

CITY OF TEMPE, ARIZONA
PUBLIC WORKS DEPARTMENT
DIVISION OF ENGINEERING

JOB ORDER NO. 4 TO FORESITE DESIGN & CONSTRUCTION, INC.
THROUGH EXISTING CONTRACT NO. C2015-282

**SWITCHGEAR REPLACEMENT –
JOHNNY G. MARTINEZ WATER TREATMENT PLANT**

PROJECT NO. 3207142

This **JOB ORDER NO. 4** is entered into on this 22 day of September, 2016, by and between the **City of Tempe**, an Arizona municipal corporation (“City”) and **Foresite Design & Construction, Inc.**, an Arizona corporation (“JOC”), through the existing Contract made and entered into by and between the parties on December 17, 2015 (Contract No. C2015-282).

SECTION 1 – JOB ORDER PRICE AND WORK LOCATION: JOC shall furnish any and all plant, materials, labor, construction equipment, services and transportation (all applicable taxes included) required for performing all work for the construction of Switchgear Replacement, Project No. 3207142 (“Project”) for the sum of Eight-Hundred Thirty-Three Thousand Two-Hundred Twenty-Five and 00/100 (\$833,225.00), as detailed in the Proposal (Exhibit “A”) attached hereto and incorporated herein by this reference, and to completely and totally construct the same and install the materials therein for the Project, in a good and workmanlike and substantial manner and to the satisfaction of City or its properly authorized agents and strictly pursuant to and in conformity with the Specifications and Plans for the Project and other documents that may be requested by City through its Engineer or other properly authorized agents, as provided herein. The full street or physical address of the construction work location (“Work Location”) is 255 E. Marigold Lane, Tempe, Arizona. JOC shall list the Work Location in any subcontract related to this job order at any level and each subcontractor shall likewise include the Work Location in any of its subcontracts.

SECTION 2 – REQUIRED SUBMITTALS: JOC shall submit the completed forms referenced in the Forms Appendix (Exhibit “B”) attached hereto to City for approval prior to receipt of a Notice to Proceed issued by City for the Project.

SECTION 3 – AMENDMENT: City of Tempe Contract No. C2015-282, , the terms and conditions contained therein and all exhibits attached to the Contract and to this Job Order No. 4, are by reference incorporated into this Job Order No. 4. All provisions of the underlying Contract where not inconsistent with this Job Order No. 4 shall remain binding on the parties.

SECTION 4 – JOB ORDER TERM: Work shall start as soon as practicable, and in no case later than seven (7) calendar days after the Notice to Proceed is issued by City, and shall be completed within thirty five (35) calendar days thereafter.

[SIGNATURE PAGE TO FOLLOW]

Switchgear Replacement –
Johnny G. Martinez Water Treatment Plant
Project No. 3207142

DATED this _____ day of _____, 2016.

CITY OF TEMPE, ARIZONA

By: _____
Mayor

By: _____
Public Works Director

ATTEST:

Recommended by:

City Clerk

Deputy PW Director/Interim City Engineer



APPROVED AS TO FORM:

City Attorney

JOC warrants that the person who is signing this Job Order on behalf of the JOC is authorized to do so and to execute all other documents necessary to carry out the terms of this Job Order.

FORESITE DESIGN & CONSTRUCTION,
INC.

By: W. Scott Breeding
Signature

W. SCOTT BREEDING
Printed Name

Its: V.P.
Title

06 0711556
Federal I.D. No./Social Security No.

EXHIBIT A

FORESITE DESIGN & CONSTRUCTION INCORPORATED

August 18, 2016

Via e-mail: Erich_Bonz@tempe.com

Mr. Erich Bonz, P.E.
City of Tempe
Engineering Division
31 E. Fifth Street
Tempe, AZ 85281

RE: City of Tempe
Johnny G Martinez Switchgear Upgrade
JOC Proposal

Dear Mr. Bonze,

ForeSite Design & Construction, Inc. proposes to furnish all labor, materials, tools and equipment necessary for the JGM Switchgear Improvements at the above referenced project for the total sum of: **Eight Hundred Thirty Three Thousand, Two Hundred Twenty Five and NO/100th dollars: \$833,225.00.**

All work shall be in accordance with the following documents:

Plans: (11 sheets) entitled "Switchgear Improvements, Johnny G. Martinez Water Treatment Plant" and Addendum 1, as prepared by Burges & Niple and Jensen Engineering.

Specifications: (107 sheets) entitled "Switchgear Improvements, Johnny G. Martinez Water Treatment Plant", as prepared by Burges & Niple and Jensen Engineering, dated July 28, 2016.

We have attached a milestone schedule for the project showing the proposed time duration for the project.

In submitting this proposal, we agree:

1. To hold the proposal open for thirty (30) days after the date of this proposal.
2. To commence with the project during the January to March shutdown scheduled for the plant.
3. To accomplish the work in accordance with the JOC contract documents and the following project description, clarifications and exclusions listed below.

Clarifications and qualifications:

1. Our approach to this project is based on a continuous work flow. Once the project team develops a schedule and we mobilize to start work, work will continue without significant "stops". All owner provided scopes of work and owner provided material and equipment will be furnished timely based on the schedule.
2. ForeSite will be allowed to utilize existing water and power sources on site for the construction of the project. All consumption costs will be paid by City of Tempe.
3. Work will occur during normal business hours, 7:00am to 4:00pm during a plant maintenance shutdown between January 3, 2017 and March 7, 2017.



4. The facility will remain on generator power for the entirety of the feeder and equipment replacement process.
5. ForeSite will be allowed to shut down power to the site in order to safely make all connections between the generator and the existing equipment.
6. All coordination with the utility company will be by the City of Tempe.
7. Generator rental is included for a three week time period, but the weekly rate for the third week has been broken out and will be credited back to the City of Tempe if not utilized.
8. City of Tempe to provide a hazardous material survey of the selective demolition areas within the past 12 months for our review and use on the project (if applicable).
9. Material warranties will be transferred to the City of Tempe upon closeout.
10. No UL Listing will be required for Switchgear 1
11. Prior to the electrical shutdown a detailed Method of Procedure (MOP) will be submitted to Tempe for review and approval.
12. Prior to billing, an expanded schedule of values will be provided for the electrical work.

Exclusions:

- Asbestos abatement or hazardous material removal
- Asbestos or hazardous material surveys
- Plan review and Building Permit fees
- Development fees & utility company charges
- Material acceptance testing
- Special inspections
- Temporary utilities
- Plan review comments or corrections

Sincerely,
ForeSite Design & Construction, Inc.

Jarrod Kerns
Project Manager

City of Tempe
Job Order Price

COT Project Name: **City of Tempe Public Works Department
 JGM Switchgear**
 COT Project Number: **3207142**

8/12/2016

Negotiated Prices	
Price of Subcontractor(s)	\$701,362
Price of Subconsultant(s) (If applicable)	\$0
General Conditions	\$22,675
Preconstruction Labor (If applicable)	\$0
Construction Labor	\$1,237
Subtotal	\$725,274
Unit Prices	
Unit Price (Per Unit Price Attachment)	\$0
Subtotal	\$0
Overhead and Profit (6 %)	\$43,516
Total	\$768,790
Insurance (1.79%)	\$13,761
Bonds (1.08%)	\$8,999
Sales tax (5.265%)	\$41,675
Combined Total	\$833,225
City's Allowance	\$0
Project Total	\$833,225



COT Project Name: City of Tempe Water Treatment
Warner Road Pedestrian Median Refuge
COT Project Number: 3204402

LIST OF SUBCONTRACTORS

In accordance with the provisions of Section 108.2 of the MAG Specifications, the JOC Contractor shall provide for each Job Order the information listed below regarding proposed subcontractors which are subject to approval by the City.

Subcontractor				
<u>Name</u>	<u>Address</u>	<u>Type of Work</u>	<u>% of Total Contract</u>	<u>Contract Value</u>
K&F Electric, Inc	4970 East Beverly Rd Phoenix, AZ 85044	Electrical	56.89%	\$474,000

\$833,225 Total contract amount

City of Tempe
JGM Switchgear
JOC Proposal

Project name	JGM Switchgear Tempe AZ 85283
Estimator	Jarrod Kerns
Labor rate table	1.0X w/brd
Job size	1 ls
Duration	5 wk
Bid date	7/15/2016 4:00 PM
Report format	Sorted by 'Group phase/Phase' 'Detail' summary

50

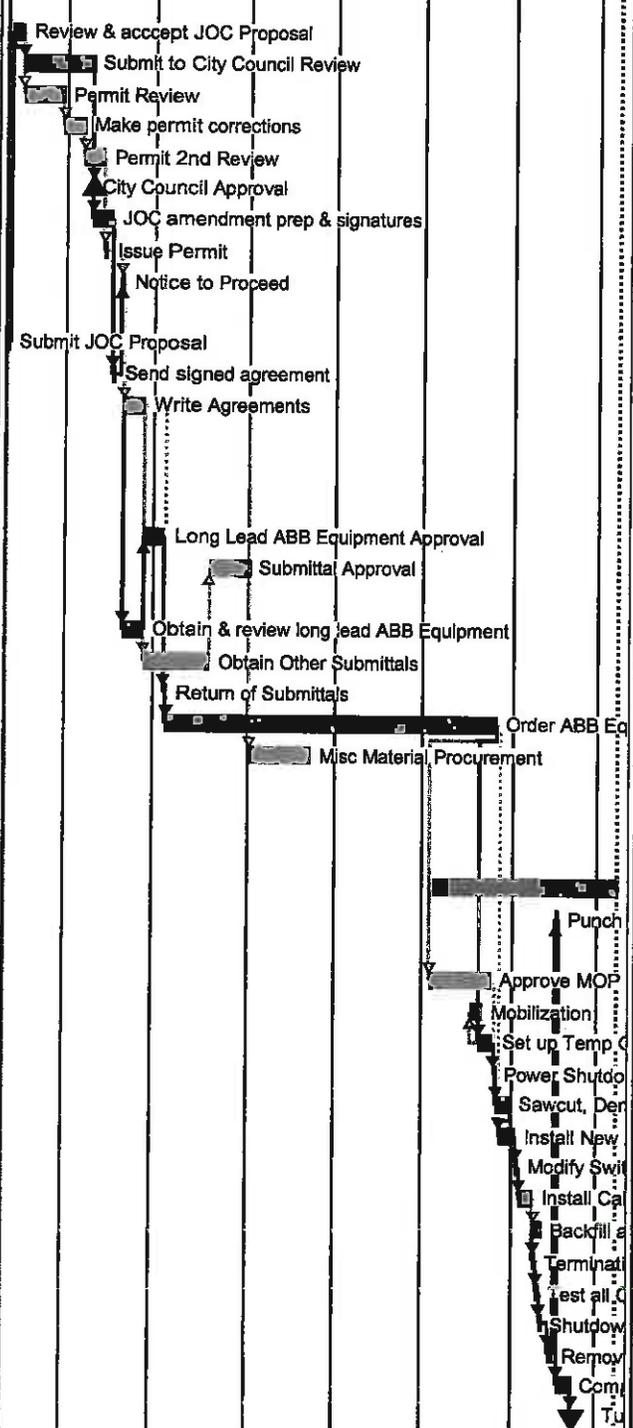
Group	Phase	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
1.000		GENERAL REQUIREMENTS							
	1.002	Project Manager							
		Project Manager	2.50 wk	5,838					5,838
	1.003	Project Superintendent							
		Project Superintendent	6.00 wk	11,178					11,178
	1.011	General Field Supervisor							
		General Field Supervisor	24.00 hr	1,560					1,560
	1.209	Plans & Specifications							
		Plans	33.00 sht		33				33
	1.309	Information Technology							
		IT Expense	340.00 hr				551		551
	1.310	Office Supplies							
		Job Office Supplies	1.50 mo		45				45
	1.311	Office Machine Rental							
		On Site Computer	1.50 mo				375		375
		All in One Copier/Printer/Scanner	1.50 mo				180		180
	1.315	Temporary Toilet							
		Temporary Toilet	1.50 mo				143		143
	1.322	Drinking Water							
		Drinking Water	1.50 mo		60				60
	1.329	Communications							
		Monthly Usage (in town)	364.00 hr				160		160
	1.602	Fore-site Equipment							
		Fore-site 3/4 Ton Pick up/Mo	1.75 mo				1,472		1,472
	1.615	Gas & Minor Maint.							
		Gas & Minor Maint.	6.00 wk				1,080		1,080
2.000		SITWORK							
	2.003	Construction Protection							
		Signage, flagging & barricades	1.00 ls	128	150				278
	2.009	General Clean-up							
		General Clean-up	16.00 hr	720			20		740
	2.013	Safety & Inspections							
		Safety Consultant	3.00 hr						330
		Safety Plan	1.00 ls	220					220
16.000		ELECTRICAL							
	16.001	Electrical							
		Electrical	1.00 ls			474,000			474,000
	16.800	Special Systems							
		Generator Rental	1.00 ls			157,280			157,280

Group	Phase	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
16.800		Special Systems							
		24 Hour On Site Monitor (2 wks)	1.00 ea			28,600			28,600
		Additional Week if Required	1.00 ea			41,152			41,152

Estimate Totals

Description	Amount	Totals	Rate
Labor	19,644		
Material	288		
Subcontract	701,362		
Equipment	3,980		
Other	725,274	725,274	
OVERHEAD AND PROFIT	43,516		6.000 %
	43,516	768,790	
Tempe JOC Insurance	13,761		1.790 %
Tempe JOC Bond Rate	8,999		1.080 %
	22,760	791,550	
Tempe Sales Tax (65% x 8.10%)	41,675		5.265 %
Total		833,225	

ID	Description	Original Duration	Remaining Duration	Start	Finish	2016					2017	
						Aug	Sep	Oct	Nov	Dec	Jan	Feb
PRE-CONSTRUCTION												
Project Wide												
Area Wide												
Area Wide												
City of Tempe												
10	Review & accept JOC Proposal	2	2	08/12/16	08/15/16							
15	Submit to City Council Review	18	18	08/16/16	09/08/16							
20	Permit Review	10	10	08/16/16	08/29/16							
25	Make permit corrections	5	5	08/30/16	09/05/16							
30	Permit 2nd Review	5	5	09/06/16	09/12/16							
35	City Council Approval	0	0	09/09/16								
40	JOC amendment prep & signatures	5	5	09/09/16	09/15/16							
45	Issue Permit	1	1	09/13/16	09/13/16							
55	Notice to Proceed	1	1	09/19/16	09/19/16							
ForeSite												
5	Submit JOC Proposal	1	1	08/11/16	08/11/16							
50	Send signed agreement	1	1	09/16/16	09/16/16							
60	Write Agreements	5	5	09/20/16	09/26/16							
Procurement												
Area Wide												
City of Tempe												
70	Long Lead ABB Equipment Approval	5	5	09/27/16	10/03/16							
93	Submittal Approval	10	10	10/18/16	10/31/16							
ForeSite												
75	Obtain & review long lead ABB Equipment	5	5	09/20/16	09/26/16							
92	Obtain Other Submittals	15	15	09/27/16	10/17/16							
80	Return of Submittals	1	1	10/04/16	10/04/16							
85	Order ABB Equipment	80	80	10/05/16	01/25/17							
90	Misc Material Procurement	15	15	11/01/16	11/21/16							
Construction												
Area Wide												
City of Tempe												
91	JGM Maintenance Shutdown	45	45	01/04/17	03/07/17							
213	Punch Walk	1	1	02/15/17	02/15/17							
ForeSite												
108	Approve MOP	15	15	01/03/17	01/23/17							
105	Mobilization	4	4	01/17/17	01/20/17							
103	Set up Temp Generators	3	3	01/20/17	01/24/17							
113	Power Shutdown	1	1	01/25/17	01/25/17							
123	Sawcut, Demo and Trench	3	3	01/26/17	01/30/17							
143	Install New ABB Gear	4	4	01/27/17	02/01/17							
153	Modify Switchgear 1 Section	1	1	02/02/17	02/02/17							
163	Install Cabling	3	3	02/03/17	02/07/17							
148	Backfill and Patch Trench	3	3	02/08/17	02/10/17							
173	Terminations	1	1	02/08/17	02/08/17							
183	Test all Cable and Gear	1	1	02/09/17	02/09/17							
193	Shutdown to Return to Normal Power	1	1	02/10/17	02/10/17							
203	Remove Generators	2	2	02/13/17	02/14/17							
223	Complete Punch List	3	3	02/16/17	02/20/17							
233	Turn over to City of Tempe	0	0		02/20/17							



Start Date: 07/15/16
 Finish Date: 03/07/17
 Data Date: 08/11/16
 Run Date: 08/12/16

JGM Switchgear Improvements
 Proposal Schedule



EXHIBIT B

SWITCHGEAR IMPROVEMENTS JOHNNY G. MARTINEZ WATER TREATMENT PLANT PROJECT NO. 3207142

SUPPLEMENTAL CONDITIONS AND TECHNICAL SPECIFICATIONS

Prepared For:



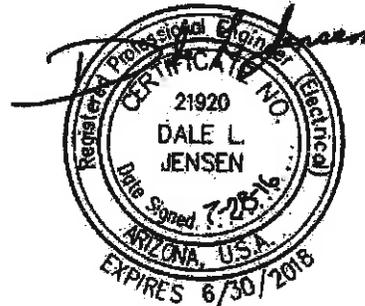
City of Tempe
ARIZONA

Prepared By:

Burgess & Niple, Inc.



EXPIRES 3-31-2017



EXPIRES 6/30/2018

July 28, 2016

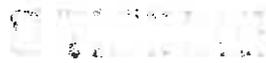


TABLE OF CONTENTS
Switchgear Improvements
Project No. 3207142

Description	Section
<i>Division 01 – General Requirements</i>	
Summary of Work	01 11 00
Work Restrictions	01 14 00
General Contractor Conducted Project Meetings	01 31 19.02
Submittals (Standard)	01 33 00
Materials and Equipment	01 60 00
Start-up Demonstration & Training	01 79 00
<i>Division 02 – Existing Conditions (Demolition, Landfills and Remediation)</i>	
Demolition	02 41 00
<i>Division 16 –Electrical</i>	
Common Work Results for Electrical	26 05 00
Medium Voltage Cables	26 05 13
Low Voltage Electrical Power Conductors and Cables	26 05 19
Grounding and Bonding for Electrical Systems	26 05 26
Hangers and Supports for Electrical Systems	26 05 29
Raceway and Boxes for Electrical Systems	26 05 33
Overcurrent Protective Device Coordination Study	26 05 73
Medium Voltage Metal-Clad Switchgear	26 13 19

SECTION 01 11 00

SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. **General.** Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1, and all related specification sections, apply to this section.

1.2 DESCRIPTION OF WORK

- A. **General.** Provide all labor, materials, tools, and equipment necessary to construct the project in accordance with the plans and as specified herein.
- B. **The project consists of improvements at the City of Tempe Johnny G. Martinez Water Treatment Plant (JGMWTP) as shown on Contract Documents prepared by Burgess & Niple, Inc, dated June 28, 2016.**
- C. **The work consists of** The existing 4160V power to the plant is supplied through switchgear no.1. This switchgear is equipped with two switches, one main and one generator switch, which operate as a transfer switch. This switchgear in turn feeds existing switchgear no.4, which distributes power to the plant through branch circuits. Switchgear no.1 is at the end of its useful life and requires removal or replacement. This project eliminates this switchgear by relocating the connection of the generators to the existing switchgear no.4 and creating a transfer switch with the main of this switchgear.

The scope is to provide a new switching section connected to the end of the existing switchgear no.4 for the connection of the standby generators. This switch will be interconnected with the main switch on this switchgear for automatic transfer of power to the generators upon utility power failure. This work includes all new conductors from the existing generator building to the new switch, new control conduit and conductors, reconfiguring of the main switch, and fully testing the operation of the new switch and the transfer operation of the two switches.

