such that the programmable pump controller and power sections are isolated from each other by internal barriers. The pump control panel shall house the main circuit breaker. . The main circuit breaker, and all wiring shall be located behind the panel door. Circuit breaker operation shall be possible without opening the door. Elapsed time meters, indicating devices and H.O.A. switches, shall be mounted on the panel door. Breaker cutouts for breaker toggle protrusion, to eliminate exposure to hazardous potentials, shall be supplied. A physical lockout device shall be supplied on each motor circuit breaker. Thermostatically controlled heating and cooling systems shall

be provided, as approved by the Engineer, to maintain suitable climate conditions within the control panel. Lightning/surge protector shall be furnished to protect the panel equipment from lightning and utility power surges. Provide GFCI receptacle, PFR power fail relay, and fluorescent light with door activated switch. All bussing and wire shall be copper. All wire shall be stranded with locking spade pressure connectors and labeled with clip-on permanent plastic wire markers. All circuit breakers and dead front mounted devices (lights and switches) shall be equipped with engraved phenolic nameplates.

2.3 TERMINAL AND DISTRIBUTION BLOCKS

- A. Description: Distribution blocks shall be furnished and installed as required for "fan-out" of control power and other 120V sources within the enclosure. The blocks shall be rated 300V at a minimum of 20 amperes and sized for the conductors served. Distribution blocks shall be Entrelec, Connectron NFT, or equal

2.4 CIRCUIT BREAKERS

- A. All 480 volt circuit breakers shall have interrupting capacities at 25,000 amperes. All 120 volt breakers shall be rated 25,000 amperes interrupting capacity. Circuit breakers shall be of the indicating type, providing ON, OFF and TRIPPED positions of the operating handle. Circuit breakers shall be quick-make, quick-break, with a thermal-magnetic action, except when protecting motor feeders where motor circuit protector (MCP) breakers may be used. Circuit breakers shall be the bolted on type. The use of tandem or dual circuit breakers in a normal single-pole space to provide the number of poles or spaces specified is not acceptable. All multiple-pole circuit breakers shall be designed so that an overload on one pole automatically causes all poles to open. Circuit breakers shall meet the requirements of UL and NEMA AB 1. Breakers shall be Westinghouse ED, QC, MCP or equal. All circuit breakers shall be heavy duty molded case circuit breakers conforming to Federal specification W-C-375B and shall be UL listed.

2.5 MOTOR CONTROL

- A. Provide each motor with a suitable controller and devices that will perform the functions as specified for their respective motors. Controllers shall conform to the applicable requirements of NEMA ICS, ANSI C19.1, the NEC, and UL. Anticipated horsepower ratings are shown on the contract documents. This information is for guidance only and does not limit the equipment size. When motors furnished differ from the expected ratings indicated, make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed, at no additional cost to the Owner.

- B. Each motor control system shall be equipped with a hand-off-auto control switch, indicating lights, elapsed time meter, motor starter, control transformer with primary fuses and secondary control power fuse. Control switches and indicating lights shall be U.L. listed oil-tight devices rated heavy duty. Provide Allen Bradley, Westinghouse, or equal. Motor starters shall be NEMA rated with an electrically held contractor and a single reset, 3 phase, overload relay with a normally closed holding contact and a normally open isolated contact for overload alarm. Each overload shall be ambient compensated and shall trip on 600% of full load current in less than 6 seconds. Each motor starter Size 3 and larger shall be furnished with a minimum of 4 auxiliary contacts and provisions for adding 2 more. Auxiliary contacts shall be convertible, in the field, from normally open to normally closed. Each overload relay shall have a test trip push-button built-in and a adjustable calibrated trip with indicating dial. There shall be an unbreakable steel operator, with insulated plastic foot (for safety) through the front door for manual reset. Motor starters shall be Allen Bradley 509 or equal. Control power transformers shall be sized as shown on the plans, minimum size shall be 100VA where not designated. Provide Micron, G.E., or equal. An elapsed running time meter for recording total elapsed running time for each motor. The meter shall be six digit, non-reset, recording in hours and tenths. Meters shall be mounted to dead front with stainless steel machine screws. Sheet metal screws will not be acceptable.

2.6 NAMEPLATES

- A. Description: Nameplates shall be black phenolic with white lettering. Nameplates shall be stainless steel screw mounted. Glue type will not be acceptable.

2.7 PANELBOARD

- A. Panelboard shall be circuit breaker type custom constructed to utilize minimum enclosure space with breakers as shown. Circuit breakers shall be bolted on type. The panelboard shall be furnished with phenolic nameplates. The panelboard transformer shall be dry type construction sized as shown on the plans with primary breaker protection. The panelboard transformer shall be a Jefferson 211, G.E., or equal.

2.8 PANEL LIGHTS

- A. Furnish and install push-to-test lights to indicate status and alarm conditions locally as shown on drawings. Engraved phenolic nameplates shall specify each light's function. Lights shall be wired as shown on drawings. Panel lights shall be full voltage Allen Bradley 800H or equal.

2.9 PUSH-BUTTONS AND SELECTOR SWITCHES

- A. Push-buttons, and selector switches, for non hazardous indoor dry locations shall be U/L listed oil-tight type, Allen Bradley 800H or equal. These devices shall have individual, extra large nameplates indicating their specific function.