Remove the existing generator switch and main switch in existing switchgear no.1 and reconnect the conductors to the bus. This panel becomes a junction box with no operable devices.

Provide temporary rental generators for critical loads throughout the facility to provide power while work on the switchgears is taking place. These generators will be monitored 24 hours per day.

1.3 QUALITY ASSURANCE

- A. **Codes and Standards.** Perform all work in compliance with all federal, state, and local codes.

1.4 SUBMITTALS

- A. **Submittal Requirements.** See other Division 1 sections for required administrative submittals and for procedures necessary for transmittal of submittals.

1.5 JOB CONDITIONS

Not used.

1.6 DELIVERY, STORAGE, AND HANDLING

Not used.

1.7 SPECIAL WARRANTY

Not used.

1.8 WORK UNDER OTHER CONTRACTS

Not used.

1.9 PREORDERED PRODUCTS

- A. Not used.

1.10 OWNER FURNISHED ITEMS

- A. Not used.

1.11 MISCELLANEOUS PROVISIONS

Not used.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

SECTION 01 14 00

WORK RESTRICTIONS

PART 1 - GENERAL

- 1.1 **RELATED DOCUMENTS.** Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1, and all related specification sections, apply to this section.
- 1.2 **DESCRIPTION OF WORK.** Provide the labor, materials, tools, and equipment necessary, temporary or permanent, required to construct the project and improvements in accordance with the drawings and specifications, including the work restrictions specified herein.
- 1.3 **QUALITY ASSURANCE (Not used)**
- 1.4 **SUBMITTALS. Submit the following** submittal package in accordance with the Division 1 Submittal Requirements.
 - A. **Submittal Package No. 1 – Written Notice**
 1. **Schedule.** Submit a written notice 72 hours in advance of any cut-in that requests consent to proceed, including:
 - a. Identification of project.
 - b. Description of affected work and work areas of the facility.
 - c. Effect on other work and on structural integrity and safety of the project.
 - d. Description of the proposed work including:
 - 1) Scope of connection.
 - 2) Contractor and trades to execute work.
 - 3) Products proposed to be used.
 - 4) Extent of refinishing.
 - 5) Schedule of operations including required downtime for any of the Owner's facilities, starting time, duration, and completion.
- 1.5 **JOB CONDITIONS**
 - A. **General Requirements.** It is imperative that existing facilities remain functional during the construction unless noted otherwise in the Contract Documents.

B. Coordination

1. Coordinate the work of all subcontractors, crafts, and trades engaged in the work.
2. The General Contractor will coordinate the work of all Contractors on-site.

C. Site Accessibility

1. Keep driveways and entrances clear and available to the Owner at all times.
2. Only use designated areas for parking or storage.
3. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

D. Noise, Dust, and Odor Control

1. Conduct all construction activities to minimize all unnecessary noise, dust, and odors.
2. Do not use oil, or other materials which may cause tracking, to control dust.

E. Specific Requirements

1. Meet with the Engineer/Architect and Owner to determine which systems or facilities must be maintained in use or operation and to determine the acceptable timing of shutdowns.
2. The Owner has the authority to stop or prohibit work which would interfere with or jeopardize the continuous operation of the facility.

1.6 **DELIVERY, STORAGE, AND HANDLING** (Not used)

1.7 **SPECIAL WARRANTY** (Not used)

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification

1. Confirm all requirements, conditions, dimensions, and time intervals prior to beginning actual construction in any given area.
2. Confirm that the conditions have not changed since preparation, submission, and approval of the shut down plan.
3. Notify the Owner and Engineer/Architect prior to commencing the connection if the proposed work is incompatible or incomplete.

3.2 REQUIREMENTS

A. Sequences and Interferences

1. Since alterations, additions, and tie-ins are included in this work that potentially could interfere with the existing facilities' function, take any and all steps necessary to avoid this interference.
2. Complete as much work as possible before making tie-ins or switchovers.
3. Install and start-up new components prior to removal of the existing components from service.
4. Install and maintain temporary parallel components until service is restored.
5. When interferences are unavoidable by the above methods, take the following additional steps:
 - a. Schedule the work so as to minimize the time interval and/or frequency that any critical facility or component is out of service.
 - b. Coordinate all labor, materials, and equipment to be on the site at the start of a shutdown.
 - c. Work continuously (24 hours per day, 7 days per week) until service is restored.
 - d. Schedule the work to correspond with minimum demands on any system or facilities. This may include weekend or evening work.
 - e. Notify the Owner in writing 72 hours in advance of a shutdown so that the Owner can make the necessary preparations.
 - 1) Signed Notice. Each written notice must be signed by the Owner and Engineer/Architect prior to the start of work.
 - 2) Notify all utility companies whose equipment and facilities are directly involved with the proposed work prior to the start of work. Coordinate all work with the utility companies.
 - 3) Notify the Owner when connection has been completed and normal operations can resume.
 - f. Shutdown Time.
 - 1) Allow for a minimum of 7-day window (float time) per shutdown when assembling connection schedule.

Owner will use this window only to maintain or ensure continuous plant operation during critical operating conditions.

- 2) If the scope of the connection requires the shutdown of all or part of the facility, work continuously around the clock to complete the connection and return the facility to normal operations.

B. Construction Compliance

1. The Owner will judge the practicality of compliance with this specification in any given situation.
2. The Owner will approve the shutdown plan in the written notice only. Any deviations from the proposed plan will require further review and approval.
3. Furnish all labor, equipment, and materials, temporary or permanent, required for compliance at no additional cost to the Owner.

C. Coordination. Coordinate and schedule the activities of subcontractors and utility work forces with the Owner. The following list of interconnections and sequencing requiring special coordination is provided for the Contractor's convenience. Do not consider this list complete; any omissions of interconnections or sequencing from this list shall not relieve the Contractor of his responsibility.

1. Each Contractor and subcontractor shall coordinate installation of materials and equipment so as to not interfere with the work of other Contractors or subcontractors. Where interferences are anticipated, they shall be brought to the attention of the General Contractor for resolution, which shall be subject to approval by the Engineer/Architect.
2. Each Contractor and subcontractor shall locate and install embedded materials before concrete is poured and shall do so as directed by the General Contractor and shown in an approved shop drawing.
3. No extra compensation will be allowed to cover the cost of removing piping, conduit, ducts, etc., or equipment due to a lack of coordination or communication between Contractors and subcontractors.
4. Each Contractor or subcontractor shall be responsible for coordinating and scheduling the activities of their subcontractors and utility work forces with the General Contractor.
5. Maintain all approved schedules, sequences of construction, copies of communications of all coordination, and other information as required at the construction site.
6. Designate a single point of coordination in one responsible individual.

D. Existing Units. The Owner's personnel shall operate all existing valves, gates, and equipment required for the work to be completed.

END OF SECTION

SECTION 01 31 19.02

PROJECT MEETINGS

PART 1 - GENERAL

- 1.1 **RELATED DOCUMENTS.** Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 specification sections, apply to this section.
- 1.2 **DESCRIPTION OF WORK**
- A. **General.** Provide the labor and materials necessary to attend, conduct, and participate in project meetings in accordance with the plans and specifications.
- B. **Conferences and Meetings.** This section specifies administrative and procedural requirements for project meetings including but not limited to:
1. Preconstruction conference.
 2. Progress meetings facilitated by the General Contractor.
- 1.3 **QUALITY ASSURANCE** (Not used)
- 1.4 **SUBMITTALS**
- A. **General.** Submit all submittals in accordance with the Division 1 Submittal Requirements and the requirements within this specification section.
- B. **Submittal Package No. 1 – Progress Meeting Minutes**
1. Monthly progress meeting minutes.
- 1.5 **JOB CONDITIONS** (Not used)
- 1.6 **DELIVERY, STORAGE, AND HANDLING** (Not used)
- 1.7 **SPECIAL WARRANTY** (Not used)

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

- 3.1 **PRECONSTRUCTION CONFERENCE**
- A. **Schedule.** The Engineer/Architect will schedule and conduct a preconstruction conference and organizational meeting at the project site or other convenient location after execution of the agreement and prior to commencement of construction activities. No work shall commence prior to the meeting.
- B. **Attendees.** The Owner, Engineer/Architect and their consultants, the Prime Contractors and their superintendents, major subcontractors, manufacturers, suppliers, and other concerned parties shall each be represented at the

conference by persons familiar with and authorized to conclude matters relating to the work.

C. **Agenda.** Discuss items of significance that could affect progress including such topics as:

1. Tentative construction schedule.
2. Critical work sequencing.
3. Designation of responsible personnel.
4. Procedures for processing field decisions and Change Orders.
5. Procedures for processing Applications for Payment.
6. Distribution of Contract Documents.
7. Submittal of shop drawings, product data, and samples.
8. Preparation of record documents.
9. Use of the premises.
10. Office, work, and storage areas.
11. Equipment deliveries and priorities.
12. Site safety.
13. Security.
14. Housekeeping.
15. Working hours.
10. Others as appropriate.

D. **Minutes.** Within 7 days of the preconstruction meeting, the Engineer/Architect will distribute minutes to all attendees.

3.2 PROGRESS MEETINGS

A. **Schedule**

1. The General Construction Contractor will conduct regularly scheduled progress meetings at the project site on a monthly basis.
2. Provide sufficient notice so that the Owner and Engineer/Architect can attend these meetings.
3. Coordinate dates of meetings with preparation of the monthly payment requests.
4. Contractor can request to schedule more or fewer meetings depending on the current construction activities.

B. **Attendees.** In addition to representatives of the Owner, Engineer/Architect, and all Prime Contractors, each subcontractor, supplier, or other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings by persons familiar with the project and authorized to conclude matters relating to progress.

C. **Agenda.** Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the current status of the project.

1. Contractor's Construction Schedule.

- a. Review progress since the last meeting.
 - b. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead of or behind schedule.
 - c. Determine how construction behind schedule will be expedited.
 - d. Secure commitments from parties involved to do so.
 - e. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the contract time.
2. Review the present and future needs of each entity present, including such items as:
- a. Interface requirements.
 - b. Completion times.
 - c. Preferred sequences.
 - d. Delivery schedule.
 - e. Off-site fabrication problems.
 - f. Access issues.
 - g. Site utilization.
 - h. Temporary facilities and services.
 - i. Hours of work.
 - j. Hazards and risks.
 - k. Housekeeping.
 - l. Quality and work standards.
 - m. Change Orders.
 - n. Documentation of information for payment requests.
- D. **Schedule Updating.** The General Construction Contractor shall revise the construction schedule after each progress meeting and issue the revised schedule concurrently with the meeting minutes.
- E. **Minutes.** Within 7 days of the progress meeting, the Contractor will distribute minutes to all attendees.

END OF SECTION

SECTION 01 33 00

SUBMITTALS

PART 1 - GENERAL

- 1.1 **RELATED DOCUMENTS.** Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1, and all related specification sections, apply to this section.
- 1.2 **DESCRIPTION OF WORK**
 - A. **Scope of Work.** Provide all labor and materials necessary to furnish the following submittals as required by each individual section of the specifications.
 1. Shop drawings.
 2. Product data.
 3. Samples/mock-ups.
 4. Operation and Maintenance (O&M) manuals.
 5. Personnel qualifications.
 6. Training documents.
 7. Source quality control documents.
 8. Material field test reports.
 9. Start-up documents.
 10. Operational demonstration documents.
 11. Product/material certifications.
 12. Special warranties.
 13. Project record documents.
 14. Others (as specified in the individual technical specifications).
- 1.3 **QUALITY ASSURANCE** (Not used)
- 1.4 **SUBMITTALS**
 - A. **General.** Submit all submittals in accordance with the requirements within this specification section.
 - B. **Submittal Package No. 1 – Submittal Schedule**
 1. Submit a submittal schedule according to paragraph 2.05 of Section 00 70 00, "General Conditions."
 - a. This schedule shall include all submittals (including all Prime Contractors' submittals) that are required to be used on the project, and the date of submittal to the Engineer/Architect.
 - b. Include in schedule a milestone for notification of the Engineer/Architect prior to field-verifying operation and maintenance manuals.
 - c. Submittals requiring multiple submissions shall include multiple listings on the documents.

- d. The Engineer/Architect will review the list and make any necessary comments.
- e. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
- f. Coordinate transmittal of different types of submittals for related elements of the work so processing will not be delayed by the need to review submittals concurrently.
- g. Multiple Prime Contracts. Allow time in schedule for all submittals to go through the Prime General Contractor for coordination purposes before they are forwarded to the Engineer/Architect.
- h. Processing. Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals, depending upon the complexity of the submittal.
 - 1) Allow 2 weeks for processing each submittal.
 - 2) No extension of the Contract Time will be authorized because of failure to transmit submittals to the Engineer/Architect sufficiently in advance of the work to permit processing.

1.5 **JOB CONDITIONS** (Not used)

1.6 **DELIVERY, STORAGE, AND HANDLING**

- A. **Store and protect large samples and mock-ups** until the Project is completed, then properly dispose of off-site.
- B. **Maintain and make available** to the Engineer/Architect, at the job site, a complete file of all approved submittals as part of the project record documents.

1.7 **SPECIAL WARRANTY** (Not used)

PART 2 - PRODUCTS

2.1 **SUBMITTAL TRANSMITTAL**

- A. **Transmit each submittal** from the Contractor to Engineer/Architect using a transmittal form. Include the following on the transmittal form.
 - 1. Relevant information and requests for data.
 - 2. Deviations from Contract Document requirements, including minor variations and limitations.
 - 3. The specification section number.

4. Other pertinent information to identify the items being submitted.

2.2 GENERAL REQUIREMENTS FOR SUBMITTALS

A. Originals

1. The Contractor, the subcontractors, or suppliers shall generate submittal information.
2. No reproductions of partial (or complete) versions of the plans, sections, details, schematics, specification pages, etc., from the Contract Documents are acceptable.

B. Complete Submittals. Clearly describe the equipment to be furnished with complete and detailed submittal information.

C. Identification. Properly identify all submittal-related documents and arrange in a logical order to best present the information. Provide an index that includes the following on every submittal.

1. Manufacturer's name and address.
2. Submittal date and revision number, if applicable.
3. Contract identification and specification section.
4. Drawing scale and orientation.
5. Submittal page number or sequence of pages.
6. Drawing number.

D. Verification

1. Where existing conditions or structures exist, field-verify dimensions, elevations, clearances, etc.
2. The submittal shall not be accepted for review until such verified data is clearly indicated.

E. Legends

1. All submittal diagrams, drawings, schematics, etc., shall include complete keys, legends or similar explanation as to the graphics, and symbols and abbreviations used.
2. In general, all graphics, symbols, abbreviations, and equipment nomenclature used for a submittal shall duplicate those used on the Contract Drawings.

F. Approvals. Provide the following on each submittal.

1. A space approximately 4" x 5" on to record the Contractor's review and approval markings and the action taken. These shall include the Contractor's:
 - a. Approval stamp.
 - b. Signature.
 - c. Date of approval.

- d. Deviations from the Contract Documents.
- 2. An equal area beside the Contractor's review and approval markings for the Engineer/Architect's review stamp.
- G. **One Section per Submittal.** Each submittal shall pertain to only one specification section.
- H. **All submittal information shall be:**
 - 1. Neatly arranged.
 - 2. Legible.
 - 3. Not distorted or faded.
 - 4. English.
 - 5. In United States standard units.
 - 6. Typed.
- I. **All letters, certifications, and similar documents** shall be submitted in their entirety. Single pages of multiple-page letters, or letters with deleted passages will not be acceptable for submittal purposes.
- J. **"Generic" letters, test reports, material certifications, or similar documents** which do not specifically address the requirements of the Contract Documents for the actual materials being furnished will not be acceptable.
- K. **Mark all submittals** to clearly indicate the full extent of the equipment to be furnished.
 - 1. Indicate all options to be provided, materials of construction, dimensions, and other information pertinent to the submittal.
 - 2. Options, materials, and dimensions which do not pertain to the materials or equipment to be furnished shall be neatly marked out so as to avoid confusion and doubt during review, delivery, and installation.
- L. **Resubmittals must clearly identify** all changes and revisions.
 - 1. The drawing shall be marked "revised" with the revision date indicated.
 - 2. Each resubmittal shall reference the previous submittal by the Engineer/Architect's log number.
- M. **"By Others"**
 - 1. All submittals are reviewed as if prepared by the Prime Contractor.
 - 2. The term "By Others" is appropriate to indicate supply by the Owner or another Prime Contractor.
 - 3. Where a subcontractor or supplier uses the term "By Others" to indicate work by the Prime Contractor or another subcontractor or supplier, the Prime Contractor shall change "By Others" to indicate the actual source.
- N. **Deviations from Contract.** Highlight, encircle, or otherwise indicate deviations from the Contract Documents in all submittals.

2.3 SPECIFIC SUBMITTAL-TYPE REQUIREMENTS

A. **Shop Drawings.** The following paragraphs detail the general requirements for shop drawings and specific requirements for specific types of shop drawings.

1. General Requirements.

a. A shop drawing is a detailed representation of the work to be performed to demonstrate compliance with the Contract Drawings including:

- 1) Material and equipment layout.
- 2) Fabrication drawings.
- 3) System and electrical schematic diagrams.
- 4) Equipment and material schedules.
- 5) Installation details.

b. Submit newly prepared information, drawn to accurate scale.

c. Standard information prepared without specific reference to the project is not considered shop drawings.

2. Equipment/Material Layout Drawings.

a. Include:

- 1) Plot plans.
- 2) Plant site maps.
- 3) Equipment location plans.
- 4) Equipment and material layout plans and sectional views.
- 5) Connection detail drawings.
- 6) Similar drawings showing the incorporation of materials and equipment into the work.
- 7) The physical layout to scale, including elevations, plant grid coordinates, dimensions to new/existing structures, and other items of the work.
- 8) Dimensions.
- 9) Labeling.
- 10) Notes.
- 11) Legends.
- 12) Bills of materials.
- 13) All other information required to graphically describe the proposed work.

3. System Schematics and Diagrams.

a. These include schematic representations of systems and equipment in a manner which shows the relative relationship of the components within the system and interconnections or interfaces with other systems or equipment.

- b. These systems shall be shown on the most appropriate type and format of schematic diagram.
- c. Diagrams shall identify all equipment and other components.
- d. Indications shall be provided of system features such as flow directions, flow ranges, component sizes, capacities, settings, interlocks, component identification, and component or subsystem function.
- e. Various types of systems for which schematic diagrams shall be required include:
 - 1) Process Piping Systems.
 - 2) Plumbing and Utility Piping Systems.
 - 3) Heating and Air Conditioning Systems.
 - 4) Ventilating Systems.
 - 5) Pneumatic Systems.
 - 6) Hydraulic Systems.
 - 7) Conveying Systems.
 - 8) Process and Chemical Feed Equipment Systems.
 - 9) Electrical Distribution Systems.
 - 10) Control Systems.
 - 11) Alarm Systems.
 - 12) Communication Systems.
- f. In some instances it may be appropriate to combine multiple types of system schematics onto a single drawing. In general, this practice would be appropriate for simple, self-contained systems and the adjacent subsystems and when required to clearly show system functionality.

B. Product Data. Product data is submittal information that fully describes the item to be incorporated into the work. Product data shall include when applicable:

- 1. Manufacturer name.
- 2. Catalog cut-sheets.
- 3. General descriptive bulletins/brochures/specifications.
- 4. Materials of construction data and parts list.
- 5. Finish/treatment data.
- 6. Equipment/material weight/loading data.
- 7. Power/utility requirements.
- 8. Engineering design data, calculations, and system analyses.
- 9. Digital system documentation.
- 10. Any deviations from the contract documents.
- 11. Material Certifications. These include signed certificates or declarations by the Contractor, supplier, manufacturer, testing laboratory, or recognized certification agency which document that materials and

product composition or construction comply with specified requirements and stated reference standards.

12. Manufacturer's printed recommendations.
13. Compliance with recognized trade association and testing agency standards.
14. Application of testing agency labels and seals.
15. Notation of dimensions verified by field measurement.
16. Notation of coordination requirements.
17. Specific response to detailed specification requirements.
18. Maximum operating pressure and temperature ratings.
19. Other information specifically called for under the sections of Divisions 1 through 44 shall be included in this category.

C. Samples or Mock-Ups

1. **Samples.** Samples are portions of or complete units of the precise article proposed to be furnished.
2. **Color and Pattern Charts.** When the precise color and pattern are not specifically prescribed in the Contract Documents, or when the Contract Documents require that a product be furnished in a color or pattern directed by the Owner or Owner's Representative, submit accurate color charts and pattern charts of the available ranges for review and selection.
3. **Mock-Ups.** Build mock-ups with full-size products to match the scale of the proposed construction to demonstrate compliance with specified requirements and construction standards.

D. O&M Manuals

1. **General.**
 - a. Bind each copy in an appropriately sized three-ring notebook a cover designating the name of equipment, maintenance, and specification section number.
 - b. Bind operation and maintenance instructions for each specification section in a separate notebook.
2. **Required Information.** Include the following information to provide a description of the incorporation of the equipment into the work and with functional data to evaluate equipment operation.
 - a. **Operation Sequence Descriptions.** These shall:
 - 1) Include complete, detailed written descriptions of the operating sequence of all control systems and operations in all modes.
 - 2) Be specifically prepared for this work.
 - 3) Be fully referenced to control diagrams and system components.
 - 4) Include start-up and shut-down procedures and operations under manual, automatic, and emergency (alarm) conditions and any alternate operating modes.

- 5) Include operation of switches, lights, timers, relays, contacts, valves, motors, and equipment components.
 - 6) Describe interlock functions including system safety functions.
- b. Software/Programming Documentation.
- 1) Reference this documentation to the Operating Sequence Descriptions and include flow charts, program source codes listings, and documentation ladder diagrams with detailed descriptions for each rung of the software provided.
 - 2) Provide information to instruct and to familiarize the operator with the system programming to enable a step-by-step evaluation of the program.
 - 3) Provide notations, remarks, and labeling on the program source code listing to indicate the program operation and function.
 - 4) Provide any additional narrative description of the program operation to fully describe the system parameters and functionality in a clear and logical manner.
- c. Manufacturer's Instructions. Include:
- 1) Installation, routine preventive maintenance, troubleshooting, and lubrication instructions.
 - 2) Procedures for moving, supporting, and anchoring of equipment, including tolerances for settings and adjustment.
 - 3) Storage requirements to protect products prior to installation and during periods of prolonged shutdown.
 - 4) Storage requirements of extra materials.
- d. Parts List. Include assembly, exploded-view illustrations, or sectional drawings with all parts identified. Also include descriptions, quantity (per assembly) required, and original equipment manufacturer's part numbers.
- e. Supplier Data. Provide addresses, telephone numbers, and names of contact persons for equipment manufacturer and manufacturer's representative. Include both regional (local) and home offices.
- f. Warranties and Guarantees. Include copies of the approved draft warranties in the initial operation and maintenance manual submittal. Following substantial completion, provide copies of the executed final warranties for insertion into the final operation and maintenance manuals.

- g. Approved Submittals. Provide a complete list (including submittal numbers) of all approved submittals pertaining to the operation and maintenance instructions.
- h. Copies of all materials shipped with the equipment.
- i. Copies of all approved submittals including control wiring diagrams.

E. Personnel Qualifications

- 1. General. These qualification statements and information pertain to personnel and entities employed in the prosecution of the work.
- 2. Specific Information. Provide the following information regarding the proposed personnel or entity.
 - a. Education/training.
 - b. Company employment history.
 - c. Professional experience.
 - d. References.
 - e. Certifications or licenses.

Stated qualifications shall be pertinent to the specific task for which qualifications are requested.

F. Source Quality Control Documents

- 1. Inspection.
 - a. Inspection data includes inspection procedures and results of factory inspections of products, equipment, or systems.
 - b. Within this type of submittal information are factory witness test procedures, schedules and reports, and similar data.
- 2. Testing.
 - a. Test data is the information leading to or resulting from tests performed on materials, equipment, or systems at the manufacturer's facilities or in testing laboratories.
 - b. This also includes data on testing equipment.
 - c. Examples of test data include all information, test arrangement, drawings, illustrations, diagrams, curve plots, graphs, and other data which substantiates or establishes a material or product characteristic, quality, or other trait as a result of test required by the Contract Documents.

G. Material Field Test Reports

- 1. Report Data. Written reports of each inspection, test, or similar service shall include, but not be limited to:

- a. Date of issue.
 - b. Project title and number.
 - c. Name, address, and telephone number of testing agency.
 - d. Dates and locations of samples and tests or inspections.
 - e. Names of individuals making the inspection or test.
 - f. Designation of the work and test method.
 - g. Identification of product and specification section.
 - h. Complete inspection or test data.
 - i. Test results and interpretations of test results.
 - j. Ambient conditions at the time of sample taking and testing.
 - k. Comments or professional opinion as to whether inspected or tested work complies with Contract Document requirements.
 - l. Name and signature of laboratory inspector.
 - m. Recommendations on testing.
2. Example reports covered by this paragraph include compaction tests and concrete, leakage, and disinfection tests.

H. Start-Up Documents

Start-Up Request. Start-up requests shall include the following:

- a. Qualifications of Manufacturer's Representative. See paragraph 2.3 E.
 - b. Field Test Procedures.
 - 1) List of materials and equipment necessary for testing.
 - 2) Calibration. Certification of calibration of all test instruments used.
 - 3) Test Form Report. Copy of testing results report form.
 - c. Proposed start-up schedule including all field testing.
2. Manufacturer's Representative's Reports.
- a. Each manufacturer's representative shall prepare a report on every site visit for each system or item of equipment inspected, adjusted, started up, or worked on.
 - b. If a manufacturer's representative visits the site for equipment specified in several specification sections, a separate report shall be filed for each specification section.
 - c. The report shall state:
 - 1) The purpose of the visit.
 - 2) The representative's observations and conclusions.

- 3) Recommendations for further visits or action.
- 4) A tabulation or log of the settings of all adjustable components.
 - a) Initial settings shall be recorded and submitted on the first visit.
 - b) During subsequent visits, the manufacturer's representative shall add the current or adjusted setting to the tabulation or log.
- 5) Include manufacturer's certification that equipment being tested has been inspected with regard to conformance to the plans, specifications, and shop drawings and that it has been tested and is ready for operational demonstration.
- 6) All test reports for all required field testing.

I. Special Warranties

1. Manufacturer's Express Warranties.

- 1) These are formal statements of certifications by manufacturers which warrant to the Owner that products and equipment are free from defects in material and workmanship.
 - 2) These are standard warranties issued with products and equipment which supplement the Contractor's warranty and may also extend coverage past the expiration of the Contractor's warranty.
 - 3) Include with the manufacturer's warranty data shall be a notification of the availability of an extension to the standard warranty including terms.
2. Term or Period. Unless otherwise established by individual sections in Divisions 2 through 44, all Contractor express warranties shall extend for 1 calendar year from the date of substantial completion of the project or acceptance date of the product or portion of work thereof, whichever is the later date.
3. Content of Warranty. The warranty shall contain, as applicable:
- a. Effective starting date of the warranty period.
 - b. Statement of the terms and conditions of the warranty, if any.

J. Project Record Documents

1. Project record documents are to be in accordance with paragraph 6.12 of Section 00 70 00, "General Conditions."

2. Record Contract Drawings. Legibly mark contract drawings to record actual construction including:
 - a. Depths of various elements of foundation in relation to data.
 - b. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
 - c. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
 - d. Field changes of dimension and detail.
 - e. Changes made by change order or field order.

K. Extra Materials/Spare Parts

1. Coat or package extra materials to prevent corrosion or deterioration during long-term indoor storage.
2. Clearly label all packaging with:
 - a. Part name.
 - b. Part number.
 - c. Associated equipment name and number.
 - d. Manufacturer's name and address.
 - e. The required storage environment for the materials.

- L. **Other.** These include special tools/repair parts list, photographs, videos, certificates, construction schedules, drawings, reports, meeting minutes, data, and information required by the Contract Documents which do not logically fall into the submittal types defined above.

PART 3 - EXECUTION

3.1 SUBMITTAL PREPARATION AND TRANSMITTAL

A. Coordination

1. Coordinate preparation and processing of submittals with performance of construction activities.
2. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay and in accordance with the submittal schedule.
3. Submittals shall be made electronically and shall be submitted to the Owner and the Engineer.

B. Verification

1. Verify the correctness and completeness of all submittals prior to forwarding same for review.
2. All submittals shall comply with the Contract Documents.

- C. **Package each submittal** appropriately for transmittal and handling including a transmittal form.
- D. **The Prime General Contractor shall submit** the minimum number of submittals as listed in paragraph 3.3 of this specification.
- E. **Submittals received from sources** other than the Prime General Contractor will be returned without action.
- F. **All submittals** shall be made by the Prime General Contractor.

3.2 ENGINEER/ARCHITECT'S REVIEW AND ACTION

A. General

1. Except for submittals for record, information, or similar purposes where action and return is not required or requested, the Engineer/Architect will review each submittal, mark to indicate action taken, and return promptly.
2. Cost to review any submittal more than twice will be deducted from Contractor's monthly estimates and final payments.
3. The Engineer/Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Action Stamp. The Engineer/Architect will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate action taken.

1. **Final Unrestricted Release.** Where submittals are marked "Approved," that part of the work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
2. **Final-but-Restricted Release.** When submittals are marked "Approved as Noted," that part of the work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.

3. Returned for Resubmittal.
 - a. When submittal is marked "Not Approved" and/or "Revise and Resubmit," do not proceed with that part of the work covered by the submittal, including purchasing, fabrication, delivery, or other activity.
 - b. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
 - c. Do not permit submittals marked "Not Approved" and/or "Revise and Resubmit" to be used at the project site or elsewhere where work is in progress.

3.3 MINIMUM NUMBER OF SUBMITTALS AND DISTRIBUTION

- A. **After a submittal has been approved**, the Engineer/Architect will make the following distribution:

Contractor submittals shall be made electronically and provided to both the Owner and Engineer. Reviewed submittals shall be returned electronically.

- B. **Multiprime Contract Distribution.**

1. The Engineer/Architect will forward all reviewed submittals to the Owner for delivery to the Prime General Contractor only.
2. The Prime General Contractor is then responsible to send each submittal to every subcontractor that it affects for their use.

3.4 SPECIFIC SUBMITTAL-TYPE EXECUTION REQUIREMENTS

A. O&M Manuals

1. **Submittal Procedure.** Submit one initial copy of the O&M manual for review. After approval of the initial copy, submit the remainder of the revised manuals.
2. **Verification.** Verify the accuracy of the initial O&M manual by visual and physical inspection of the installed equipment during start-up.
 - a. Perform field verification in the presence of the Owner or Owner's Representative.
 - b. Physically trace and document as required all wiring and piping.
 - c. Visually inspect equipment and components and compare configurations and nameplate information to O&M manual.
 - d. Make any changes, additions, or deletions to the O&M manual identified during field verification.
 - e. In the event changes are made to the equipment following field verification, submit a final supplement of the revisions of the O&M manuals before approval.

B. Sample Panels

1. Construct any required sample panels on-site.
2. Construct sample panels only after the individual samples and components used in the sample panel have been approved.
3. If a sample panel does not conform to the Contract requirements, construct additional ones until conformance is achieved.

- C. **Samples for Tests.** Furnish samples of material as may be required for examination and test. Take all samples of materials for tests according to standard methods or as provided in the Contract Documents.

END OF SECTION

SECTION 01 60 00

MATERIALS AND EQUIPMENT

PART 1 - GENERAL

- 1.1 **RELATED DOCUMENTS.** Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1, and all related specification sections, apply to this section.
- 1.2 **DESCRIPTION OF WORK.** Transport and handle materials and equipment in accordance with the manufacturer's recommendations and requirements of Contract Documents. Make all arrangements for transportation, delivery, storage, and handling of equipment and materials required for prosecution and completion of the work.
- 1.3 **QUALITY ASSURANCE** (Not used)
- 1.4 **SUBMITTALS** (Not used)
- 1.5 **JOB CONDITIONS** (Not used)
- 1.6 **DELIVERY, STORAGE, AND HANDLING**
 - A. **Delivery**
 1. Deliver shipments of materials and equipment to the site only during regular working hours.
 2. Shipments shall be addressed and consigned to the proper party giving name of Contract, street number, and city.
 3. Shipments shall not be delivered to the Owner or Owner's Representative, except as otherwise directed.
 4. Transportation shall be in accordance with Part 3 of this section.
 - B. **Storage and Handling**
 1. Store, handle, and protect materials in accordance with the manufacturer's recommendations and the requirements of Part 3 of this section.
 2. Maintain equipment in an undeteriorated and fully serviceable condition and as specified in Part 3 of this section.
- 1.7 **SPECIAL WARRANTY** (Not used)

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.1 TRANSPORTATION

- A. **General.** Arrange deliveries of products in accordance with the construction schedule and in ample time to facilitate inspection prior to installation.

B. Coordination

1. Coordinate deliveries to avoid conflict with work and conditions at site and to accommodate the following:
 - a. Work of other contractors.
 - b. Limitations of storage space.
 - c. Availability of equipment and personnel for handling products.
 - d. Owner's use of premises.
2. Do not have products delivered to project site until related shop drawings have been approved.
3. Do not have products delivered to site until required storage facilities have been provided.
4. Have products delivered to site in manufacturer's original, unopened, labeled containers. Keep Engineer/Architect informed of delivery of all equipment to be incorporated in the work.

C. Inspection. Immediately upon delivery, inspect shipment to ensure that:

1. Product complies with requirements of Contract Documents and reviewed submittals.
2. Quantities are correct.
3. Containers and packages are intact and labels are legible.
4. Products are properly protected and undamaged.
5. Damaged products are rejected and removed from the site.

3.2 HANDLING

A. Methods

1. Provide equipment and personnel necessary to handle products without soiling or damaging products or packaging.
2. Lift heavy components only at designated lifting points.
3. Handle materials and equipment at all times in a safe manner and as recommended by manufacturer or supplier so that no damage will occur to them.
4. Do not drop, roll, or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.
5. Keep interiors completely free of dirt and foreign matter.

3.3 STORAGE AND PROTECTION

A. General

1. Make all arrangements and provisions necessary for the storage of materials and equipment.

2. Place all excavated materials, construction equipment, and materials and equipment to be incorporated into the work so as not to damage anything.
3. Keep materials and equipment neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants, and occupants.
4. Arrange storage in a manner to provide easy access for inspection.

B. Storage Areas

1. Areas available on the construction site for storage of material and equipment shall be as approved.
2. Store materials and equipment which are to become the property of the Owner in a way to facilitate their inspection and ensure preservation of the quality and fitness of the work, including proper protection against damage.
3. Private property shall not be used for storage purposes without written permission of the Owner in control of such premises.
4. Restore all storage areas to their original condition.

C. Storage Methods

1. Do not open manufacturer's containers until the time of installation unless recommended by the manufacturer or otherwise specified.
2. Do not store products in the structures being constructed unless approved in writing.
3. The following types of materials may be stored out-of-doors and on wood blocking so there is no contact with the ground.
 - a. Masonry units.
 - b. Reinforcing steel.
 - c. Structural steel.
 - d. Piping.
 - e. Precast concrete items.
 - f. Castings.
 - g. Handrailing.
4. The following types of materials may be stored out-of-doors if covered with material impervious to water and sunlight. Store materials on wood blocking and tie down covers with rope and slope to prevent accumulation of water on covers.
 - a. Construction lumber.
 - b. Wood for formwork.
 - c. Fiberglass and plastic materials which are not ultraviolet (UV) protected.
5. Store all products not listed above in buildings or trailers which have a concrete or wooden floor, a roof, and fully closed walls on all sides.

6. Protect mechanical and electrical equipment from contamination by dust, dirt, and moisture.
7. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

D. Inspection

1. Regularly inspect stored products to ensure that:
 - a. State of storage facilities is adequate to provide required conditions.
 - b. Required environmental conditions are maintained on continuous basis.
 - c. Products exposed to elements are not adversely affected.
2. Be fully responsible for loss or damage to stored materials and equipment.

3.4 MAINTENANCE

A. Maintenance Log. Prepare a maintenance log for all equipment.

1. This log shall include a list of required maintenance services and inspections, as provided by the manufacturer.
2. The log shall include checklists for the periodic services and inspections required.
3. Initial and date the checklist upon completion of the individual servicing or inspection.
4. Locate the maintenance log in the field office and have it available for review until it is submitted for record purposes upon completion of the work and the start of the warranty period.

B. Preparation

1. Before removing an item from storage, review the installation location. Protection and services at the installed location must meet the equipment storage requirements.
2. Before moving equipment to the installed location, have materials available for temporary shelter or services required to establish the proper storage environment.

C. Performance of Maintenance

1. Perform all storage and preventive maintenance and inspections required by the manufacturer at the specified intervals from the time of delivery until completion of the work.
2. When notified by the Owner or Owner's Representative of a maintenance deficiency, perform corrective maintenance. Corrective maintenance will be performed per the manufacturer.

3. Reestablish storage maintenance in the event an item or equipment is removed from service.

END OF SECTION

SECTION 01 79 00

START-UP, DEMONSTRATION, AND TRAINING

PART 1 - GENERAL

- 1.1 **RELATED DOCUMENTS.** Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1, and all related specification sections, apply to this section.
- 1.2 **DESCRIPTION OF WORK.** This section includes general requirements for start-up, training, and operational demonstration as required by the specifications.
- 1.3 **QUALITY ASSURANCE.** Provide all instruments required for testing. Calibrate all test instruments to within appropriate test standards as established by American Society for Testing and Materials (ASTM) or the governing technical standard. Retain calibration data at the Contractor's site office for Owner or Owner's Representative's review.
- 1.4 **SUBMITTALS** (Not used)
- 1.5 **JOB CONDITIONS** (Not used)
- 1.6 **DELIVERY, STORAGE, AND HANDLING** (Not used)
- 1.7 **SPECIAL WARRANTY** (Not used)
- 1.8 **DEFINITIONS**
 - A. **Operational Demonstration.** An activity performed by the Contractor wherein the Owner operates and the Contractor maintains a fully functional component, system, or unit process for a minimum period of 30 continuous calendar days after start-up has been completed and stable operation has been achieved.
 - B. **Field Testing.** Testing performed on-site by the Contractor to satisfy requirements of the manufacturer and Contract Documents.
 1. **Dry Testing.** Dry testing is performed by the Contractor without introducing either process material or other test material into the component, system, or unit process.
 2. **Wet Testing.** Wet testing is performed by the Contractor utilizing test material in the component, system, or unit process. Process tankage shall be filled with test material to operating level.
 3. **Performance Testing.** Performance testing is performed by the Contractor to demonstrate system performance in accordance with specification requirements.
 - C. **Start-Up.** An activity performed by the manufacturer's representative with the Contractor immediately after equipment or system is completed to verify the installation.
 1. Check the installation for conformance with the plans and specifications.