2.10 RECEPTACLES, DUPLEX

- A. Receptacles shall be of specification grade and of NEMA configuration and rated 2 pole, 3 wire grounding, 20 amperes, 125 volts, such as Pass & Seymour 5252, Leviton 6898, Bryant 5252, or equal. Bases shall be of ivory phenolic composition. Wire terminals shall be suitable for 10 AWG wire and shall be screw type. Receptacles shall be UL listed. The receptacles shall have corrosion resistant conducting parts of nickel-plated brass and other metal parts of stainless steel. All external and dead front receptacles shall be installed on ground fault interrupter circuits "GFCI".

2.11 RELAYS, CONTROL

- A. Control relays shall be Potter and Brumfield KU, Idec Type RR or equal. Two form-C contacts (minimum) shall be provided on each relay. Provide relay energized neon lamp (inside relay case).

2.12 RELAY, POWER FAIL

- A. The power fail relay shall continuously monitor the three phases for power loss, low voltage, phase loss, phase reversal and have automatic reset. The power fail monitor shall have a drop-out voltage adjustment and a failure indicating LED. Provide Timemark B269.

2.13 RELAYS, FLOAT SWITCH INTERFACE

- A. Float interface relays shall be provided for functions as shown on plans. The units shall be specifically designed for monitoring intrinsically safe circuits. The unit shall utilize low current (120 micro amps maximum) and low voltage (12 volts d-c maximum) limiting the power entering the hazardous area to less than 1.5 milli-watts. Unit sensitivity shall allow pick-up on circuit closures of 100k ohms or less. The float switch interface relay shall be TESCO 72-144 or pre-approved equal.

2.14 RELAYS, CONTROL

- A. Control relays shall be Idec type RR or equal. Two form C contacts (minimum) shall be provided on each relay. Provide relay energized neon lamp (inside relay case).

2.15 RELAYS, TIME DELAY

- A. Time delay relays shall be solid state relays with a timer adjustable over the range 1 to 60 seconds unless other ranges are indicated or required. Provide LED relay energized indicator lamp. Time delay relays shall be Idec RTE, or equal.

2.16 PROGRAMMABLE PUMP CONTROLLER (PC)

- A. The PC shall be a microprocessor based unit with capability to accept digital and analog inputs, produce digital and analog outputs, perform local control and data manipulation functions, provisions for future SCADA and perform all other functions required to meet the specified performance and functional requirements of the integrated system. Each controller shall be furnished with all necessary power supplies, processors, memory, process I/O cards, serial communication ports, features etc. to meet its specified functions, requirements and environmental conditions. The pump controller shall contain all of the hardware devices listed below in a single removable integrated unit, and shall be inherently capable of performing all of the features described herein without the need for any additional hardware. The PC's acceptable to be furnished under this contract shall be TESCO pump controller L2000 with integral operator interface. Any proposed PC alternates or substitutions will require prior approval. Owner reserves the right to reject any or all proposals that are not in the owner's best interest. Owner's decision is final.
- B. The PC shall adhere to the minimum specification requirements. The PC supplier shall submit in detail all information required to establish that the PC meets the minimum requirements set forth in the PC specification. The PC supplier shall be prepared to demonstrate all functions specified at the Engineers request. PC's that do not meet the minimum requirements will not be acceptable.
- C. The PC components shall employ a solid-state design. All PC processors and I/O components shall be contained in plug-in modules. Chassis wired logic is not acceptable. The PC and any associated I/O modules shall be removable without disconnecting the I/O wiring.
- D. The PC shall operate correctly under an ambient temperature range of -40 to +200 degrees F without requiring forced air or other special cooling measures. At minimum, each Pump Controller shall be subjected by the manufacturer to a 5 day burn-in procedure at 165

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degrees F. Coatings on connectors, component leads, and other materials used in the construction of the PC shall be substantially resistant to atmospheres containing significant amounts of Hydrogen Sulfide gas and Chlorine gas. Each component shall have passed testing and be certified in writing by the manufacturer to be acceptable for use in water treatment and waste water treatment environments.

- E. The PC shall have all of the facilities required to implement the control schemes, I/O and data base shown and specified in the Contract Plans and Documents. PCs shall have floating point math and PID controller modulating capability. The PC shall be guaranteed free from defects for a period of ten years.
- F. Pump Controller Manufacturer: The PC shall be furnished by a manufacturer that has at least 10 years experience manufacturing its own PC's and control systems designed specifically for the water and waste water industry. The PC itself and support for the controller shall be available directly from the manufacturer.
- G. Telephone Support: The PC manufacturer shall provide telephone support for questions related to any aspect of the controller, including general use, application-specific issues, programming, and use of the programming software. This support shall be available directly from the manufacturer at no extra charge with the purchase of a controller.