2. Check the installation for conformance with the shop drawings and manufacturer's data.
 3. Verify quantities and data with the operation and maintenance (O&M) manuals.
 4. Verify that equipment is ready for operation.
 5. Place component, system, or unit process on-line.
 6. Perform all required field testing.
 7. Prepare and submit a manufacturer's representative's report including certification, recommendations, and conclusions.
- D. **Training.** To educate Owner's personnel to become qualified and proficient in the operation, maintenance, and repair of the complete system. Training shall include:
1. Classroom instruction.
 2. In-plant, on-site demonstration.
 3. Equipment demonstration.
 4. Actual hands-on operation by the Owner's staff.
- E. **Adjusting.** To install or change setting, parameters, calibrations, flows, processes, etc., so that the equipment or system operates in a logical or more efficient state.
- F. **Balancing.** To make equipment or subsystems operate in harmony or equilibrium by adjusting, altering, or modifying parts of the system.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.1 START-UP EXECUTION

A. Start-Up Preparation

1. Prior to beginning a start-up, inspect the systems and equipment to verify their readiness to begin with the manufacturer's representative.
2. Correct hazardous conditions to equipment or personnel prior to start-up of equipment.
3. Do not proceed with start-up operations using temporary power or temporary instrumentation and control wiring unless approved. All electrical and control connections shall be permanent and complete, and all such electrical components and equipment fully functional.
4. Design, fabricate, and install all necessary testing and monitoring equipment before commencing the test.
 - a. **Quality.** Use materials and equipment of good quality and suitable for the intended service. The use of miscellaneous items found at the job site is not acceptable.

- b. **Maximum Gauge Readings.** Select capacity or range of test equipment to provide meaningful test results. Select pressure or differential pressure gauges so that test pressure is 50 percent to 75 percent of maximum gauge reading.
 - c. **Temporary Equipment.** Fabricate, as necessary, any temporary equipment used in testing. This equipment shall remain the property of the Contractor who will remove it from the site upon substantial completion.
5. **Manufacturer's representative(s)** shall be present for the initial start-up of all systems or equipment.
 6. **Request permission to start up equipment, including electrical gear, and notify the Engineer/Architect of the start-up.**
 - a. Submit the start-up request a minimum of 72 hours before the scheduled start-up. Make requests in writing during normal working hours.
 - b. Start-up request shall be in accordance with Section 01 33 00, "Submittals."
 - c. The Owner and/or Engineer/Architect shall have the right to reject the use of an individual for facility start-up.
 - d. Approval of the request is based solely on impact on plant operations. Approval does not relieve the Contractor of any responsibility for plant and personnel safety.
 - e. Coordinate the start-up of each piece of equipment with the Owner and the Engineer/Architect so that operation does not interfere with the normal operation of the facility.
 7. **Normal installation checks, such as for rotation, are not considered start-ups and do not require start-up notification. Clearly mark all electrical apparatus which is energized.**

B. Conduct of Start-Up

1. **Equipment Adjustments.** Make all adjustments, corrections, and calibrations to set points, process parameters, etc., necessary to achieve normal, stable operation of systems.
2. **Equipment Failure.** Consider any failures of equipment or systems as deficiencies and correct them. Stop testing and the start-up until all deficiencies have been corrected.
3. **System Failure.**
 - a. When there appears to be a system failure and the system is composed of separate but functionally codependent individual pieces of equipment and check-out of each piece of equipment by its respective manufacturer's representative verifies that the

- equipment is functioning properly, then the Contractor's remains responsible for overall system operation.
- b. Verify compatibility of equipment during the submittal process to minimize overall system operating problems.
 - c. Reconfigure, repair, modify, or replace parts or all the equipment in order to provide a system that shall perform as specified at no additional cost to the Owner.
4. Dry Testing.
- a. Test, adjust, align, lubricate, and balance all equipment and systems in accordance with the manufacturer's instructions prior to testing.
 - b. Test individual components prior to testing the system of which they are a part.
5. Wet Testing.
- a. After dry testing, wet test all equipment and systems for a minimum of 72 hours under the design operating conditions utilizing a test material similar to or same as the process material.
 - b. All costs, including materials and equipment, for delivery of the test material shall be at the Contractor's expense. Test each component or item of equipment to demonstrate compliance with the design criteria and operating range specified.
 - c. Suspend or secure all tests in the event that test failures or hazardous conditions occur. Make repairs, replacements, or adjustments and restart test in its entirety.
 - d. Dispose of the test material at no additional cost to the Owner.
 - e. Clean all equipment systems and structures upon conclusion of testing at no additional cost to the Owner.
 - f. Comply with any performance testing requirements specified.
6. Retesting. Repeat tests if results fail to meet test criteria, whether the failure is identified during field testing or through reviewing the test report later.
7. Performance Testing. Verify operating ranges, capacities, low and high limits, efficiencies, temperatures, speeds, pressures, sequences, etc., of each piece of equipment being tested. Check monitors, indicators, alarms, and fail-safe devices.
8. Do not use repair parts during start-up operations unless approved.
9. Furnish all lubrication and operating fluids per the manufacturer's instructions.
10. Field-verify initial copy of O&M manual according to Section 01 33 00, "Submittals."

- C. **Start-Up Conclusion.** Submit manufacturer's representative's report within 48 hours of conclusion of each start-up. Report shall be in accordance with Section 01 33 00, "Submittals."

3.2 OPERATIONAL DEMONSTRATION EXECUTION

- A. **Operational Demonstration Preparation.** Prior to the operational demonstration beginning:

1. Complete start-up procedures including submitting all reports for all parts of the work designated for the operational demonstration.
2. Complete all required construction activities, including any activities by any entity that would interrupt the normal operations of the demonstration.
3. Ensure that adequate parts and supplies for routine maintenance and replacement are on hand to support system operation through the demonstration period.
4. Deliver all repair parts to the Owner.
5. Submit an operational demonstration request according to Section 01 33 00, "Submittals," 48 hours prior to start of operational demonstration.

- B. **Conduct of Operational Demonstration**

1. During the operational demonstration and at other times, the work will be on-line and an integral part of the plant operations and process. The Owner maintains control of plant operations and processes at all times. Therefore:
 - a. Do not commence, resume, modify, terminate, or suspend the operations without the permission of the Owner and only in a sequence and manner suitable to the Owner except in the case of an emergency.
 - b. The operation of the work shall be in strict accordance with the operational orders of the Owner.
 - c. Adjust or repair immediately, on a 24-hour-per-day, 7-day-per-week basis, any malfunction in the work which in the opinion of the Owner jeopardizes or may jeopardize the proper operation of the total facility.
2. Perform operational demonstrations of the entire work. With approval, individual systems may be independently demonstrated as long as their complete range of operation and performance can be shown without the rest of the facility.
3. Update. Keep the log on-site during the operational demonstration and updated on a regular basis. The log shall be available for review by the Owner or Owner's Representative at all times during the operational demonstration.

4. **Maintenance.** Perform all required maintenance and servicing during the operational demonstration at the specified intervals and as necessary. Note all maintenance and servicing in the operational demonstration log.
5. **Time.**
 - a. The operational demonstration shall last for a period of 30 consecutive days.
 - b. All equipment and systems shall remain totally operational during this period.
 - c. Upon successful completion of the operational demonstration, the work is considered to be ready for its intended use, and the Contractor may make recommendation for substantial completion.
 - d. **Outages.**
 - 1) Note all outages of equipment, system(s), or the plant in the operational demonstration log.
 - 2) Plant power outages such as power failure, process failure or existing equipment, and planned outages of existing systems for cleaning, maintenance, or repair are considered a part of normal plant operation and will not invalidate the operational demonstration.
 - 3) Be responsible for the safe and orderly shutdown and restart of equipment as necessary in the event of an outage.
 - 4) Do not include outage time in the demonstration time period.
 - e. Do not count activities such as filling, draining, purging, heating or cooling to temperature, stabilizing, adjusting, testing, or other start-up activity time as operational demonstration time.
 - f. **Failed Operational Demonstration.**
 - 1) If, during the operational demonstration, any part of the work fails to fully conform to the requirements of the Contract Documents, consider the operational demonstration to have failed, and the work not to be substantially complete.
 - 2) Upon failure of the operational demonstration, promptly remedy any defects in the work and promptly reschedule and restart the complete operational demonstration time period. No operational demonstration time will be considered to have accrued to any part of the work by reason of a failed operational demonstration.

- g. **Suspension of Operational Demonstration.**
 - 1) During the operational demonstration, the Owner may require or permit the operational demonstration to be suspended upon the written request of the Contractor to correct or adjust the work, when in the judgement of the Owner or Owner's Representative such required correction or adjustment is insufficient to deem the operational demonstration to have failed.
 - 2) If an operational demonstration is suspended for any reason except failure, operational demonstration time shall accrue to the work from the time of the beginning of the operational demonstration to the time of the suspension. No operational demonstration time shall accrue during the period of suspension.
 - 3) If an operational demonstration is suspended at the request of the Contractor, continue operation and maintenance of the work without additional charges to the Owner, according to all provisions of this section of the specifications, and to the extent required by the Owner.
- 6. **O&M Manuals.** Start-up and operation of the system and all associated equipment shall be in accordance with the O&M manuals. If deviations from the manuals are necessary, note these in the operational demonstration log, and subsequently submit as revisions to the O&M manuals.
- 7. **Personnel and Consumables.**
 - a. Have sufficient personnel available during the entire demonstration to ensure proper maintenance, adjusting, troubleshooting, and any and all repairs to equipment, controls, etc., to maintain and keep the entire facility operating continuously for 30 consecutive days (720 hours).
 - b. The Owner will remain in control of the facility processes and provide the manpower to operate the facility.
 - c. The Owner will furnish all consumable supplies and power required for the 30 day complete facility operational demonstration.
 - d. **Contractor's Supervision.** When Owner personnel are operating systems or equipment under supervision of the Contractor during operational demonstration, make available, at all times, persons knowledgeable about the systems or equipment to direct the Owner personnel in its operation.
- 8. To the extent possible, operate all equipment or individual components throughout their range during this period.

C. Operational Demonstration Completion

1. Within 2 weeks of the termination or completion of the operational demonstration, submit for approval:
 - a. Any changes to O&M Instructions.
 - b. The completed operational demonstration logs according to Section 01 33 00, "Submittals."
2. The Owner will not assume full responsibility for operation and maintenance of the system and equipment until successful completion of the operational demonstration and all conditions for substantial completion have been satisfied and both the Contractor and Owner have accepted the Certificate of Substantial Completion.

3.3 TRAINING EXECUTION

A. Training Preparation. Coordinate and verify to ensure that, prior to the scheduled training time(s):

1. The equipment is ready for operation and has completed its start-up.
2. That all associated construction required to operate the equipment in all normal and anticipated operating modes is complete.
3. That the equipment area is safe, well lit, and unobstructed, so that all training class attendees may access, hear, view, and participate in the training.
4. That the equipment area is free of construction activities that could present a hazard to training class participants.
5. That adequate training materials, as required, are on hand for use during the training session.
6. Any representatives of interfacing Prime Contractors, subcontractors or equipment suppliers needed to perform supporting operations allowing demonstration of equipment operation, have been notified and will be available.
7. Schedule training sessions through Owner and the Engineer/Architect. Cooperate with the Owner in scheduling all required training sessions.
8. Verify that the training materials are compatible with this equipment. Provide other audio/visual equipment and training aids as needed.
9. The approved O&M manuals shall be available and frequent reference shall be made to the equipment O&M manuals.
10. The instructor's qualifications, the training schedule, the lesson plan, and any instructional materials have been submitted and approved before training begins. Submittals shall be in accordance with Section 01 33 00, "Submittals."
11. Training schedules should be submitted far enough in advance that the Owner can adjust work schedules so that all participants are available for the training sessions.

B. Conduct of Training

1. Provide at least one copy of instructional materials used for training at the time of the first training session for each attendee.
2. Before the training is complete, have all training session attendees sign an attendance sheet.
3. Discuss all items of the approved lesson plan in the classroom or the field, in complete and sufficient detail to allow the Owner's operating personnel to knowledgeably operate and maintain the equipment in accordance with manufacturer's recommended procedures and safety considerations during all anticipated operational and maintenance situations.
4. Address safety concerns and features intended to enhance safety.
5. Address tasks required to maintain the warranty.
6. The Owner reserves the right to record the training session for the future use in training employees.
7. Address all questions and comments as they are raised by the training session participants to the maximum extent practicable. If questions or comments cannot be addressed during the training session, additional materials and/or training may be required.
8. O&M material and instructional material shall not conflict.

C. Training Conclusion. Within 2 weeks of the training being completed:

1. Correct, revise, and update the O&M manuals as necessary to agree with training.
2. Submit completed sign-in sheet in accordance with Section 01 33 00, "Submittals."

END OF SECTION

SECTION 02 41 00

DEMOLITION

PART 1 - GENERAL

- 1.1 **RELATED DOCUMENTS.** Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1, and all related specification sections, apply to this section.
- 1.2 **DESCRIPTION OF WORK.** Provide the labor, tools, and equipment necessary to remove and salvage or dispose of the equipment, structures or portions thereof in accordance with the plans and specifications.
- 1.3 **QUALITY ASSURANCE** (Not used)
- 1.4 **SUBMITTALS.** Submit the following submittal packages in accordance with the Division 1 Submittal Requirements and the requirements of this specification section.
 - A. **Submittal Package No. 1 – Demolition Package**
 1. **Package Contents.** A proposed schedule of demolition for the purposes of coordinating shutoff, capping, and continuation of utility services as required to operate the facility.
- 1.5 **JOB CONDITIONS**
 - A. **Beginning Work.** Vacate structures to be demolished and discontinue their use prior to start of work.
 - B. **Protection**
 1. **Structural.** Prior to the removal of any wall, beam, or column, or cutting of any openings, examine the existing structure and, when required, protect the structure by shoring, bracing, or underpinning.
 2. **Equipment and Tanks.** Protect all equipment and tanks from dust, dirt, debris, and damage by covering with planking and tarpaulins during demolition.
 3. **Ensure safe passage of persons and vehicles around area of demolition.** Conduct operations to prevent damage to adjacent buildings, structures, and other facilities and injury to persons.
 - C. **Explosives.** Do not use explosives.

1.6 **DELIVERY, STORAGE, AND HANDLING.** In accordance with Section 01 60 00.

1.7 **SPECIAL WARRANTY** (not used)

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.1 **EXAMINATION.** Verify the actual areas, structures or parts of structures, pipes, or other items to be demolished in the presence of the Owner and Engineer/Architect.

3.2 **PREPARATION**

- A. **Equipment and Manpower.** Have all required equipment and manpower available at the job site prior to beginning of demolition. This includes any special equipment to permit continued uninterrupted Owner operations as required.
- B. **Coordination.** Provide adequate but no less than 48 hours of notice when any Owner operations are affected by demolition.

3.3 **DEMOLITION**

- A. **Demolition Schedule.** Perform demolition work in accordance with the final approved schedule of demolition.
- B. **Salvage.** Remove with care, clean, and store all material and equipment designated to be salvaged in an approved area at the site.
- C. **Openings**
 - 1. **Concrete.** Close concrete openings using a nonshrink, nonmetallic grout.
 - 2. **New.** Neatly cut or drill new openings to prevent face chipping or spalling. Repair all damaged areas to a condition equivalent to that which existed prior to the start of work.
- D. **Patching Concrete**
 - 1. Repair all concrete that has been marred, damaged, or defaced as a result of demolition.
 - 2. **Procedure.** Repair concrete surfaces as follows:
 - a. Saw cut and remove concrete to a depth of not less than 1 inch.
 - b. Remove exposed reinforcing where noted.
 - c. Apply an approved bonding agent to the cut surface.
 - d. Patch with a nonshrink, nonmetallic grout finished to match the existing surface unless noted otherwise.
- E. **Anchors.** Cut all embedded anchors of removed items flush with the existing surface.

- F. **Pipe.** Plug all abandoned pipe at each end.
- G. **Cleanup.** Remove from the site all debris, rubble, unusable materials, and items not salvaged.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SUMMARY

- A. All work and installation provided under this contract shall comply with the NEC, 2011 edition.
- B. Refer to NECA 1, latest edition as a minimum baseline of quality and workmanship for installing electrical products and systems for this contract. The Standard defines what is meant by "neat and workmanlike" as required by the NEC Section 110.12. Specified requirements supersede NECA practices in cases of conflicts.
- C. All materials and equipment provided under this contract shall be new and free from any defects.
- D. Hazardous areas and classifications shall be as shown on the drawings per definitions in NFPA 820, latest edition.
- E. The Contractor shall retain an independent InterNational Electrical Testing Association (NETA) member Engineering and Testing Firm (Testing Firm) for specified on-site acceptance testing of the project electrical power distribution system and utilization equipment.
- F. The Contractor shall test motors, conductors, and dry transformers as specified and shown.
- G. Related Sections:
 - 1. All 22 series sections
 - 2. All 25 series sections
 - 3. All 26 series sections.
 - 4. All 28 series sections.
 - 5. All 32 series sections.
 - 6. All 33 series sections.

1.2 REFERENCES

- A. InterNational Electrical Testing Association's (NETA):
 - 1. NETA - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (ATS).

2. NETA - Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems (MTS).
- B. National Fire Protection Association (NFPA):
1. NFPA 70 – National Electrical Code (NEC).
 2. NFPA 820 – Fire Protection in Wastewater Treatment and Collection Facilities.
- C. National Electrical Contractor’s Association (NECA):
1. NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting.

1.3 SUBMITTALS

- A. As herein called for in the submittal procedure, the Contractor's signature shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria, and similar data have been verified and that, in his/her opinion the submittals fully meet the requirements of the contract plans and specifications.
- B. If Contractor's submittals depart from the contract documents, the Contractor shall make specific mention thereof in his letter(s) of transmittal, otherwise review of such submittals by the City shall not constitute acceptance or review of such departure(s). Review of drawings shall constitute review of the specific subject matter for which the drawings were submitted and not of any other structure, materials, equipment or apparatus shown on the drawing.
- C. The Primary Contractor shall be responsible for and shall provide all documentation and wiring diagrams, regardless of whether the equipment was supplied, wired and/or installed by the Primary Contractor or any Sub-contractor.
- D. Wiring diagrams shall include all interconnections, inter-wiring and terminals between all electrical and/or instrumentation units. Wire numbers shall be continuous from start to finish. Wire numbers shall not change when going from one unit, cabinet, enclosure, terminal or any device to another.
- E. The Contractor shall submit the following:
1. Fully dimensioned drawings and bills of materials for service entrance equipment, motor control equipment, transformer/panelboard units and process control panels showing layouts of door devices, nameplates and print pocket locations. Technical specifications, ratings and certifications pertinent to each of these items shall also be submitted.
 2. A separate technical brochure or bulletin for each instrumentation device called for in Process Control Instrumentation.
 3. Catalog cut sheets for: all raceways, conduit boxes, fittings, and securing hardware, ground conductor connections including

proposed exothermic method, bonding bushings, 600 volt conductors, cable ties and their tensioning/cut off tool, #10 AWG and larger wire lugs and their compression tool(s), premises wiring devices such as switches, convenience outlets, area lighting fixtures and the like. All non-pertinent information and depictions are to be marked out on cut sheets.

4. After review by the City, drawings and/or descriptive data will be stamped "Approved", "Approved as Noted", or "Unacceptable-Resubmit" and one copy of a Letter of Transmittal will be mailed to the Contractor at an address designated by the Contractor.
 5. If a shop drawing or data is stamped "Unacceptable-Resubmit", the Contractor shall make the necessary corrections and resubmit. The letter transmitting corrected documents shall indicate that the documents are re-submittals. Submittal items stamped "Approved" or "Approved as Noted" need not be resubmitted.
 6. If any changes, other than those requested in the City's review are made on a shop drawing prior to re-submittal, such changes shall be pointed out by the Contractor upon re-submittal.
- F. The Contractor will be charged for costs incurred by the City for third and subsequent submittals, and/or Contractors failure to comply with the procedure outlined above.
- G. Testing Firm Qualifications: The Contractor shall receive approval of the proposed Testing Firm and their project team prior to the Pre-Test Submittals. Submit the following for review.
1. Project Team: Identify lead technical person and testing staff. Provide documentation of training and experience demonstrating compliance with the qualifications specified.
 2. Testing Firm: Provide reference names and current phone numbers of the Owner, Contractor, Engineer, or Construction Manager that has knowledge of the Firm's work:
 - a. Three projects for Owner completed within the past four years, or
 - b. Provide references for five recent projects that were completed within the last four years. Provide a description of the scope of the referenced project.
- H. Product Data:
1. Test Firm Pre-Test Submittal:
 - a. Description or samples of specified test procedures.
 - b. Sample test report forms for the specified tests.
 - c. List of items to be tested, tests to be performed, and time durations for tests.
 2. Contractor Pre-Test Submittal:
 - a. Separate submittal for each process area.
 - b. Pre-Functional test procedures and testing schedule.
 - c. Functional test procedures and testing schedule.

3. Contractor Post-Test Submittal: Completed Specification Test Forms.
 - a. Wire and Cable Resistance.
 - b. Installed Motor.
 - c. Loop Wiring and Insulation Resistance.
 - d. Dry Transformer
4. Test Firm Post-Test Submittal:
 - a. Test Reports for each item including:
 - 1) Description.
 - 2) Identification number.
 - 3) Nameplate data.
 - 4) Electrical equipment settings.
 - 5) Time and date of test.
 - 6) Ambient conditions at time of test.
 - 7) Inspection checklist and results.
 - 8) Test results.
 - 9) Test equipment used with manufacturer, model number, and calibration date.
 - 10) Remarks about test procedures, results, and suggestions.
 - 11) Name and signature of testing personnel.
 - 12) Name and signature of test witness.

1.4 QUALIFICATIONS

- A. Testing Firm shall be an independent testing organization providing unbiased testing authority, professionally independent of the manufacturer, suppliers, and installers of equipment or systems to be evaluated by the Testing Firm.
- B. Testing Firm shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.
- C. Testing Firm shall be a member company of the InterNational Electrical Testing Association (NETA), a NETA Associate Member company providing testing in accordance with NETA ATS published specifications.
- D. Testing Firm's lead technical person shall be currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution systems testing.
- E. Testing Firm's technicians shall be regularly employed, qualified testing staff.

1.5 SEQUENCING AND SCHEDULING

- A. Schedule work to ensure completion of testing prior to energizing equipment.
- B. The Contractor shall submit a schedule for the Testing Firm work and notify the Construction Manager 30 days prior to commencement of any witnessed testing.

- C. Section 01 10 00 - Summary: Requirements for sequencing.
- D. Requirements for scheduling.

1.6 DOCUMENTS

- A. The Contractor shall preserve all manufacturers' paperwork that is shipped with equipment assemblies, process control panel components and field installed components. All literature accompanying each and every item shall be considered a part of that item such as specification sheets, installation instructions, operating, maintenance write-ups, etc.
- B. Manufacturer's documentation of any supplied electrical equipment shall fully indicate the control and power wiring of each item being supplied. Drawings shall include electrical single line diagrams, wiring diagrams, schematic diagrams, panel installation details showing all devices within.
- C. The Contractor shall, prior to commencement of any work, supply the City with a complete and separate set of plans, electrical drawings, P & ID diagrams and specifications. These 'record drawings' shall be used for no other purpose than to record changes to, or deviations from, the contract plans and specifications. All electrical drawings shall be submitted on a CD compact disk for IBM compatibles using AutoCAD 2012 and on 11" x 17" paper copy. The Primary Contractor shall be responsible for and shall provide all documentation and wiring diagrams, regardless of whether the equipment was supplied, wired and/or installed by the Primary Contractor or any Sub-contractor.
- D. Final electronic as-built (drawings with all corrections and field changes after completion of project) wiring diagrams shall be of the highest quality. All electrical drawings shall be submitted on a CD compact disk for IBM compatibles using AutoCAD 2012 and on 11" x 17" paper copy. Poor quality copies will not be accepted.
- E. Wiring diagrams shall include all interconnections, inter-wiring and terminals between all electrical and/or instrumentation units. Wire numbers shall be continuous from start to finish. Wire numbers shall not change when going from one unit, cabinet, enclosure, terminal or device to another.
- F. Wiring diagrams shall identify each line of electrical ladder logic by sequentially numbering them directly to the left of each line, and shall continue sequentially from one page to the next.
- G. Wiring diagram conductors that continue from one wiring diagram page or drawing to another shall be cross referenced by the use of line numbers.
- H. Wiring diagrams shall identify the function of each relay coil by having the relay 'function identity' directly to the right of each relay coil symbol.

- I. Wiring diagram relay contacts shall identify their coil location by having the coil line number in parenthesis (xxx) below each contact.
- J. Wiring diagram relay coils shall indicate the location of each of their contacts by having the line number of each contact directly below the relay function identity to the right of each relay coil symbol. Wiring diagrams symbol identification numbers shall be placed directly above each symbol.
- K. The Contractor shall furnish operation and maintenance manuals containing:
 - 1. Manufacturer's brochures, bulletins and catalog sheets with catalog numbers highlighted.
 - 2. Component and equipment assembly warranties.
 - 3. Installation, operation and maintenance instructions.
- L. The Contractor shall document all testing and functional checkouts as called for in these specifications.
- M. A complete receipt of all documents called for in these specifications shall be a condition of final acceptance of the project by the City.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

- A. The manufacturer of the electrical equipment supplied for the project shall complete their on-site factory inspection, testing, and setup prior to the Testing Firm's testing and Protective Device setting work. The power monitors shall be set up by the factory representatives and power monitor readings and settings verified by the Testing Firm.
- B. Contractor shall provide the labor, tools, material, including quality power sources required by the Testing Firm equipment, and other services necessary to provide specified tests and retesting.
- C. The test equipment, instruments and devices used for testing shall be calibrated to test equipment standards with references traceable to the National Institute of Standards and Technology. The test equipment, instruments and devices shall have current calibration stickers indicating date of calibration, deviation from standard, name of calibration laboratory and technician, and date of next recalibration.

- D. The required tests, including correction of defects where found, and subsequent retesting, shall be completed prior to functional testing. The installation of the protective device, breaker, and relay settings shall be completed and verified.

3.2 TESTING FIRM REQUIREMENTS

- A. Testing shall not commence until the pre-test submittals are approved.

- B. Acceptance testing procedures and test results shall be as specified in NETA ATS. The following types of equipment and systems shall be inspected and tested by the Testing Firm. Refer to the electrical drawings for location and identification of the electrical distribution system equipment, utilization equipment, and electrical conductors, included but not limited to:
 1. Switchgear and Switchboard Assemblies.
 2. Transformers Dry-Type Air-Cooled.
 3. Cables Low-Voltage 600 Volt Maximum.
 4. Cables Medium-Voltage.
 5. Air Switches Medium-Voltage, Metal.
 6. Circuit Breakers Low-Voltage, 100A frame and larger.
 7. Circuit Breakers Medium-Voltage.
 8. Protective Relays.
 9. Instrument Transformers.
 10. Metering, include non-utility power metering equipment.
 11. Grounding Systems include installed grounding systems and existing grounding systems that are being utilized.
 12. Ground Fault Protection Systems.
 13. Motors.
 14. Motor Starters Low-Voltage.
 15. Motor Starters Medium-Voltage.
 16. Motor Control Centers Medium-Voltage.
 17. Adjustable Speed Drive Systems.
 18. Surge Protection Devices, include lightning arresters, surge capacitors, and TVSS.
 19. Capacitors and Inductors.

3.3 CONTRACTOR TESTING

- A. Testing shall not commence until the pre-test submittals are approved.

- B. Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Where not specified, the minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, ICEA, NEMA, or ANSI standards for the equipment or material being tested. A megohmmeter shall be used for insulation resistance measurements.

1. Conductor and cable phase-to-ground insulation resistance shall be measured for circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation with resistance of less than 10 megohms is not acceptable.
 2. The Installed Motor Test Form shall be completed for each motor after installation. All motors shall have their insulation resistance measured before they are connected. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery and again when they are connected. Insulation resistance values less than 10 megohms are not acceptable.
 3. Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground. Insulation resistance values less than 10 megohms are not acceptable.
 4. Signal conductors and shield drain shall be tested for insulation resistance with the other conductors in the cable grounded. Each shield drain conductor shall be tested for continuity. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500-volt or 1000-volt meg-ohmmeter shall be used for insulation resistance measurements as appropriate.
- C. Verify that motors are connected to rotate in the correct direction with the load disconnected. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.
- D. Motor running current shall be measured on each phase with the motor operating under load. Current imbalance shall be less than 5-percent difference between phases. During the functional test period below, obtain baseline operating data on all equipment with motors greater than 1 horsepower. The baseline data shall be recorded on the test form.
- E. Test receptacles and power outlets using a device to verify polarity, grounding, and the correct wiring connections.
- F. Prior to energizing equipment, perform a pre-functional checkout of the power and the control circuits.
1. Protective devices shall be installed and available for service and calibrated or adjusted with specified setpoints installed, refer to Section 26 05 73. Contractor selected initial setpoints shall be installed and recorded, when specified setpoints are not required from the manufacturer or the Engineer.
 2. Pre-functional checkout shall consist of energizing each control circuit and operating each control device, protective device,

monitoring or alarm device, and each interlock and verify the specified action or response occurs.

- G. Perform a functional checkout of all electrical and instrumentation control equipment. Individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these specifications. If available, [plant effluent][potable water] may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system. Disposal methods for test media shall be subject to review by the Construction Manager.

END OF SECTION

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes medium voltage cable and cable terminations.
- B. Related Sections:
 - 1. Section 26 05 00 – Common Work Results for Electrical.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 48 - Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV Through 765 kV.
 - 2. IEEE C2 - National Electrical Safety Code.
- B. National Electrical Manufacturers Association:
 - 1. NEMA WC 3 - Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - 2. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - 3. NEMA WC 7 - Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electric Energy.
 - 4. NEMA WC 8 - Ethylene Propylene Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Product Data: Submit for cable, terminations, and accessories.
- B. Samples: Submit two 24 inch long sections of cable for each size.
 - 1. Select each length to include complete set of manufacturer markings.
 - 2. Attach tag indicating cable size and application information.

- C. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual sizes and locations of cables.
- B. Operation and Maintenance Data: Submit instructions for testing and cleaning cable and accessories.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience, and with service facilities within 100 miles of Project.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect cable from weather and moisture by covering with plastic or canvas and storing in a clean, dry indoor space keeping the cable ends individually capped.

PART 2 PRODUCTS

2.1 MEDIUM VOLTAGE CABLE

- A. Manufacturers:
 - 1. Okonite.
 - 2. Kerite.
 - 3. Southwire.
 - 4. Substitutions: Engineer approved equal.
- B. Product Description: Cable:
 - 1. Newly manufactured (not more than 12 months old) of soft drawn copper with not less than 97 percent conductivity, with size, grade of insulation, voltage, and manufacturer's name permanently marked on outer covering at not more than 2 feet 0 inch intervals.
 - 2. Identify and mark conductors in accordance with NEC Article 310.
 - 3. Cable shall meet requirements of ICEA, NEMA, and AEIC.
 - 4. Cable ends shall be capped and remain capped until stress cone installation.
- C. Cable Assembly:
 - 1. Single-conductor, stranded Class B annealed copper, compressed or compact round.
 - 2. Covered with an extruded semi-conductor EPR strand screen, 220 mil ethylene propylene rubber insulation, extruded EPR semi-conducting insulation screen,

5 mil bare copper shielding tape with 12 percent minimum overlap, and 80 mil (minimum) polyvinyl chloride jacket.

3. Cable rated 5 kilovolt Type MV-105, 133 percent insulation level, continuous 105 degrees Centigrade conductor operating temperature.
- D. Furnish color differentiation between semi-conducting layers and insulation.
- E. EPR insulation shall not contain polyethylene polymer as a component, and ethylene content not exceeding 72 percent by weight of elastomer used in compounding.
- F. Insulation Thickness: Not less than that specified by National Electrical Code.
- G. Conductor Sizes: American Wire Gauge (AWG) sizes, unless otherwise specified, as indicated on the Drawings.

2.2 CABLE TERMINATIONS

- A. Manufacturers:
 1. Elastimold
 2. Raychem
 3. 3M
 4. Substitutions: Not Permitted.
- B. Product Description: Cold shrink terminations.

2.3 CAST-EPOXY CABLE TERMINATION

- A. Manufacturers:
 1. 3M
 2. Substitutions: Not Permitted.
- B. Product Description: IEEE 48, Class 1 cast epoxy cable termination in kit form with stress cone, shield ground connection, wet porcelain rain shield for outdoor units, epoxy resin molding material, and accessories and molds required for proper application.

2.4 MODULAR CABLE TERMINATION

- A. Manufacturers:
 1. Elastimold
 2. 3M
 3. Substitutions: Not Permitted.

- B. Product Description: IEEE 48, Class 1, molded-rubber cable termination in kit form with stress cone, ground clamp, non-tracking rubber skirts, [load break] connector, rubber cap, and aerial lug.
- C. Terminations to circuit breakers, disconnect switches and transformers, load break elbow type.
- D. Circuit breaker terminations to include grounding stud with removal insulating cap.

2.5 FIREPROOFING TAPE

- A. Manufacturers:
 - 1. 3M
 - 2. Substitutions: Engineer Approved Equal.
- B. Installation: Where required.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify conduit, duct, trench and manholes are ready to receive cable.
- B. Verify routing and termination locations of cable prior to rough-in.

3.2 PREPARATION

- A. Use swab to clean conduits before pulling cables.

3.3 INSTALLATION

- A. Avoid abrasion and other damage to cables during installation. Provide tarps to protect cables from direct contact with the ground and abrasion during pulls.
- B. Use manufacturer approved lubricants and pulling equipment.
- C. Submit pull tension and side wall pressure forms for engineering approval.
- D. Provide pull tension and side wall pressure calculations four weeks prior to installation for engineering approval.
- E. Engineering to witness cable installation, and all splices and terminations. Inform engineering one week prior to cable installation.
- F. Sustain cable pulling tensions, side wall pressure and bending radii below manufacturer's recommended limits.

- G. Ground cable shield at each termination and splice.
- H. Install cables in manholes along wall providing longest route.
- I. Arrange cable in manholes to avoid interference with duct entrances.
- J. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping. Extend fireproofing 1 inch into duct, trench, vault or under equipment.

3.4 WIRE COLOR

A. General:

- 1. Up to 5kV Rated medium voltage cable:
 - a. Conductors to be marked with two stripes or rings of phase tape color coded as follows:
 - 1) A phase=Red, B phase=Yellow, C phase=Blue.
- 2. For 6kV up to 15kV Rated cable.
 - a. Conductors to be marked with three stripes or rings of phase tape color coded as follows.
 - 1) A phase=Red, B phase=Yellow, C phase=Blue.

B. Ground Conductors:

- 1. Identify and color code ground conductors under provisions of Section 26 05 26.

3.5 FIELD QUALITY CONTROL

- A. Inspect exposed cable sections for physical damage.
- B. Inspect cable for proper connections .
- C. Inspect shield grounding, cable supports, and terminations for proper installation.
- D. Inspect and test in accordance with NETA ATS, except Section 4. Refer to Section 26 05 00 – Common Work Results for Electrical.
- E. Perform inspections and tests listed in NETA ATS, Section 7.3. Refer to Section 26 05 00 – Common Work Results for Electrical.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

- A. Protect installed cables from entrance of moisture.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes 600 Volt Class wire and cable; and wiring connectors and connections.
- B. Related Sections:
 - 1. Section 26 05 00 – Common Work Results for Electrical.
 - 2. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.

1.2 REFERENCES

- A. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- C. Electronic Industries Association/ Telecommunications Industry Association:
 - 1. TIA/EIA-568-B.2.
 - 2. TIA/EIA-568-B.2-10 Draft Category 6A.
- D. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 802.3af PoE.
 - 2. IEEE 802.3an 10GBASE-T Ethernet.
- E. UL Listed ISO/IEC 11801 and EN50173.
- F. IEC 60603-7-5.

1.3 SYSTEM DESCRIPTION

- A. Wiring Products:
 - 1. Stranded conductors for all power, control and instrument circuits.
 - 2. Shielded Ethernet cables for industrial SCADA network connection.
 - 3. Conductor not smaller than 12 AWG for power and lighting circuits.

4. Conductor not smaller than 14 AWG multi-conductor for 120 Vac control circuits.
 5. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 ft.
 6. 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 ft.
 7. 16 AWG multi-conductor for 24 V circuits.
 8. 18 AWG shielded with drain wire for analog circuits.
- B. Wiring Methods:
1. Concealed Dry Interior Locations: Type THHN/THWN insulation, in raceway.
 2. Exposed Dry Interior Locations: Type THHN/THWN insulation, in raceway.
 3. Above Accessible Ceilings: Type THHN/THWN insulation, in raceway.
 4. Wet or Damp Interior Locations: Type THHN/THWN insulation, in raceway.
 5. Exterior Locations: Type THHN/THWN insulation, in raceway.
 6. Underground Locations: Type THHN/THWN insulation, in raceway.
 7. Cable Tray: Type TC insulation, in cable tray.
- 1.4 DESIGN REQUIREMENTS
- A. Conductor sizes are based on copper.
- 1.5 SUBMITTALS
- A. Product Data: Submit for wire, cable, and connectors.
- B. Test Reports: Indicate procedures and values obtained.
- 1.6 CLOSEOUT SUBMITTALS
- A. Project Record Documents: Record actual locations of components and circuits.
- 1.7 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- 1.8 FIELD MEASUREMENTS
- A. Verify field measurements are as indicated on Drawings.
- 1.9 COORDINATION
- A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.
- B. Wire and cable routing indicated is approximate unless dimensioned.

PART 2 PRODUCTS

2.1 600 VOLT WIRE AND CABLE

- A. Manufacturers:
 - 1. Okonite Cable Co.
 - 2. Essex Group Inc.
 - 3. General Cable Co.
 - 4. Rockbestos Company
 - 5. Southwire
 - 6. Substitutions: Not Permitted.

- B. Product Description: Single conductor insulated wire.

- C. Conductor: ASTM B8 Soft drawn copper, Class B or C stranded.

- D. Insulation: NFPA 70; THHN/THWN insulation for feeders and branch circuits, and material rated 90 degrees C.

2.2 MULTI-CONDUCTOR CONTROL CABLE

- A. Manufacturers:
 - 1. Okonite
 - 2. Cablec
 - 3. Belden.
 - 4. Substitutions: Not Permitted.

- B. Product Description: Multi-conductor instrument and control cable.

- C. Conductor: ASTM B8 Soft drawn copper, Class B or C stranded.

- D. Insulation: Type CPE, 600 Volt.

- E. Colors: ICEA Method 1, E-2, without white neutral conductor or green ground conductor.

- F. Jacket: Cross-linked Polyethylene (XLP), type TC (tray cable).

2.3 MULTI-CONDUCTOR SHIELDED CABLE

- A. Manufacturers:
 - 1. Belden Cable Co.
 - 2. Alpha
 - 3. Substitutions: Not Permitted.

- B. Product Description: Multi-conductor Multi-pair shielding instrument and control cable.

- C. Conductor: ASTM B8 Soft drawn copper, Class B or C stranded.
- D. Insulation: 15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated, 600 Volt.
- E. Colors: ICEA Method-1: Pairs- Black and White with one conductor in each pair printed alpha-numerically for identification.
- F. Shield: 100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire
- G. Jacket: 45 mil Polyvinyl Chloride (PVC), UL1277.