2.17 PC HARDWARE

- A. Central Processing Unit (CPU): The PC CPU shall employ a 32 bit, 16 MHz microprocessor based architecture capable of performing all tasks necessary to perform the specified control functions. It shall be capable of interfacing sufficient discrete inputs, analog inputs, discrete outputs, and analog outputs to meet the specified requirements plus at least 20 percent excess capacity. All PCs shall be provided to support and implement closed loop floating point and PID control which is directly integrated into the PC's control program.
- B. Memory: RAM memory shall be (CMOS) semi-conductor memory with 1 year battery backup. The CMOS user programming memory shall be a minimum of 1Mb expandable to 2Mb. The CPU shall be supplied with sufficient memory to implement the specified control functions plus a reserve capacity of 40 percent of the total provided. This reserve capacity shall be totally free from any system use. ROM memory shall contain the Operating System, Diagnostics, Process I/O, communications and hardware support functions. Sufficient ROM memory shall be supplied to meet all specified requirements.

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- C. CPU Fault: The CPU shall provide internal fault analysis with a fail-safe mode and a dry contact output for remote location alarming, and a local indicator on the PC frame in the event of a fault within the PC.
- D. Real Time Clock: The CPU shall employ a real time clock for event time and date stamping. The time and date stamp shall indicate year/month/day/hour/minute/seconds accurate to 1/100 second of the event trigger. The real time clock shall be capable of remote synchronization via the specified communications network. The real time clock accuracy shall be plus/minus one minute/month.
- E. PC Housing and Bus Backplane: The PC CPU, communications, power supply, and I/O modules shall be mounted in a suitable standard housing. Modular housing slots shall be mechanically configurable to prevent insertion of incorrect modules. Each PC system employing modular housing slots shall have a minimum of 3 empty I/O module slots. The PC I/O Bus shall employ a true 16 bit data bus backplane for data transfers between I/O modules and the CPU. Serial Data bus architecture is not acceptable. Project requirements which exceed the minimum rack requirements shall utilize sufficient racks and slots to meet the I/O requirements plus three additional spare slot capacity. Additional racks employing remote I/O processors shall be provided when project I/O exceeds 12 slots.
- F. PC Communications: The PC's shall have multiple onboard communication ports including remote I/O, RS-485 and RS-232 ports. In addition to the required communications ports a dedicated programming and diagnostics port shall be provided for portable programmer access. Each PC shall be equipped with the following communications ports:
1. Two RS-232 serial communications ports (1200 - 115K Baud)
 - a. One compatible with the specified communications media
 - b. One compatible with the specified operator interface
 - c. One Remote I/O Adapter port.
 - d. One Programming and diagnostics port
- G. Protocol Conversion: The PC shall be capable of both master and slave RTU communications.
- H. Power Supply: The PC power supply shall be sized to power all modules mounted in that housing and an "average module load" for any empty housing slots plus 60 percent above that total. The power supply input voltage shall be compatible with the battery back-up

system. The programmable controller and its associated communications devices shall be battery backed up for a period of eight hours.

- I. PC Input/Output (I/O) Modules: All integral I/O housings or modules shall be suitable for hostile industrial environments as described. All I/O modules shall be isolated and conform to IEEE Surge Withstand Standards and NEMA Noise Immunity Standards. I/O shall be removable without having to disconnect wiring from the module's terminals by means of a swing-arm or plug-in wiring connector. Sufficient I/O shall be provided to meet the specified requirements plus 20 percent spare capacity.
- J. Discrete Inputs: Discrete inputs defined as contact closure inputs from devices external to the PC module. Individual inputs shall be optically isolated from low energy common mode transients to 1500 volts peak from users wiring or other I/O Modules. The inputs shall have LED's to indicate status of each discrete input. Signal levels shall be 24 VDC or 120 VAC.
- K. Discrete Outputs: Discrete Outputs defined as contact closure output for ON/OFF operation of devices external to the PC module. The output modules shall be optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volts peak. All outputs shall have LED's to indicate status of each output point. Output contact rating shall be 2A minimum, with a momentary surge rating of at least 20A at 120 VAC.
- L. Analog Inputs: Analog inputs shall accept both 4 to 20 mA or 0 - 5 Volt DC signals, where an analog to digital conversion is performed with a minimum of 12-bit precision and the digital result is entered into the processor. The analog to digital conversion shall be updated with each scan of the processor. Analog input modules shall have a minimum of eight differential inputs each.
- M. Analog Outputs: Analog outputs shall be 4 to 20 mA DC output signals where each output circuit performs a digital to analog conversion with each scan of the processor. Each analog output module shall have four isolated output points which shall be rated for loads of up to 1200 ohms.