2.4 SINGLE PAIR TWISTED SHIELDED CABLE (TWSH)

- A. Indoor Above ground installations rated 300V:
 - 1. Manufacturers:
 - a. Belden #8760.
 - b. Alpha
 - c. Substitutions: Not Permitted.
 - 2. Product Description: Two-conductor Single pair shielding instrument and control cable.
 - 3. Conductor: ASTM B8 18 gage Soft drawn tinned copper, Class B or C stranded.
 - 4. Insulation: 46 mil Polyethylene, 60 degree C temperature rated, 300 Volt.
 - 5. Colors: ICEA Method-1: Pairs- Black and Clear.
 - 6. Shield: 100 percent, Beldfoil with #20AWG stranded tinned copper drain wire.
 - 7. Jacket: 71 mil Polyvinyl Chloride (PVC), UL1277.
- B. Outdoor Above ground and Underground installations rated 300V:
 - 1. Manufacturers:
 - a. Belden #9318.
 - b. Alpha
 - c. Substitutions: Not Permitted.
 - 2. Product Description: Two-conductor Single pair shielding instrument and control cable.
 - 3. Conductor: ASTM B8 18 gage Soft drawn tinned copper, Class B or C stranded.
 - 4. Insulation: 43 mil Polyvinyl Chloride (PVC), 105 degree C temperature rated, 300 Volt.
 - 5. Colors: ICEA Method-1: Pairs- Black and Red.
 - 6. Shield: 100 percent, Beldfoil with #20AWG stranded tinned copper drain wire.
 - 7. Jacket: 93 mil Polyvinyl Chloride (PVC), UL1277.
- C. Outdoor Above ground and Underground installations rated 600V:
 - 1. Manufacturers:
 - a. Belden #9342.
 - b. Alpha
 - c. Substitutions: Not Permitted.

2. Product Description: Two-conductor Single pair shielding instrument and control cable.
3. Conductor: ASTM B8 16 gage Soft drawn tinned copper, Class B or C stranded.
4. Insulation: Polyvinyl Chloride (PVC)/ Nylon, -30 degree C to +90 degree C temperature rated, 600 Volt.
5. Colors: ICEA Method-1: Pairs- Black and Red.
6. Shield: 100 percent, Beldfoil with #16AWG stranded tinned copper drain wire.
7. Jacket: 119 mil Polyvinyl Chloride (PVC), UL1277.

2.5 SHIELDED ETHERNET CABLE

- A. Manufacturers:
 1. Phoenix Contact order #1416347
- B. Conductor: 26 AWG Stranded Copper
- C. Insulation:
 1. CMP: FEP
 2. CMR: Polyolefin
- D. Pairing:
 1. 1: ORN + WHT/ORN
 2. 2: BLU + WHT/BLU
 3. 3: GRN + WHT/GRN
 4. 4: BRN + WHT/BRN
- E. Cabling: four twisted pairs around a star filler, wrapped with a polyester foil tape.
- F. Jacket:
 1. CMP: Low smoke PVC
 2. CMR: PVC
 3. PUR
- G. Connectors: Phoenix Contact order #1419001.
- H. Tools: Phoenix Contact order #1657407

2.6 WIRING CONNECTORS

- A. Non-reversible Compression Connectors:
 1. Burndy
 2. T & B Model Stakon.
 3. T & B Model Color Keyed.
 4. T & B Model Blackburn
 5. Substitutions: Substitutions: Not Permitted.
- B. Motor Termination Kits:
 1. Tyco Gel Cap Insulating Splice

2. 3M Motor Lead Pigtail Splice
3. Substitutions: Substitutions: Not Permitted.

2.7 SOURCE QUALITY CONTROL

- A. Material and equipment shall be listed or recognized by Underwriters Laboratories Inc. (UL) for the use intended.
- B. The Owner and Construction Manager require the specified manufacturer to provide the equipment and/or products to be furnished under this section. The Owner and Construction Manager believe the manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this Section. Manufacturers shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify interior of building has been protected from weather.
- B. Verify mechanical work likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.

3.2 PREPARATION

- A. Mandrel and swab all conduits 2" and larger after conduit installation.
- B. Complete raceway installation prior to conductor installation.

3.3 EXISTING WORK

- A. Remove exposed abandoned wire and cable. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.

- D. Extend existing circuits using materials and methods [compatible with existing electrical installations, or] as specified.

3.4 INSTALLATION

- A. Route wire and cable to meet Project conditions.
- B. Neatly train and lace wiring inside boxes, equipment, and panelboards. Train and bundle conductors with cable ties, black polypropylene, T&B brand, series TYP or equivalent. Adhesive mounting bases are not allowed, epoxy or screw type only. Cable ties to be trimmed with a cable tie installation tool or twisted off as not to leave a sharp edge.
- C. Identify wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
- D. Terminations shall be irreversible crimp type connectors. Mechanical lugs allowed only if approved
- E. If mechanical lugs are approved, apply an approved anti-galling compound such as Noalox or Kopr-Shield to the threads before terminating. If mechanical lugs are approved, only two conductors per lug allowed unless listed otherwise
- F. Special Techniques--Building Wire in Raceway:
 - 1. Pull conductors into raceway at same time.
- G. Special Techniques – Cable:
 - 1. Avoid abrasion and other damage to cables during installation.
 - 2. Use suitable cable fittings and connectors.
- H. Special Techniques – Underground ducts, long raceway pulls, and sizes 4AWG and larger:
 - 1. Provide tarps to protect cables from direct contact with the ground and abrasion during pulls.
 - 2. Use manufacturer approved lubricants and pulling equipment.
 - 3. Submit pull tension and side wall pressure forms for engineering approval.
 - 4. Provide pull tension and side wall pressure calculations four weeks prior to installation for engineering approval.
 - 5. Engineering to witness cable installation, and all splices and terminations. Inform engineering one week prior to cable installation.
 - 6. Sustain cable pulling tensions, side wall pressure and bending radii below manufacturer's recommended limits.
- I. Special Techniques - Wiring Connections:
 - 1. Clean conductor surfaces before installing lugs and connectors.
 - 2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 - 3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.

4. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller on lighting and receptacle circuits only.
- J. Install stranded conductors for branch circuits . Install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.
- K. Special Techniques for Motor Connections:
 1. Above 25 HP: Motor Termination Kits
 2. Less than 25 HP: Install insulated spring wire connectors with plastic caps, tape wrapped.
- L. 24 VDC control and analog signal conductors and cables shall not be routed in the same raceways with 120 Volt or higher circuits.

3.5 WIRE COLOR

- A.
 - A. General:
 1. For wire sizes 500 kcmil and smaller, install wire colors by continuous colored insulation in accordance with the following:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Brown, orange, and yellow for circuits at 277/480 volts single or three phase.
 2. For wire sizes 600 kcmil and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Brown, orange, and yellow for circuits at 277/480 volts single or three phase.
 - B. Neutral Conductors: White for 120/208 volt and 120/240 volt circuits, Grey for 277/480 volt circuits. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
 - C. Ground Conductors:
 1. Identify and color code ground conductors under provisions of Section 26 05 26.
 - D. Analog Loops: Black is the most negative conductor when White / Black, Red / Black or Clear /Black color codes are used on shielded twisted pair cables.

3.6 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4. Refer to Section 26 05 00 – Common Work Results for Electrical.
- B. Perform inspections and tests listed in NETA ATS, Section 7.3.1. Refer to Section 26 05 00 – Common Work Results for Electrical.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ground rods.
 - 2. Chemical ground rods.
 - 3. Bonding and grounding electrode conductors.
 - 4. Grounding well components.
 - 5. Mechanical connectors.
 - 6. Exothermic connections.
- B. Related Sections:
 - 1. Section 26 05 00 – Common Work Results for Electrical.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
 - 3. IEEE 81 – Guide for measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

- A. Grounding systems use the following elements as grounding electrodes:
 - 1. Metal building frame.
 - 2. Concrete-encased electrode.

3. Existing Metal underground gas piping system.
4. Ground rod.
5. Plate electrode.

1.4 DESIGN REQUIREMENTS

- A. Not Included.

1.5 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 2 ohms maximum.

1.6 SUBMITTALS

- A. Product Data: Submit data on ground rods, wells, and connections.
- B. Test Reports: Indicate overall resistance to ground and resistance of each ground rod and equipment ground bus.
- C. Manufacturer's Installation Instructions: Submit for chemical ground rods.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements .

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of components and ground rods

1.8 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and has a UL label.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.10 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.12 COORDINATION

- A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 GROUND RODS

- A. Manufacturers:
 - 1. Apache Grounding/Erico Inc.
 - 2. Copperweld, Inc..
 - 3. Erico, Inc..
 - 4. O-Z Gedney Co..
 - 5. Thomas & Betts.
 - 6. Burndy .
 - 7. Substitutions: Not Permitted.
- B. Product Description:
 - 1. Material: Copper-clad steel.
 - 2. Diameter: 3/4 inch .
 - 3. Length: 10 feet .
- C. Connector: Connector for exothermic welded connection or irreversible crimp by Burndy.

2.2 CHEMICAL GROUND RODS

- A. Manufacturers:
 - 1. Apache Grounding/Erico Inc. .
 - 2. Copperweld, Inc..
 - 3. Erico, Inc..
 - 4. O-Z Gedney Co..
 - 5. Thomas & Betts, Electrical .
 - 6. Substitutions: Not Permitted.

- B. Product Description:
 - 1. Material: Metallic-salt-filled copper-tube electrode.
 - 2. Shape: Straight.
 - 3. Length: 10 feet.
 - 4. Connector: Connector for exothermic welded connection. or U-bolt clamp if test point requiring disconnection.

2.3 WIRE

- A. Material: Soft drawn, bare annealed copper, concentric strand.
- B. Foundation Electrodes: 4/0 AWG.
- C. Grounding Electrode Conductor: Copper conductor bare, minimum 20 feet.
- D. Bonding Conductor: Copper conductor with continuous green factory insulation.

2.4 GROUNDING WELL COMPONENTS

- A. Well Pipe: 8 inches NPS by 24 inches long [fiberglass] pipe with belled end.
- B. Well Cover: Cast iron with legend "GROUND" embossed on cover.

2.5 MECHANICAL IRREVERSIBLE CRIMP CONNECTORS

- A. Manufacturers:
 - 1. Burndy
 - 2. Burndy Model YGF_Ground Plate.
 - 3. Substitutions: Not Permitted.
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation, materials, accessories, and tools for preparing and making permanent field connections between grounding system components.
- C. Mechanical connectors and split bolt connectors are not allowed. Only mechanical irreversible connectors are allowed.

2.6 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. Apache Grounding/Erico Inc.
 - 2. Cadweld, Erico, Inc.
 - 3. Copperweld, Inc.
 - 4. ILSCO Corporation

5. O-Z Gedney Co.
6. Thomas & Betts
7. Substitutions: Not Permitted.

- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.7 SOURCE QUALITY CONTROL

- A. Material and equipment shall be listed or recognized by Underwriters Laboratories Inc. (UL) for the use intended.
- B. The Owner and Construction Manager require the specified manufacturer to provide the equipment and/or products to be furnished under this section. The Owner and Construction Manager believe the manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this Section. Manufacturers shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify final backfill and compaction has been completed before driving ground rods.

3.2 PREPARATION

- A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.3 EXISTING WORK

- A. Modify existing grounding system to maintain continuity to accommodate renovations.
- B. Extend existing grounding system using materials and methods compatible with existing electrical installations, or as specified.

3.4 INSTALLATION

- A. Install in accordance with IEEE 142 and 1100 .
- B. Install ground rods at locations as indicated on Drawings . Install additional ground rods to achieve specified resistance to ground.

- C. Install grounding and bonding conductors concealed from view. Grounding conductors shall not utilize wire nuts or split bolt connectors for terminations or splices.
- D. Compression irreversible crimps shall be made with manufacturer's recommended crimping tool.
- E. Install ground well pipe with cover at each rod location. Install well pipe top flush with finished grade.
- F. Install 4/0 AWG bare copper wire in foundation footing as indicated on Drawings .
- G. Install grounding electrode conductor and bond to reinforcing steel in foundation footing as indicated on Drawings .
- H. Bond together metal siding not attached to grounded structure; bond to system ground.
- I. Bond together each metallic raceway, pipe, duct and other metal object entering building.
- J. Equipment Grounding Conductor: Install separate, green insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- K. Equipment Grounding Conductor: Install separate, green insulated conductor within each instrument analog signal raceway. Terminate each end on suitable lug, bus, or bushing.
- L. Bond switchboards, panelboards, MCCs, transformer frames, equipment skids, equipment racks, motor frames, well casings, RTU radio antenna surge suppressors, and electromagnetic flow meters to site grounding system. Install Burndy YGF ground plate in concrete slab at each device. Install green insulated bond jumper from ground plate to equipment.
- M. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
- N. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
- O. Install branch circuits feeding isolated ground receptacles with separate insulated green with yellow stripe grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
- P. Install green insulated equipment grounding conductor with feeders and branch circuit conductors in conduits. Size equipment grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal

enclosures of service equipment. Ground each conduit by means of a grounding bushing at terminations with installed green insulated No. 12 AWG conductor to grounding bus.

- Q. Permanently attach equipment and system grounding conductors prior to energizing equipment.
- R. Provide single ground bus bar or terminal strip in each control panel, disconnect switch, wireway or electrical enclosure to which all ground connections are made. No direct ground connections to panel chassis or back plate are allowed.
- S. Install threaded ground bushings at both ends of rigid conduit runs. Bond ground bushings to the grounding system. Ground bushings shall be of the set screw locking, bond wire lay-in connection, with insulated throat.
- T. Paint or provide protection for grounding conductor to grounding / bonding connection point.

3.5 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4. Refer to Section 26 05 00 – Common Work Results for Electrical.
- B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13. Refer to Section 26 05 00 – Common Work Results for Electrical.
- C. Perform ground resistance testing in accordance with IEEE 81 and 142.
- D. Perform leakage current tests in accordance with NFPA 99.
- E. Perform continuity testing in accordance with IEEE 142.
- F. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. **Section Includes:**
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Equipment bases and supports.
- B. **Related Sections:**
 - 1. Section 26 05 00 – Common Work Results for Electrical.

1.2 REFERENCES

- A. **FM Global:**
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- B. **National Fire Protection Association:**
 - 1. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. **Shop Drawings:** Indicate system layout with location and detail of trapeze hangers.
- B. **Product Data:**
 - 1. **Hangers and Supports:** Submit manufacturers catalog data including load capacity.
 - 2. **Design Data:** Indicate load carrying capacity of trapeze hangers and hangers and supports.
 - 3. **Manufacturer's Installation Instructions:**
 - a. **Hangers and Supports:** Submit special procedures and assembly of components.
 - 4. **Manufacturer's Certificate:** Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. B-Line
 - 2. Robroy
 - 3. Perma-Cote
 - 4. O-Z Gedney Co.
 - 5. T&B
 - 6. Substitutions: Not Permitted.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon, 316 stainless or PVC coated steel as dictated by the area of installation with free running threads with matching hardware.
- C. Beam Clamps: Malleable iron, 316 stainless, or PVC coated with tapered hole in base and back to accept either bolt or hanger rod. Set screw: galvanized or 316 stainless steel.
- D. Conduit strut straps: Galvanized for Rigid Steel Conduit or PVC Coated for PVC coated Rigid Steel Conduit.
- E. Conduit clamps - general purpose: One hole with back strap malleable iron for Rigid Steel Conduit or PVC coated for PVC coated Rigid Steel Conduit.

- F. When PVC coated straps and clamps are used they are to be of the same manufacturer as the PVC coated conduit.

2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Super Strut
 - 2. B-Line Systems
 - 3. Unistrut Corp.
 - 4. Substitutions: Not Permitted.
- B. Product Description: 12 gauge steel hot-dipped galvanized for Rigid Steel Conduit or PVC coated steel for PVC Rigid Steel Conduit. Strut fittings and brackets to match strut type.

2.3 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation
 - 3. Crouse Hinds Model TW Series.
 - 4. Substitutions: Not Permitted.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill equipment or wall penetrations annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
- C. Color: Red.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide 316 stainless steel expansion anchors and preset inserts.
 - 2. Steel Structural Elements: Provide beam clamps, and welded fasteners.
 - 3. Concrete Surfaces: Provide 316 stainless steel expansion anchors.
 - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.

5. Solid Concrete Walls: Provide 316 stainless steel expansion anchors and preset inserts.
 6. Sheet Metal: Provide sheet metal screws.
 7. Wood Elements: Provide wood screws.
- B. Inserts:
1. Install inserts for placement in concrete forms.
 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- C. Install conduit and raceway support and spacing in accordance with NEC.
- D. Do not fasten supports to guard rails, hand rails, pipes, ducts, mechanical equipment, or conduit.
- E. Install multiple conduit runs on common hangers.
- F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers with square strut washers top and bottom under nuts.
 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
 4. Support vertical conduit at every floor in multiple floor buildings.

3.3 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads and equipment bases of concrete, minimum 3-1/2 inches thick and extending 2 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install 316 stainless steel anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.

3.4 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.

- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with stuffing or fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install stainless steel escutcheons at finished surfaces.

3.5 FIELD QUALITY CONTROL

- A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.6 PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, and pull and junction boxes.
- B. Related Sections:
 - 1. Section 26 05 00 – Common Work Results for Electrical.
 - 2. Section 26 05 03 - Equipment Wiring Connections.
 - 3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 4. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 5. Section 26 05 53 - Identification for Electrical Systems.
 - 6. Section 26 27 16 - Electrical Cabinets and Enclosures.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory

requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

- B. Underground More than 5 feet outside Foundation Wall: Provide PVC conduit for straight underground runs. Schedule 40 if concrete encased. All 90 degree bends to be PVC coated rigid steel conduit. Provide cast concrete boxes.
- C. Underground within 5 feet from Foundation Wall: Provide PVC coated rigid steel conduit. Provide cast concrete boxes.
- D. In or Under Slab on Grade: Provide Schedule 40 PVC conduit for straight underground runs. All 90 degree bends to be PVC coated rigid steel conduit. Provide cast concrete boxes.
- E. Outdoor Locations, Above Grade: Provide PVC coated rigid steel conduit. Provide cast FD PVC Coated outlet boxes with cast threaded hubs, NEMA 4X stainless steel pull, and junction boxes, appropriate for the environmental conditions.
- F. In Slab Above Grade: Provide PVC coated rigid steel conduit . Provide cast PVC Coated outlet boxes with threaded hubs, appropriate for the environmental conditions.
- G. Conduit Stub-ups or Penetrating Slab or Columns: PVC coated rigid steel conduit.
- H. Wet and Damp Locations: Provide PVC coated rigid steel conduit. Provide cast FD PVC Coated outlet boxes with cast threaded hubs, NEMA 4X stainless steel pull, and junction boxes, appropriate for the environmental conditions.
- I. Indoor Dry Locations: Provide rigid steel conduit Provide NEMA Type 12 boxes. Provide flush mounting outlet box in finished areas. Use hinged covers on boxes 24" and larger.
- J. Use hinged covers on boxes 24" and larger, all conditions..

1.4 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.5 SUBMITTALS

- A. Product Data: Submit for the following:
 - 1. Metallic conduit.
 - 2. Liquidtight flexible metal conduit.
 - 3. Nonmetallic conduit.
 - 4. Raceway fittings.
 - 5. Conduit bodies.
 - 6. Surface raceway.

7. Wireway.
8. Outlet boxes.
9. Pull and junction boxes.

- B. **Manufacturer's Installation Instructions:** Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

- A. **Project Record Documents:**

1. Record actual routing of all conduits.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. **Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.**
- B. **Protect PVC conduit from sunlight.**

1.8 COORDINATION

- A. **Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.**
- B. **Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.**

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. **Manufacturers:**
1. LTV Steel Tubular Products Company.
 2. Triangle PWC, Inc.
 3. Allied Tube and Conduit Corporation
 4. Substitutions: Not Permitted.
- B. **Rigid Steel Conduit: ANSI C80.1.**
- C. **Fittings and Conduit Bodies: NEMA FB 1; cast malleable iron for rigid conduit, material to match all other material.**

2.2 PVC COATED METAL CONDUIT

- A. **Manufacturers:**
 - 1. Plasti-Bond
 - 2. Robroy
 - 3. Perma-Cote
 - 4. Substitutions: Not Permitted.