2.18 OPERATOR INTERFACE

- A. An integral operator display and keypad shall be provided to allow operator monitoring and control functions. The operator shall be capable of viewing all internal registers and status flags via a menu driven format without programming. The operator interface shall be configured to provide the following minimum display and control functions:
1. Analog Variable Displays: All analog variable registers shall be displayed in engineering units utilizing real numbers with a two decimal precision. All supplied analog inputs including spares shall be preconfigured and calibrated for use by merely wiring the input to the PC input card. Each analog input shall be scalable from the operator interface and preconfigured with High and Low alarm setpoints. All analog variables shall be configured with out of range failure alarms.
 2. Setpoint Displays: All setpoints shall be accessible by the operator for display and modification. Setpoints shall be displayed in engineering units utilizing real numbers with two decimal precision. The operator interface shall employ password protection such that setpoint variables may not be altered without a valid password entry. A numeric keypad shall be provided for direct numerical entry of setpoint values.
 3. Status Displays: All status registers DI and DO shall be displayed continuously and simultaneously identifying the variable name with up to 25 characters and the On/Off condition of the variable.
 4. Alarm Handling and Display: Alarms shall be displayed utilizing a standard ISA sequence for indication and acknowledgment functions. The display shall flash the alarm condition on the current screen or via an LED bar segment until acknowledged with a valid password. Upon acknowledgment the alarm shall go to steady state until reset.
 5. Macro/Function Keys: The operator keypad shall employ a minimum of four macro/function keys. The operator shall be capable of utilizing the macro/function keys to invoke control changes or view commonly accessed data.
 6. Timer and Counter Displays: All timers and counters shall be displayed identifying the timer value and timer activity (i.e. timing, not timing)
 7. PC Diagnostics: The operator interface shall employ the means to run diagnostic programs which at a minimum shall verify and detect memory errors, program configuration errors, and communications hardware errors. The Operator Interface shall continuously display the communications traffic transmit and receive status of the PC identifying source address, destination address and message type. The communications status failed/normal shall be continuously displayed.

8. PC Calibration: The operator interface shall provide the means to test and calibrate analog inputs and outputs in engineering units. The operator shall be capable of calibrating all analog I/O including spares on-line.
9. Operator Keypad: The keypad shall utilize a sealed membrane overlay employing tactile feedback for positive verification the key has been depressed. The keypad and display shall be impervious to corrosive gases such as those typically found in wastewater applications. The keypad shall support a minimum of 20 keys including numeric keypad, arrow control and 4 macro keys.

2.19 PC PROGRAMMING SOFTWARE

- A. The PC shall be programmed utilizing the PC manufacturers PC programming development software. Two copies of programming development software shall be provided to owner. The development software shall be Microsoft Windows compatible. The development software shall be provided with the minimum functionality:
 1. PC Programming and Debugging
 2. PC Diagnostics
 3. Program Upload and Download
 4. On-line Communications Monitoring and Diagnostics
 5. Analog Input and Output Calibration
 6. On-line Variable Test Mode (allow user to fix register values on-line)
- B. The PC shall be programmed to meet the functional control requirements specified. In addition to the specified control programming the PC shall be capable of implementing the following control functions without additional software or hardware:
 1. Array Logging: The PC software shall be capable of logging register variables to an array with time and date stamping to 10ms resolution. The arrays shall be configured to allow the user to establish the register to be logged, event condition to begin and end logging, size of the array, logging rate and rollover conditions for a minimum of 10 variables. The user shall select the compression rate for min/max and average in minutes or hours.
 2. Array Retrieval: The arrays shall be retrievable via the programming software and formatted in file accessible by standard windows spreadsheet and database software packages. At a minimum the array file shall be directly accessible via Excel.

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3. Analog Input Filtering: All analog inputs shall be filtered by an adjustable software first order lag filter. The filter constant shall be tunable via a setpoint displayed on the specified Operator Interface.
 4. Unsolicited Messaging: The PC shall be capable of transmitting information without a poll request for peer-to-peer and quiescent communications. Data shall be transmitted based on user definable parameters for elapsed time, event trigger or differential change in analog value individually for each variable.
- C. Approval of an alternate PC to that of the L2000', does relieve the supplier from meeting all functions supplied with the L2000' Programmable Controller. The functions to be met by the alternative PC shall be at the users discretion.

2.20 PUMP CONTROLLER I/O CONFIGURATION

- A. Analog inputs: Inputs shall be provided for wet well level. As a minimum, a total of 6 analog inputs shall be provided. All inputs are 4-20 mADC.
- B. Analog outputs: 2 outputs shall be furnished for future use.
- C. Digital Inputs: Inputs shall be provided for primary station power (three phase) failure, DC power failure, alarm acknowledge, pump hand and auto and seal failure for each pump. As a minimum, a total of 16 digital inputs shall be provided.
- D. Digital Outputs: 115 VAC triac outputs shall be provided for the common alarm flashing beacon, pump motor starter call and pump fail. As a minimum, 16 - triac outputs shall be furnished. Alarm LED driver outputs shall be furnished for high and low wet well alarm and level transducer fail. As a minimum, 8 LED driver outputs shall be furnished.

2.21 PUMP CONTROLLER FUNCTIONS

- A. Pump Level Control and Alarms: Start and stop of the lift station pumps shall be controlled by the level in the wet well. There shall be an individually adjustable starter setpoint for each pump and a single stop setpoint. The pump start sequence shall be automatically alternated, with alternation on a first on/first off, first off/first on basis. If a pump fails to start, the next pump in sequence is started. High and low wet well alarms and transducer out of range alarms shall also be furnished.
- B. Pump Run and Fail: When a pump is called to run, either through the local hand switch or automatic pump control, a pump run signal shall be generated. If flow is not sensed within an adjustable time period, a pump fail alarm shall be generated.

- C. Common Alarm: The Controller shall activate the common alarm beacon on occurrence of alarms.