- B. **Product Description:** NEMA RN 1; ETL label for high temperature H₂O PVC coating adhesion test “ETL Verified PVC-001”; rigid steel conduit with external PVC coating, [40] mil thick.

- C. **Fittings and Conduit Bodies:** NEMA FB 1; steel fittings and conduit bodies with external PVC coating to be from the same manufacturer as the PVC coated conduit.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. **Manufacturers:**
 - 1. ALFLEX
 - 2. Allied Tube and Conduit Corporation
 - 3. Electri-Flex
 - 4. Substitutions: Not Permitted.

- B. **Product Description:** Interlocked steel construction with PVC jacket.

- C. **Fittings:** NEMA FB 1. Steel fittings, cast fittings not allowed. Damp and Wet locations PVC coated steel fittings to match PVC coated conduit manufacturer.

2.4 NONMETALLIC CONDUIT

- A. **Manufacturers:**
 - 1. Carlon Electrical Products
 - 2. Triangle Conduit and Cable
 - 3. Cantex
 - 4. Substitutions: Not Permitted.

- B. **Product Description:** NEMA TC 2; Schedule 40 PVC.

- C. **Fittings and Conduit Bodies:** NEMA TC 3.

2.5 SURFACE METAL RACEWAY

- A. **Manufacturers:**
 - 1. Carlon Electrical Products
 - 2. Hoffman Wiring Devices
 - 3. Thomas & Betts Corp.
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
 - 6. Substitutions: Not Permitted.

- B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- C. Minimum Size: 6" x 6" inch.
- D. Finish: Gray enamel. Stainless steel for wet, damp, process, outdoor, washdown, or corrosive areas.
- E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.6 WIREWAY

- A. Manufacturers:
 1. Carlon Electrical Products
 2. Hubbell Wiring Devices
 3. Thomas & Betts Corp.
 4. Walker Systems Inc.
 5. The Wiremold Co.
 6. Substitutions: Not Permitted.
- B. Product Description: Oiltight and dust-tight or Raintight type wireway.
- C. Knockouts: None.
- D. Cover: Hinged cover with full gaskets.
- E. Connector: Flanged.
- F. Fittings: Lay-in type with removable top, bottom, and side; captive screws
- G. Finish: Rust inhibiting primer coating with gray enamel finish. NEMA 4X stainless steel for wet, damp, process, outdoor, washdown, or corrosive areas.

2.7 OUTLET BOXES

- A. Manufacturers:
 1. Carlon Electrical Products
 2. RACO/Hubbell Wiring Devices
 3. Thomas & Betts Corp.
 4. Crouse Hinds
 5. Appleton
 6. Substitutions: Not Permitted.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
 2. Concrete Ceiling Boxes: Concrete type.
- C. Nonmetallic Outlet Boxes: NEMA OS 2.
- D. Cast Boxes: NEMA FB 1, Type FD cast epoxy coated malleable iron or PVC coated depending on environmental conditions, with cast threaded conduit hubs. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- E. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- F. Wall Plates for Unfinished Areas: As specified in Section 26 27 26.

2.8 PULL AND JUNCTION BOXES

- A. Manufacturers:
1. Hoffman
 2. Substitutions: Not Permitted.
- B. Mild Steel Boxes: NEMA Type 12 boxes for indoor use.
- C. Mild Steel Boxes: NEMA Type 4 boxes for outdoor use.
- D. Hinged Enclosures: As specified in Section 26 27 16.
- E. Surface Mounted Metal Box: NEMA 250, Type 4X stainless steel for wet, damp, process, washdown, or corrosive areas 6 for vaults or where subject to flooding; flat-flanged, surface mounted junction box:
- F. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover box for flush mounting:
1. Material: Galvanized cast iron .
 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 3. Cover Legend: "ELECTRIC".

2.9 SOURCE QUALITY CONTROL

- A. Material and equipment shall be listed or recognized by Underwriters Laboratories Inc. (UL) for the use intended.
- B. The Owner and Construction Manager require the specified manufacturer to provide the equipment and/or products to be furnished under this section. The Owner and Construction Manager believe the manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this Section. Manufacturers shall be as specified

for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

- A. Remove exposed abandoned raceway,. Cut raceway flush with walls and floors, and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- E. Extend existing raceway and box installations using materials and methods as specified only.
- F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

- A. Ground and bond all raceways and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.
- E. Install exposed raceway and boxes plumb and level, parallel and perpendicular to walls

3.4 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29 ; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway plumb and level, parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit in and under slab from point-to-point.
- K. Maximum Size Conduit in Slab Above Grade: 3/4 inch Do not cross conduits in slab.
- L. Maintain clearance between raceway and piping for maintenance purposes.
- M. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F .
- N. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- O. Bring conduit to shoulder of fittings; fasten securely.
- P. Join nonmetallic conduit using primer and cement. Wipe nonmetallic conduit dry and clean before joining. Apply primer and a full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- Q. Install Meyer's type conduit hubs on all boxes and equipment that do not have threaded hubs for the purpose.
- R. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2 inch size.
- S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

- T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control, and expansion joints.
- U. Install 1250 lb. measuring tape in conduits ¾" thru 1.5" and 2500 lb. measuring tape for conduits 2" and larger. Install measuring tape in each empty raceway except sleeves and nipples.
- V. Install suitable caps or plugs on all spare conduits to protect installed conduit against entrance of dirt and moisture.
- W. Surface Raceway: Install anchors , clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- X. Seal all used conduits 1" and larger using either sealing bushings or fire stop compound.
- Y. Liquidtight flexible metal conduit angle fittings allowed only at the final termination of conduit runs. Minimum length 18 inches, Maximum length 3 feet.
- Z. Work and installation shall comply with Section 26 05 00.
- AA. Mandrel all underground conduits 2" and larger prior to cable pulling.

3.5 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings or as specified in Section 26 27 26 for outlet devices.
- B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
- C. Install and orient boxes to accommodate wiring devices as specified in Section 26 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- F. Do not fasten boxes to ceiling support wires or other piping systems.
- G. Support boxes independently of conduit.
- H. Install gang box where more than one device is mounted together. Do not use sectional box.
- I. Install gang box with plaster ring for single device outlets.

J. Work and installation shall comply with Section 26 05 00.

3.6 INTERFACE WITH OTHER PRODUCTS

- A. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
- B. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused openings in boxes.

3.8 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

ARC FLASH HAZARD ANALYSIS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes short circuit protective device coordination study and arc flash hazard analysis encompassing portions of electrical distribution system from normal power source or sources up to and including breakers in service entrance switchboard, fuses in service entrance switchboard, main breaker in sub-distribution panels, and main breaker in each panelboard.

- B. Related Sections:
 - 1. Section 26 05 13 - Medium-Voltage Cables.
 - 2. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 - 3. Section 26 13 19 - Medium-Voltage Vacuum Interrupter Switchgear.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution in Industrial Plants
 - 2. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).

- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.3 DESIGN REQUIREMENTS

- A. Complete Short Circuit and Protective Device Coordination Study to meet requirements of NFPA 70.

- B. Report Preparation:
 - 1. Prepare study prior to ordering distribution equipment to verify equipment ratings required.
 - 2. Perform study with aid of SKM computer software program.
 - 3. Obtain actual settings for motor characteristics and for equipment incorporated into Work.

 - 4. Calculate short circuit interrupting and, when applicable, momentary duties for assumed 3-phase bolted fault short circuit current and phase to ground fault short circuit current at each of the following:
 - a. Utility supply bus.
 - b. Medium voltage air interrupter switchgear.
 - c. Medium voltage circuit breaker switchgear.
 - d. Automatic transfer switch.
 - e. Manual transfer switch.
 - f. Engine generator.
 - g. Medium voltage motor controllers.
 - h. Low-voltage switchgear.
 - i. Switchboards.
 - j. Motor control centers.
 - k. Distribution panelboards.
 - l. Branch circuit panelboards.
 - m. Busway.
 - n. Each other significant equipment location throughout system.

- C. Report Contents:
 - 1. Include the following:
 - a. Calculation methods and assumptions.
 - b. Base per unit value selected.
 - c. One-line diagram.
 - d. Source impedance data including power company system available power and characteristics.
 - e. Typical calculations.
 - 1) Fault impedance.
 - 2) X to R ratios.
 - 3) Asymmetry factors.
 - 4) Motor fault contribution.
 - 5) Short circuit kVA.
 - 6) Symmetrical and asymmetrical phase-to-phase and phase-to-ground fault currents.
 - 7) Tabulations of calculation quantities and results.
 - f. One-line diagram revised by adding actual instantaneous short circuits available.
 - g. State conclusions and recommendations.

2. Prepare time-current device coordination curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms.
 3. Prepare with each time-curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet.
 4. Prepare detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
 5. Plot device characteristic curves at point reflecting maximum symmetrical fault current to which device is exposed. Include on curve sheets the following:
 - a. Power Company relay characteristics.
 - b. Power Company fuse characteristics.
 - c. Medium voltage equipment protective relay characteristics.
 - d. Medium voltage equipment protective fuse characteristics.
 - e. Low voltage equipment circuit breaker trip device characteristics.
 - f. Low voltage equipment fuse characteristics.
 - g. Cable damage point characteristics.
 - h. Pertinent transformer characteristics including:
 - 1) Transformer full load current.
 - 2) Transformer magnetizing inrush.
 - 3) ANSI transformer withstand parameters.
 - 4) Significant symmetrical fault current.
 - i. Pertinent motor characteristics.
 - j. Generator characteristics including:
 - 1) Phase and ground coordination of generator protective devices.
 - 2) Decrement curve and damage curve.
 - 3) Operating characteristic of protective devices.
 - 4) Actual impedance value.
 - 5) Time constants.
 - 6) Current boost data.
 - 7) Do not use typical values for generator.
 - k. Transfer switch characteristics.
 - l. Other system load protective device characteristics.
- D. Obtain and verify all data needed to perform the arc flash hazard analysis. The arc flash hazard analysis shall include the following IEEE Standard 1584 nine step analysis process:
1. Collect system and installation data.
 2. Determine modes of operation.
 3. Determine bolted fault current.
 4. Determine arc fault current.
 5. Determine protective device characteristic and arc fault duration.
 6. Document system voltages and equipment class.
 7. Select working distances.
 8. Calculate incident energy.
 9. Calculate the arc flash protection boundary.

1.4 SUBMITTALS

- A. **Qualifications Data:** Submit the following for review prior to starting study.
 - 1. Qualifications and background of Preparer.
 - 2. Qualifications of Professional Engineer performing study.
 - 3. Provide reference names and current phone numbers of the Owner, Contractor, Engineer, or Construction Manager that has knowledge of the Preparer's work:
 - a. Three projects for Owner completed within the past four years, or
 - b. Three projects for the Engineer completed within the past four years, or
 - c. Provide references for five recent projects that were completed within the last four years. Provide a description of the scope of the referenced project.
- B. **Software:** Submit for review information on software proposed to be used in performing study.
- C. **Product Data:** Submit the following:
 - 1. **Report:** Summarize results of study in report format including the following:
 - a. Descriptions, purpose, basis, and scope of study.
 - b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
 - c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
 - d. Fault current calculations including definition of terms and guide for interpretation of computer printout.
 - e. Results of the arc flash hazard analysis.
- D. Submit copies of final report signed by professional engineer. Make additions or changes required by review comments.
- E. Submit electronic copy of the SKM software files used for the coordination study.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of each document on site.
- B. Use commercially available SKM software, designed specifically for short circuit and protective device coordination studies.
- C. Perform study in accordance with IEEE 242.
- D. Base study on final reviewed equipment submittals, not just contract documents. Preparer shall request copies of submittals from the Contractor. Contractor shall advise Preparer of changes or modifications to electrical equipment affecting the study.

1.6 QUALIFICATIONS

- A. Study Preparer: Company specializing in performing work of this section with minimum 5 years documented experience. The Company shall be independent, providing unbiased study authority, professionally independent of the manufacturer, suppliers, and installers of equipment or systems to be evaluated by the Study Preparer.
- B. Perform study under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Arizona with minimum of five years experience in power system analysis.
- C. Demonstrate company performing study has capability and experience to provide assistance during system start up.

1.7 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

- A. Complete study within 10 weeks after pre-installation meeting.
- B. Allow 4 weeks for review of completed study by Owner/Engineer.
- C. Submit short circuit protective device coordination study and arc flash hazard analysis to [Owner/Engineer] prior to receiving final approval of distribution equipment shop drawings and prior to releasing equipment for manufacturing.
- D. When formal completion of the short circuit protective device coordination study and arc flash hazard analysis will cause delay in equipment manufacturing, obtain approval from [Owner/Engineer] for preliminary submittal of study data sufficient in scope to ensure selection of device ratings and characteristics will be satisfactory.

1.9 SCHEDULING

- A. Schedule work to expedite collection of data to ensure completion of short circuit protective device coordination study and arc flash hazard analysis before final approval of distribution equipment shop drawings prior to release of equipment for manufacturing.

1.10 COORDINATION

- A. Coordinate work with local power company.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Provide assistance to electrical distribution system equipment manufacturer during start up of electrical system and equipment.
- B. Select each primary protective device for delta-wye connected transformer so device's characteristic or operating band is within transformer characteristics; including point equal to 58 percent of ANSI withstand point to provide secondary line-to-ground fault protection.
- C. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by 16 percent current margin to provide proper coordination and protection in event of secondary line-to-line faults.
- D. Separate medium-voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.

3.2 ADJUSTING

- A. Perform field adjustments of protective devices and modifications to equipment to place equipment in final operating condition. Adjust settings in accordance with approved short circuit and protective device coordination study.

3.3 ARC FLASH SIGNAGE

- A. Study Preparer shall fabricate signs or labels with the arc flash hazard study results in accordance with NFPA 70E that includes the Arc Flash Protection Boundary, Limited Approach Boundary, Prohibited Approach Boundary, Restricted Approach Boundary, Calculated Incident Energy, and the required level of personnel protective equipment (PPE).
- B. The Study Preparer shall work with the Contractor for implementing the Arc Flash Hazard sign or label installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.
- C. The signs or labels shall be rated for outdoor use.

END OF SECTION

SECTION 26 13 19

MEDIUM-VOLTAGE METAL-CLAD SWITCHGEAR

1. SCOPE

- 1.1. The switchgear for this facility is existing and is manufactured by ABB. A new section shall be added to the existing gear in accordance with the contract drawings. Additional modifications to existing sections are required as shown on the contract drawings. Coordination with the manufacturer and manufacturer's representative are required for all modifications and additions to the switchgear. Reference ABB S.O. CS01014.

2. REFERENCES

- 2.1. The assemblies shall be constructed, wired, and tested in accordance with all applicable sections of the latest listed Standards and Codes.
- 2.1.1. American National Standards Institute ANSI / IEEE
- 2.1.1.1. C37.04 Standard Rating Structure for AC HV Circuit Breakers
 - 2.1.1.2. C37.06 Preferred Ratings for AC HV Circuit Breakers
 - 2.1.1.3. C37.09 Standard Test Procedure for AC HV Circuit Breakers
 - 2.1.1.4. C37.010 Application Guideline for AC HV Circuit Breakers
 - 2.1.1.5. C37.011 Application Guide for TRV for AC HV Circuit Breakers
 - 2.1.1.6. C37.012 Application Guide for Capacitance Switching
 - 2.1.1.7. C37.11 Requirements for Electrical Control
 - 2.1.1.8. C37.20.2 Standard for Metal-Clad and Station-Type Cubicle Switchgear
 - 2.1.1.9. C37.55 Conformance Testing Procedure of Metal-Clad Switchgear
 - 2.1.1.10. C57.10 Requirements for Instrument Transformers
 - 2.1.1.11. C57.13 Requirements for Instrument Transformers
 - 2.1.1.12. 47 Guide for Surge Withstand Capability Tests
- 2.1.2. National Electrical Manufacturers Association (NEMA)
- 2.1.2.1. CC1 Electrical Power Connectors
 - 2.1.2.2. SG-4 Standards for Power Circuit Breakers
 - 2.1.2.3. SG-5 Power Switchgear Assemblies
- 2.1.3. NEC / NFPA
- 2.1.3.1. 70E 2002 Edition (applicable portions)
- 2.2. Design tests, to verify ANSI ratings as identified in this specification, shall be documented as required by ISO9001-2000 and available for review and inspection.
- 2.3. Optional - Seismic assessment shall be conducted to assure the switchgear will withstand seismic levels through UBC Zone 4. Any special design or installation considerations to assure compliance with this requirement will be thoroughly documented on project drawings.
- 2.4. It shall be the Vendor and/or manufacturer's responsibility to be, or to become, knowledgeable of the requirements of these Standards and Codes. Any changes or alternations to the equipment to make it meet Standards and Codes requirements shall be at the expense of the Vendor.

3. GENERAL DESIGN REQUIREMENTS

3.1. The switchgear shall have a voltage rating of 4.76 kV. The switchgear will be Two high construction with indoor frame size of 36" wide x 95" high x standard – 85" deep. End dress panels will be provided on each end of a lineup and can extend the width by approximately one inch on each end. The switchgear shall meet indoor standards as defined in ANSI C37.20.2. The switchgear will be used in a 4.16 kV, 3-phase, 60 Hz system. It shall be composed of factory assembled metal clad cubicles. The circuit breakers shall be designed with vacuum interrupter technology and shall incorporate a spring operated or magnetically actuated mechanism.

3.2. Ratings

3.2.1. The switchgear will have the following rating:

3.2.1.1.	Rated Maximum Voltage	4.76 kV
3.2.1.2.	Operating Voltage	4.16 kV
3.2.1.3.	Main Bus Continuous Rating	2000 A

4. BASIC CONSTRUCTION

- 4.1. The switchgear assembly shall consist of metal-clad, free-standing, vertical, dead-front steel structures containing circuit breaker compartments and circuit breakers, primary bus system, ground bus system, auxiliary compartments and transformers, protection and control devices, control bus (as required) and connection provisions for primary, ground, and control circuits. The basic structure will be of modular construction and fabricated mainly of highly reflective, 14 gauge galvanic steel, which does not require painting due to superior resistance to corrosion. The switchgear enclosure will be constructed of double wall galvanic steel with an air gap between sheets and in the event of a fault condition, the first layer will burn and the second layer will be insulated by the air gap.
- 4.2. The circuit breaker enclosure shall include stationary support bushings and primary contacts for engagement with the circuit breaker or ground and test (G&T) device. Standard bushings shall be made of glass-reinforced polyester (or optional porcelain) capable of supporting the weight of the current transformers. Primary contacts will be made of copper and designed to accept round, tulip style connectors.
- 4.3. The switchgear shall be designed so that future units can be added to each end (unless coupled to other equipment). A removable plate will cover any unused openings in the side of the gear.
- 4.4. Hem-bends (rigid overlap bending) will be consistently used when building the switchgear compartments to enhance strength and to minimize potential exposure of working personnel to sharp steel edges during installation and maintenance.
- 4.5. A ¼" x 2" tin plated copper ground bus shall be provided for the entire length of the switchgear. It shall be equipped with a solderless connector for #2/0 AWG copper cable at each end. The ground bus shall be accessible in the cable compartment, and shall have connection points in each switchgear section for workmen's grounds. The ground bus will be connected to the breaker frames and will ground the draw-out circuit breaker in and when traveling in between the connected and test positions. Bare, un-plated copper ground bus is unacceptable.