2.22 BATTERY BACK-UP

- A. Battery back up system shall correctly sized to power the Controller, radio and I/O system for a minimum of 8 hours. Batteries shall be sealed gel cell type lead acid.

2.23 REACTIVE AIR CONTROL SYSTEM

- A. Provide control system Reactive Air Bell with stainless steel mounting hardware. Reactive Air Bell shall be 4' long, 6" in diameter with 1/4" @ parflex tubing run continuously to the pump control panel. The bottom of the bell shall be furnished with a pointed cone wire stainless steel mesh to prevent entry of grease or debris into the bell. A pressure switch mounted in the pump control panel shall operate all pumps on high high level and stop the pumps on low level (below the bottom of the bell). Back up control system will only operate if the programmable controller (PC) is inoperable. Mount Reactive Air Bell as shown on the contract plans.

2.24 BACK-UP FLOAT SWITCHES

- A. Provide float switches, stainless steel mounting bracket, float switch not affected by rotation of float about longitudinal axes, and type 50, neoprene jacket control cable to reach control panel for low level/high level alarm status as a back-up for primary ultrasonic level transducer and PC level control. The power applied to the level sensors shall be a maximum of 24 VAC with a current of less than 30mA for intrinsic safety. Electrical connections of sensor leads and signal conditioning shall be in conformance with NEC requirements for intrinsic safety.

2.25 NEW ZETRON ALARM PANEL 1550 (SENTRIMAX)

A. AUTOMATIC PHONE DIALER AND ALARMS:

1. Make connections between pump control panel and new Zetron Alarm Panel and connect to telephone system for dial out.

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2. Under normal operation, controller and intrinsically safe probe alarm circuit shall provide the following alarm contact closures to the Zentron Alarm Panel: (1) high wet-well level at West Pump Room, (2) high wet-well level at Mid-Channel Pump Room, (3) high wet-well level at East Pump Room, (4) common alarm at West Pump Room, (5) common alarm at Mid-Channel Pump Room, (6) common alarm at East Pump Room. During a power outage, controller and supporting control relays shall provide the phone dialer with contact closures for ((1) high wet-well level at West Pump Room, (2) high wet-well level at Mid-Channel Pump Room, (3) high wet-well level at East Pump Room. The Zetron panel shall also pick-up contact closure from CO control panel upon detection of high levels of CO in tunnel. Please verify with owner all the alarm functions required. Provide at a minimum the quantity of functions shown here plus an addition 4 four alarm functions if required by owner.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install pump control panels level, plumb, and square with building lines.
- B. Install pump control panels along float switches and high level pressure switch in according to manufacturers' written instructions.

3.2 IDENTIFICATION

- A. Comply with Division 16 Section Electrical Identification.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

**STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND
DEVELOPMENT**



**CONSTRUCTION PROPOSAL
RETURNABLES
FOR**

**STATE PROJECT NO. 065-30-0041
HOUMA TUNNEL MODIFICATIONS
ROUTE LA 3040
TERREBONNE PARISH**

FOR INFORMATION ONLY

BID BOND

A Bid Bond is required when the bidder's total bid amount as calculated by the Department in accordance with Subsection 103.01 is greater than \$50,000. (See Section 102 of the Project Specifications.)

_____, as Principal
(Bidder) and _____, as Surety,
are bound unto the State of Louisiana, Department of Transportation and Development, (hereinafter called the Department) in the sum of five percent (5%) of the bidder's total bid amount as calculated by the Department for payment, of which the Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, as solidary obligors.

Signed and sealed this _____ day of _____, 20_____.

The condition of this obligation is such that, whereas the Principal has submitted a bid to the Department on a contract for the construction of **STATE PROJECT NO. 065-30-0041, HOUMA TUNNEL MODIFICATIONS**, if the bid is accepted and the Principal, within the specified time, enters into the contract in writing and gives bond with Surety acceptable to the Department for payment and performance of said contract, this obligation shall be void; otherwise to remain in effect.

Principal (Bidder or First Partner to Joint Venture)
By _____
Authorized Officer-Owner-Partner

Typed or Printed Name

If a Joint Venture, Second Partner
By _____
Authorized Officer-Owner-Partner

Typed or Printed Name

Surety
By _____ (Seal)
Agent or Attorney-in-Fact

Typed or Printed Name

To receive a copy of the contract and subsequent correspondence / communication from LA DOTD, with respect to the bid bonds, the following information must be provided:

Bonding Agency or Company Name	Address
Agent or Representative	Phone Number / Fax Number

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
SCHEDULE OF ITEMS

LEAD PROJECT: 065-30-0041
OTHER PROJECTS:

DATE: 04/07/08 14:23 PAGE: 1

ITEM NUMBER	APPROXIMATE QUANTITY	UNIT OF MEASURE	PAY ITEM UNIT PRICE (IN WORDS, INK OR TYPED)
S-101	LUMP	LUMP SUM	REPLACE EAST PUMP ROOM DRAINAGE PUMPS AND ASSOCIATED PIPING _____ DOLLARS _____ CENTS
S-102	LUMP	LUMP SUM	PROVIDE ELECTRIC MOTOR OPERATORS FOR EAST PUMP ROOM DRY WELL VALVES _____ DOLLARS _____ CENTS
S-103	LUMP	LUMP SUM	EAST PUMP ROOM STRUCTURAL IMPROVEMENTS _____ DOLLARS _____ CENTS
S-104	LUMP	LUMP SUM	REPLACE EAST PUMP ROOM ENTRANCE DOORS _____ DOLLARS _____ CENTS
S-105	LUMP	LUMP SUM	EAST PUMP ROOM NEW PUMP CONTROL PANEL AND LEVEL CONTROLS _____ DOLLARS _____ CENTS
S-106	LUMP	LUMP SUM	EAST PUMP ROOM ELECTRICAL WORK _____ DOLLARS _____ CENTS

FOR INFORMATION ONLY

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
 SCHEDULE OF ITEMS

LEAD PROJECT: 065-30-0041
 OTHER PROJECTS:

DATE: 04/07/08 14:23 PAGE: 2

ITEM NUMBER	APPROXIMATE QUANTITY	UNIT OF MEASURE	PAY ITEM UNIT PRICE (IN WORDS, INK OR TYPED)
S-107	LUMP	LUMP SUM	REPLACE MID-CHANNEL PUMP ROOM DRAINAGE PUMPS AND ASSOCIATED PIPING _____ _____ DOLLARS _____ _____ CENTS
S-108	LUMP	LUMP SUM	MID-CHANNEL PUMP ROOM STRUCTURAL IMPROVEMENTS _____ _____ DOLLARS _____ _____ CENTS
S-109	LUMP	LUMP SUM	REPLACE MID-CHANNEL PUMP ROOM ENTRANCE DOORS _____ _____ DOLLARS _____ _____ CENTS
S-110	LUMP	LUMP SUM	MID-CHANNEL PUMP ROOM NEW PUMP CONTROL PANEL AND LEVEL CONTROLS _____ _____ DOLLARS _____ _____ CENTS
S-111	LUMP	LUMP SUM	MID-CHANNEL PUMP ROOM ELECTRICAL WORK _____ _____ DOLLARS _____ _____ CENTS
S-112	LUMP	LUMP SUM	REPLACE WEST PUMP ROOM DRAINAGE PUMPS AND ASSOCIATED PIPING _____ _____ DOLLARS _____ _____ CENTS

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
 SCHEDULE OF ITEMS

LEAD PROJECT: 065-30-0041
 OTHER PROJECTS:

DATE: 04/07/08 14:23 PAGE: 3

ITEM NUMBER	APPROXIMATE QUANTITY	UNIT OF MEASURE	PAY ITEM UNIT PRICE (IN WORDS, INK OR TYPED)
S-113	LUMP	LUMP SUM	PROVIDE ELECTRIC MOTOR OPERATORS FOR WEST PUMP ROOM DRY WELL VALVES _____ DOLLARS _____ CENTS
S-114	LUMP	LUMP SUM	WEST PUMP ROOM STRUCTURAL IMPROVEMENTS _____ DOLLARS _____ CENTS
S-115	LUMP	LUMP SUM	REPLACE WEST PUMP ROOM ENTRANCE DOORS _____ DOLLARS _____ CENTS
S-116	LUMP	LUMP SUM	WEST PUMP ROOM NEW PUMP CONTROL PANEL AND LEVEL CONTROLS _____ DOLLARS _____ CENTS
S-117	LUMP	LUMP SUM	WEST PUMP ROOM ELECTRICAL WORK _____ DOLLARS _____ CENTS
S-118	LUMP	LUMP SUM	VENTILATION BUILDING MECHANICAL WORK _____ DOLLARS _____ CENTS

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LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
 SCHEDULE OF ITEMS

LEAD PROJECT: 065-30-0041
 OTHER PROJECTS:

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ITEM NUMBER	APPROXIMATE QUANTITY	UNIT OF MEASURE	PAY ITEM UNIT PRICE (IN WORDS, INK OR TYPED)
S-119	LUMP	LUMP SUM	VENTILATION BUILDING ELECTRIC MOTORS _____ DOLLARS _____ CENTS
S-120	LUMP	LUMP SUM	VENTILATION BUILDING ELECTRICAL SERVICE _____ DOLLARS _____ CENTS
S-121	LUMP	LUMP SUM	VENTILATION BUILDING ELECTRICAL WORK _____ DOLLARS _____ CENTS
S-122	LUMP	LUMP SUM	TUNNEL ELECTRICAL WORK _____ DOLLARS _____ CENTS

CONSTRUCTION PROPOSAL SIGNATURE AND EXECUTION FORM

THIS FORM, THE SCHEDULE OF ITEMS, AND THE PROPOSAL GUARANTY MUST BE COMPLETED AS INDICATED AND SUBMITTED TO THE LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT (DOTD) TO CONSTITUTE A VALID BID

STATE PROJECT NO(S). 065-30-0041

FEDERAL AID PROJECT NO(S). N/A

NAME OF PROJECT HOUMA TUNNEL MODIFICATIONS

I (WE) HEREBY CERTIFY THAT I (WE) HAVE CAREFULLY EXAMINED THE PROPOSAL, PLANS AND SPECIFICATIONS, INCLUDING ANY AND ALL ADDENDA, AND THE SITE OF THE ABOVE PROJECT AND AM (ARE) FULLY COGNIZANT OF ALL PROPOSAL DOCUMENTS, THE MASTER COPY OF WHICH IS ON FILE AT DOTD HEADQUARTERS IN BATON ROUGE, LA., AND ALL WORK, MATERIALS AND LABOR REQUIRED THEREIN, AND AGREE TO PERFORM ALL WORK, AND SUPPLY ALL NECESSARY MATERIALS AND LABOR REQUIRED FOR SUCCESSFUL AND TIMELY COMPLETION OF THE ABOVE PROJECT AND TO ACCEPT THE SUMMATION OF THE PRODUCTS OF THE UNIT PRICES BID ON THE SCHEDULE OF ITEMS ATTACHED HERETO AND MADE A PART HEREOF MULTIPLIED BY THE ACTUAL QUANTITY OF UNIT OF MEASURE PERFORMED FOR EACH ITEM, AS AUDITED BY DOTD, AS FULL AND FINAL PAYMENT FOR ALL WORK, LABOR AND MATERIALS NECESSARY TO COMPLETE THE ABOVE PROJECT, SUBJECT TO INCREASE ONLY FOR PLAN CHANGES (CHANGE ORDERS) APPROVED BY THE DOTD CHIEF ENGINEER OR HIS DESIGNEE. THIS BID IS SUBMITTED IN ACCORDANCE WITH THE GENERAL BIDDING REQUIREMENTS IN THE CONSTRUCTION PROPOSAL AND ALL SPECIAL PROVISIONS, PLANS, SUPPLEMENTAL SPECIFICATIONS, AND THE LOUISIANA STANDARD SPECIFICATIONS FOR ROADS AND BRIDGES (2006 EDITION). I (WE) UNDERSTAND THAT THE SUMMATION OF THE PRODUCTS OF THE UNIT PRICES BID ON THE SCHEDULE OF ITEMS MULTIPLIED BY THE ESTIMATED QUANTITY OF UNIT OF MEASURE FOR EACH ITEM, ALONG WITH ANY OTHER FACTORS SPECIFIED TO BE APPLICABLE SUCH AS CONSTRUCTION TIME AND/OR LANE RENTAL, SHALL BE THE BASIS FOR THE COMPARISON OF BIDS. I (WE) UNDERSTAND THAT THE SCHEDULE OF ITEMS MUST CONTAIN UNIT PRICES WRITTEN OUT IN WORDS AND THAT THE SCHEDULE OF ITEMS SUBMITTED AS PART OF THIS BID IS ON THE FORM SUPPLIED BY DOTD IN THE BID PROPOSAL. MY (OUR) PROPOSAL GUARANTY IN THE AMOUNT SPECIFIED FOR THE PROJECT IS ATTACHED HERETO AS EVIDENCE OF MY (OUR) GOOD FAITH TO BE FORFEITED IF THIS BID IS ACCEPTED BY DOTD AND I (WE) FAIL TO COMPLY WITH ANY REQUIREMENT NECESSARY FOR AWARD AND EXECUTION OF THE CONTRACT, AS WELL AS, SIGN AND DELIVER THE CONTRACT AND PAYMENT/PERFORMANCE/RETAINAGE BOND AS REQUIRED IN THE SPECIFICATIONS.

NONCOLLUSION DECLARATION (APPLICABLE TO FEDERAL-AID PROJECTS)

I (WE) DECLARE UNDER PENALTY OF PERJURY UNDER THE LAWS OF THE UNITED STATES AND THE STATE OF LOUISIANA THAT I (WE) HAVE NOT DIRECTLY OR INDIRECTLY, ENTERED INTO ANY AGREEMENT, PARTICIPATED IN ANY COLLUSION, OR OTHERWISE TAKEN ANY ACTION IN RESTRAINT OF FREE COMPETITIVE BIDDING IN CONNECTION WITH THE CONTRACT FOR THIS PROJECT NOR VIOLATED LA. R.S. 48:254.

BIDDER'S DBE GOAL STATEMENT (APPLICABLE TO DBE GOAL PROJECTS)

IF THIS PROJECT IS DESIGNATED BY SPECIAL PROVISION AS A DISADVANTAGED BUSINESS ENTERPRISE (DBE) GOAL PROJECT IN ACCORDANCE WITH THE DBE PROVISIONS OF THIS CONTRACT, THE BIDDER ASSURES DOTD THAT HE/SHE WILL MEET OR EXCEED THE DBE CONTRACT GOAL, OR IF THE BIDDER CANNOT MEET THE REQUIRED DBE GOAL, THE BIDDER ASSURES DOTD THAT HE/SHE HAS MADE AND CAN DOCUMENT GOOD FAITH EFFORTS MADE TOWARDS MEETING THE GOAL REQUIREMENT IN ACCORDANCE WITH THE CONTRACT AND DBE PROGRAM MANUAL INCORPORATED HEREIN BY REFERENCE.

THE APPARENT LOW BIDDER SHALL COMPLETE AND SUBMIT TO THE DOTD COMPLIANCE PROGRAMS OFFICE, FORM CS-6AAA AND ATTACHMENT(S) AND, IF NECESSARY, DOCUMENTATION OF GOOD FAITH EFFORTS MADE BY THE BIDDER TOWARD MEETING THE GOAL, WITHIN TEN BUSINESS DAYS AFTER THE OPENING OF BIDS FOR THIS PROJECT. RESPONSIVENESS OF INFORMATION SUPPLIED IN THIS SECTION OF THIS CONSTRUCTION PROPOSAL SIGNATURE AND EXECUTION FORM IS GOVERNED BY THE DBE REQUIREMENTS INCLUDED WITHIN THE SPECIFICATIONS AND DBE PROGRAM MANUAL.

CERTIFICATION OF EMPLOYMENT OF LOUISIANA RESIDENTS TRANSPORTATION INFRASTRUCTURE MODEL FOR ECONOMIC DEVELOPMENT (TIME) PROJECTS (APPLICABLE TO TIME PROJECTS)

IF THIS PROJECT IS DESIGNATED BY SPECIAL PROVISION AS A TRANSPORTATION INFRASTRUCTURE MODEL FOR ECONOMIC DEVELOPMENT (TIME) PROJECT AS DEFINED IN ACT NO. 16 OF THE 1989 FIRST EXTRAORDINARY SESSION OF THE LEGISLATURE WHICH ENACTED PART V OF CHAPTER 7 OF SUBTITLE II OF TITLE 47 OF THE LOUISIANA REVISED STATUTES OF 1950, COMPRISED OF R.S. 47:820.1 THROUGH 820.6

THE BIDDER CERTIFIES THAT AT LEAST 80 PERCENT OF THE EMPLOYEES EMPLOYED ON THIS TIME PROJECT WILL BE LOUISIANA RESIDENTS IN ACCORDANCE WITH LOUISIANA R.S. 47:820.3.

NON PARTICIPATION IN PAYMENT ADJUSTMENT (ASPHALT CEMENT AND FUELS) STATEMENT

IF THIS PROJECT IS DESIGNATED BY SPECIAL PROVISION AS BEING SUBJECT TO PAYMENT ADJUSTMENT FOR ASPHALT CEMENT AND/OR FUELS, THE BIDDER HAS THE OPTION OF REQUESTING EXCLUSION FROM SAID PAYMENT ADJUSTMENT PROVISIONS THAT ARE ESTABLISHED BY SPECIAL PROVISION ELSEWHERE HEREIN.

IF THE BIDDER DESIRES TO BE EXCLUDED FROM THESE PAYMENT ADJUSTMENT PROVISIONS,

THE BIDDER IS REQUIRED TO MARK HERE

FAILURE TO MARK THIS BOX PRIOR TO BID OPENING WILL CONSTITUTE FORFEITURE OF THE BIDDER'S OPTION TO REQUEST EXCLUSION.

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BIDDER SIGNATURE REQUIREMENTS (APPLICABLE TO ALL PROJECTS)

THIS BID FOR THE CAPTIONED PROJECT IS SUBMITTED BY:

(Name of Principal (Individual, Firm, Corporation, or Joint Venture))

(If Joint Venture, Name of First Partner)

(Louisiana Contractor's License Number of Bidder or First Partner to Joint Venture)

(Business Street Address)

(Business Mailing Address, if different)

(Area Code and Telephone Number of Business)

(Telephone Number and Name of Contact Person)

(Telecopier Number, if any)

(If Joint Venture, Name of Second Partner)

(Louisiana Contractor's License Number of Second Partner to Joint Venture)

(Business Street Address)

(Business Mailing Address, if different)

(Area Code and Telephone Number of Business)

(Telephone Number and Name of Contact Person)

(Telecopier Number, if any)

ACTING ON BEHALF OF THE BIDDER, THIS IS TO ATTEST THAT THE UNDERSIGNED DULY AUTHORIZED REPRESENTATIVE OF THE ABOVE CAPTIONED FIRM, CORPORATION OR BUSINESS, BY SUBMISSION OF THIS BID, AGREES AND CERTIFIES THE TRUTH AND ACCURACY OF ALL PROVISIONS OF THIS PROPOSAL, INCLUSIVE OF THE REQUIREMENTS, STATEMENTS, DECLARATIONS AND CERTIFICATIONS ABOVE AND IN THE SCHEDULE OF ITEMS AND PROPOSAL GUARANTY. EXECUTION AND SIGNATURE OF THIS FORM AND SUBMISSION OF THE SCHEDULE OF ITEMS AND PROPOSAL GUARANTY SHALL CONSTITUTE AN IRREVOCABLE AND LEGALLY BINDING OFFER BY THE BIDDER.

(Signature)

(Printed Name)

(Title)

(Date of Signature)

(Signature)

(Printed Name)

(Title)

(Date of Signature)

CONTRACTOR'S TOTAL BASE BID \$ _____

IT IS AGREED THAT THIS TOTAL, DETERMINED BY THE BIDDER, IS FOR PURPOSES OF OPENING AND READING BIDS ONLY, AND THAT THE LOW BID FOR THIS PROJECT WILL BE DETERMINED FROM THE EXTENSION AND TOTAL OF THE BID ITEMS BY DOTD.

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