4.6. Bus bars

- 4.6.1. The main bus compartment shall be separated from the other compartments by an 11 gauge steel barrier (or equivalent) and shall fully enclose the main bus. The main bus compartment shall be accessible from the rear through the cable compartment. Main bus ratings shall match the highest rated circuit breaker continuous current ratings and comply with ANSI / IEEE temperature rise requirements.
 - 4.6.2. Bus bars shall be copper and shall be completely isolated and coated with an epoxy insulation that is flame retardant, non-hygroscopic and high-dielectric, except at bolted joints. The bus shall be mechanically braced for the close and latch rating of the breaker having the highest interrupting rating within each assembly. All bolted bus joints shall be (Standard – silver-plated) (Optional – tin-plated). The bus connections to the circuit breakers shall match the breaker rating. Bus supports shall be flame retardant, track resistant GPO-3 glass polyester (Optional – porcelain).
 - 4.6.2.1. Bus joint cover boots shall be manufactured from molded PVC and shall be removable and reusable for field inspection and maintenance. Taping of bus joints is not acceptable.
 - 4.6.3. The shape of the bus bar shall be full round edge. The main bus shall not be tapered.
 - 4.6.4. Bus bar connections shall be mechanically secured with reusable fastening devices that shall maintain adequate pressures at the joints within the operating temperature range of the switchgear.
 - 4.6.5. The bus bars and support systems shall be designed to withstand the forces created during short circuit conditions at the rated momentary and short-time (2-second) conditions of the highest rated circuit breaker. Supports shall be made of (Standard - glass polyester) (Optional - porcelain).
 - 4.6.6. An insulated, rigid, copper riser bus shall be provided from the circuit breaker / switchgear primary disconnects to a cable compartment location to allow cable termination lug connections. Riser bus connections to bus duct shall be rigid. Cable termination bus arrangement shall allow at least 36 inches for primary cable stress cones or potheads. Connections to roof entrance bushings shall include flexible straps from the rigid bus to the roof bushings.
 - 4.6.7. Standard termination bus shall meet the bolthole requirements of NEMA CC1-4.05, and shall typically be the NEMA 4-hole pattern. (Optional - Vendor will supply - crimp type cable lugs, compression type cable lugs, - as shown on project data sheets.)
 - 4.6.8. The design shall be adaptable for top or bottom primary entrance arrangements. In 2-high breaker arrangements, each set of primary connections and zero-sequence current transformers, if applicable, shall be isolated into separate compartments by a grounded steel partition in accordance with ANSI standards.
- 4.7. Bar type / zero-sequence current transformers, lighting arresters, surge capacitors, stationary control power transformers, ground sensors, or other auxiliary equipment shall be mounted in the cable compartments as shown on the single-line diagram and project data sheets. An optional 7" rear extension shall be provided to accommodate additional equipment and power cable if required.
 - 4.8. Control switches, instruments, meters, position indicating lights, protective relays, etc. shall be in a separate compartment from the circuit breaker unless specifically allowed by the project data sheets. All other monitoring devices such as CT's and limit switches may be located within other compartments. Low voltage compartment door mounted devices shall be mounted on the front of the switchgear panels and arranged in an approved,

logical, symmetrical manner. In those cases where there is not enough space on the door of the instrument compartment, a 10" front extension shall be installed to mount metering, protection, and control devices.

- 4.9. The breaker cubicles and circuit breaker units shall be constructed so that each unit of the same rating is interchangeable.
- 4.10. Solidly grounded metal (Optional – non-metallic poly carbonate) shutters shall automatically open when the breaker or G&T device is racked into the connected position and close (covering the primary contacts and current transformers) when racked to the test or disconnected positions or withdrawn from the cell. Shutter grounding shall be by dedicated ground wires, and shall not be dependent on grounding through hinges or moving contact surfaces. The actuation of the shutters must be by the movement of the circuit breaker. Gravity and spring-operated shutters are not acceptable.
- 4.11. Switches
 - 4.11.1. Breaker control switches shall not be mounted adjacent to meter switches, and shall have "pistol grip" handles. Switches to be Electros witch Series 24 or equivalent.
 - 4.11.2. Meter switches shall have "knurled knob" handles. Switches to be Electros witch Series 24 or equivalent.
 - 4.11.3. Control and instrument switches will be provided and wired in accordance with specified single line diagrams and data sheets, and will be mounted only on low voltage compartment doors and panels.
- 4.12. Externally-visible, permanent nameplates shall be provided to identify each instrument, instrument switch, meter, relay, control switch, indicating light, circuit breaker compartment, potential transformer compartment, and auxiliary compartment. Equipment and terminal blocks within the compartments shall be suitably identified. Relays shall be designated as to use and as to the phase to which they are connected. Nameplates shall be laminated plastic. Characters shall be black letters on a white background.
- 4.13. Auxiliary switches shall be wired out to terminal blocks for customer convenience.
- 4.14. The compartment door shall be securely held with tamper-resistant hinges and sealed with (standard - multiple, tamper-resistant, captive manual fasteners) (optional - a single handle, multi-point latching mechanism in available ratings). (Optional -Compartment doors will include provisions for padlocking. Others to supply locks).

5. POWER CIRCUIT BREAKERS

- 5.1. The power circuit breakers shall be electrically operated, 3-pole, draw-out type, with vacuum interrupters and manual charging of a spring type stored energy operating mechanism. The power circuit breaker shall be provided with self-aligning line-side and load-side disconnecting devices. Circuit breakers to be ABB type ADVAC.

OR

The power circuit breakers shall be electrically operated, 3-pole, draw-out type, with vacuum interrupters and a magnetic actuator operating mechanism with capacitor stored energy. The power circuit breaker shall be provided with self-aligning line-side and load-side disconnecting devices. Circuit breakers to be ABB type AMVAC. The circuit breaker mechanism shall have a life of 100,000 no-load operations.

- 5.2. The breaker racking system shall allow smooth, consistent breaker movement with the door closed and shall have three positions in addition to the fully withdrawn position; disconnect, test and connected. The circuit breaker shall stop and lock in all three positions, requiring operator action to move from one position to another. The circuit breaker door must be provided with impact resistant poly carbonate viewing window of at least 86 square inches and ½" thick to determine breaker position, open/closed indicator, spring charge status, and operations counter.
- 5.3. The circuit breaker will be provided with an integral racking mechanism. Circuit breakers utilizing switchgear mounted racking mechanisms separate from the circuit breaker are not acceptable.
- 5.4. The draw-out mechanism shall hold the breakers rigidly in the CONNECTED (primaries and secondaries engaged), TEST (primary contacts disconnected and shutter closed, but control contacts engaged) and DISCONNECTED (both primary and secondary contacts disengaged) positions, with the door closed. The secondary contact plug shall automatically disconnect when the breaker is moved from the TEST to the DISCONNECTED position. A single (25 pin) fully automatic, self-aligning, secondary disconnecting device shall be provided to act as a disconnect for the secondary connections between the circuit breaker and the switchgear. The disconnecting device shall be positioned and constructed as to not expose the operator to live parts. The secondary disconnect shall connect automatically when the circuit breaker is racked into the test and connected positions. A double (50 pin) disconnect arrangement shall be available as an option and provided as shown on project data sheets. The female portion of the disconnect system shall reside in the breaker compartment, so that energized contacts are recessed and remain "touch safe". To guarantee the integrity of operating personnel, it shall not be required to open or keep opened the door of the circuit breaker compartment after the breaker has been locked in the disconnected position to be able to rack the breaker or connect the secondary contacts, Circuit breakers that require manual connecting or disconnecting of the secondary contacts are unacceptable.
- 5.5. The breakers in the upper compartment and lower compartment shall be held captive in the cubicle by means of a latching mechanism, even in the disconnected position. Removal of the circuit breaker shall be by means of unlatching the mechanism and pulling the circuit breaker onto a lift truck. Cell must have a minimum of a 1" lip for proper sealing of the door and to prevent ingress of dirt and other contaminants. Circuit breakers that require rail extensions for circuit breaker removal are not acceptable.
- 5.6. Wheels shall be provided on the bottom of the circuit breaker for easy floor rolling after the breaker is removed from the frame. Circuit breakers that require a separately purchased floor rolling truck assembly are not acceptable.
- 5.7. Interlocks shall be provided which will prevent connecting the breaker to, or disconnecting it from the bus stabs unless the breaker is OPEN (tripped), assuring proper sequencing and safe operation. The close springs of the circuit breaker will automatically discharge when the breaker is released from the cell by pulling in on the truck latch assembly. Provisions shall be made for the addition of optional KIRK KEY interlocks, as shown on project data sheets and the single line diagram.
- 5.8. Control voltage and trip voltage shall be as follows:
 - 5.8.1. Close and trip circuits for each breaker shall be separately fused. Fuse blocks shall be dead front, pull-out type, which provides the control power disconnecting means.
- 5.9. The ADVAC circuit breaker shall be provided with a toroidal spring mechanism, which allows for the easiest manual charging in the industry. The mechanism shall rotate the main horizontal shaft in only one direction, in order to reduce wear and maintenance costs and eliminating mechanism binding. The breaker shall be equipped with the "stored energy operation" type, anti-pump-operating mechanism. It shall be possible to open and close

the breakers manually. The circuit breaker shall be capable of operating in three cycles which means smaller power cables, lower construction costs, and improved system quality. The mechanism shall be completely front accessible and maintainable by removing the faceplate. Breakers that require lifting to access the mechanism under the carriage are unacceptable.

- 5.10. A single (25 pin) fully automatic, self-aligning, secondary disconnecting device shall be provided to act as a disconnect for the secondary connections between the circuit breaker and the switchgear. The disconnecting device shall be positioned and constructed as to not expose the operator to live parts. The secondary disconnect shall connect automatically when the circuit breaker is racked into the test and connected positions. A double (50 pin) disconnect arrangement shall be available as an option and provided as shown on project data sheets. The female portion of the disconnect system shall reside in the breaker compartment, so that energized contacts are recessed and remain "touch safe". To guarantee the integrity of operating personnel, it shall not be required to open or keep opened the door of the circuit breaker compartment after the breaker has been locked in the disconnected position to be able to rack the breaker or connect the secondary contacts; Circuit breakers that require a manual secondary contact connecting plug are not acceptable.
- 5.11. The circuit breaker enclosure shall have interference blocking to prevent the insertion of improperly rated breakers. Note: Circuit breakers with a single secondary disconnect are not interchangeable with a dual secondary disconnect.
- 5.12. The breaker shall include 8 available mechanism operated contacts (MOC) consisting of 4a and 4b contacts, wired through the secondary disconnect. Up to 9 additional MOC contacts (5a, 4b) can be installed on the breaker and wired through the secondary disconnect, for a total of 17 available MOC contacts. All breaker-mounted contacts shall operate in both connected and test positions. Mechanism operated contacts that are installed external to the circuit breaker requiring complex linkages and alignment procedures to the breaker are not acceptable.
- 5.13. Provisions for padlocking breakers in any of the positions shall be included.
- 5.14. Circuit breaker power draw-out contacts shall be silver-plated.
- 5.15. The breaker shall have an mechanism device to indicate open or closed position, and spring charge status. Only the correct status flag for any single function shall be visible. Additionally, the breaker shall have a 5-digit, non-resettable operations counter.

6. INSTRUMENT AND CONTROL POWER TRANSFORMERS

6.1. Current Transformers

- 6.1.1. CT nameplates shall be located on the CT housing and information provided shall be in accordance with ANSI C57.13. The CT winding shall terminate on a screw type terminal on the CT housing and shall be wired to shorting terminal blocks. ABB type SAB current transformers shall be supplied as shown on project data sheets and the single line diagram. Zero-sequence transformers shall be ABB type BYZ-S.
- 6.1.2. Each current transformer shall have a 5-ampere secondary and a primary rating as shown on the Data Sheets and One-Line diagram.
- 6.1.3. Ratings and accuracies shall be in accordance with ANSI C57.13 for the metering and relay applications shown on the Data Sheets.

- 6.1.4. Each current transformer shall have a short-circuiting device (shorting type terminal blocks). The first termination of each current transformer shall be at the short-circuiting device terminal blocks where the ground connection is also made.
- 6.1.5. Low voltage ring type CT's will be bushing-mounted, located behind the shutters and accessible from the front. Bushing design will accommodate up to four standard accuracy CT's per phase (two on the bus side and two on the load side) for all ratings.

6.2. Potential Transformers

- 6.2.1. Potential transformer shall be designed to withstand the Basic Impulse Level (BIL) of the switchgear. Potential transformers shall always be fused. Potential transformers shall be mounted on a draw-out unit in an auxiliary enclosure, which disconnects them from the primary circuit safely. ABB type VIY (5kV) and VIZ (15kV) potential transformers shall be supplied in accordance with project data sheets and the single line diagram.
- 6.2.2. Potential transformers shall be mounted in a separate draw-out compartment (truck assembly) and so arranged that the unit can be withdrawn from the operating position via a racking device with the door closed. In the withdrawn position, the fuses shall be completely disconnected from service and all exposed parts shall be visibly grounded.
- 6.2.3. The potential transformers compartment shall incorporate extension rails to allow changing fuses and general maintenance without the need to take the truck assembly completely out of its compartment.
- 6.2.4. Potential transformers shall be connected to the line or load via solid copper rod, bus or shielded cable.
- 6.2.5. An impact resistant glass-viewing window shall be on the front of the potential transformer door.
- 6.2.6. Each transformer shall be protected with current-limiting primary fuses, and shall be designed to withstand the basic impulse level of the switchgear.
- 6.2.7. Each transformer shall have a 120-volt secondary and an ANSI C57.13 accuracy classification meeting the requirements of the application shown on the Data Sheets.

6.3. Control Power Transformers

- 6.3.1. Control power transformers shall be dry type with disconnecting type current limiting primary fuses and fused 120/240 volt secondary. Transformers up to 15kVA single phase (or fuses for above 15kVA) shall be mounted on a truck assembly, which is moved between the connected and disconnected position via closed door racking and utilizing the same racking device as the circuit breaker.

7. RELAYING

- 7.1. All protective relays, auxiliary relays, indicating instruments, recording instruments, indicating lights, transducers, etc. shall be housed in the low voltage compartment unless specifically allowed by the project data sheets. The low voltage compartment shall isolate the above equipment so that additional arc flash protection is available. Relays and instruments shall be provided and wired as specified on the project single line diagram and data sheets. A multi-function, 3-phase microprocessor based relay and control package shall be used in 2-high

breaker arrangements. Alternative relay types may be used in 1-high configurations to the extent allowed by mounting space in the low voltage compartments. Door-mounted protective relays will be draw-out type whenever practical.

- 7.2. Protective relays and test devices shall be semi-flush mounted. The relays shall be so arranged that they can be tested in position on the panel and readily withdrawn from the panel for inspection or replacement.
- 7.3. The relays shall be provided with targets with an external reset feature.
- 7.4. Switchgear device function numbers shall be in accordance with ANSI C-37.20.
- 7.5. An ABB type DPU-2000R distribution protection relay or equivalent shall be provided with the following functions:
 - 7.5.1. 3-phase overcurrent protection (time and instantaneous)
 - 7.5.2. Ground overcurrent (time and instantaneous)
 - 7.5.3. Multi-shot reclosing
 - 7.5.4. High set instantaneous
 - 7.5.5. Ammeter, demand and peak demand ammeters
 - 7.5.6. Event recording
 - 7.5.7. Accumulation of breaker interrupting duty
 - 7.5.8. Continuous self-checking
 - 7.5.9. RS-232 and RS-485 communications ports for remote terminal connection.

8. GENERAL CONTROL AND METERING

- 8.1. Instruments and meters shall be rectangular and anti-fungi, black finish, dust proof and semi-flush mounted digital switchboard type.
- 8.2. Meter potential coils shall be 120 volts and current coils shall be five (5) amperes.
- 8.3. The equipment panel shall be arranged symmetrically and when possible shall allow for possible future additions.
- 8.4. Instrument switches shall have black knurled non-removable handles. The circuit breaker controls shall have non-removable pistol grip handles.

9. CONTROL DEVICES AND WIRING

- 9.1. Control devices, control buses, local control, instrument cables and wiring on the equipment shall be installed at the factory. Low voltage cables shall be enclosed in grounded metal flexible conduit when routed through a high voltage compartment. Control wiring shall be neatly bundled and tie wrapped where applicable. Wiring shall be protected from rubbing against door flanges or other parts of the enclosure.
- 9.2. Control relays, auxiliary contacts and small mechanisms shall be enclosed, protected and accessible for maintenance.

- 9.3. Fuses shall be provided in each closing circuit of each circuit breaker. These fuses shall be respectively located in the low voltage compartment of the circuit breaker frame. Only the closing circuit shall be fused; there shall be no fuses in the tripping circuit
- 9.4. Control wire shall be fourteen (14) gauge SIS stranded, extra-flexible, 600V flame retardant, gray color and UL-listed wire except where larger sizes are needed for current carrying requirements. Current transformers shall be provided with a minimum of twelve (12) gauge. The conductors shall be stranded copper for fixed wiring and extra flexible stranded copper for hinge wiring. The conductors shall be 90 degrees Celsius normal operating temperature, flameproof 600-volt switchboard cable and shall meet ICEA S-66-524 NEMA publication No. WC-7 Standards for cross-linked thermosetting polyethylene insulated wire and cable. Flexible connections between stationary and hinged panels or doors shall be made between terminal blocks or clamped in such a manner as to afford flexibility without damage to the wires. The wires shall be neatly bundled and tie wrapped.
- 9.5. The assembled control equipment and wiring connections shall be insulated for 600-volts and shall be subjected to a one (1) minute test of 1500-volts AC at the factory after fabrication and assembly is complete.
- 9.6. Terminal blocks shall be provided for terminating all power and control wiring. Terminal blocks shall be rated at 600-volts, strap screw terminals with white marking strips showing terminal numbers.
- 9.7. Terminal blocks shall be conveniently located for external connection without accessing the high voltage compartments and shall be marked appropriately. A wire label at both ends will identify each internal connecting wire. (Optional - Marked wires or wire markers shall be provided on both ends of every conductor.)

10. NAMEPLATES

- 10.1. Nameplates shall be laminated white plastic with black lettering.
- 10.2. Nameplates shall be provided on all relaying, metering, and control devices.
- 10.3. Circuit identification nameplates shall be placed on the front and back of each switchgear frame.

11. FINISH

- 11.1. All non-galvanic steel within the switchgear and metal-enclosed bus enclosures shall be cleaned, iron phosphated and painted in accordance with the manufacturer's standard practice for the environmental conditions specified. The enclosure final exterior color paint coat shall be ANSI No. 61 gray.
- 11.2. The interior shall utilize galvanic steel for internal construction. The galvanic steel shall provide inherent reflective properties to its surface and shall not peel, scratch, rust or corrode. Painted interiors are subject to scratching during racking of the circuit breakers and normal maintenance of the switchgear and are therefore unacceptable.
- 11.3. Manufacturer shall supply paint, matching each color used, for field "touch up" after installation of the equipment.

12. TESTING

- 12.1. The control circuits shall be operated at the normal voltage and current for proper operation of circuit breakers, circuit breaker simulators, switches, contactors, interlocks, etc.
- 12.2. Instruments shall be energized from the low voltage winding of the potential transformers and the low current winding of current transformers. Where practical, each instrument shall be operated through its range of voltage, current and/or phase angle and frequency to produce deflections over the entire scale.
- 12.3. The ratio and interconnections of all potential transformers shall be functionally checked to verify conformance to the electrical drawings and electrical bills of material.
- 12.4. Relays shall be tested by applying rated current and/or voltage as required to determine proper performance characteristics. Each relay shall be tested to determine its proper operation in itself and also in the total overall circuit performance.
- 12.5. A static circuit check shall be performed for auxiliary switches, external circuit connections and parts of circuitry that have not been checked or cannot be checked functionally. The devices shall be checked for mechanical function and for conformance to the schematic and wiring diagrams.
- 12.6. After all electrical tests and mechanical checks have been completed and corrections have been signed off, the following dielectric tests shall be performed:
 - 12.6.1. Each power bus shall be given a high voltage withstand test from phase to phase and phase to ground at the specified voltage, frequency and time duration indicated in the Standard C37.20.
 - 12.6.2. Control wire shall be given a high voltage withstand test from wire to ground at the specified voltage, frequency and time duration with reference to the proper standard.

13. ENGINEERING DATA REQUIREMENTS

- 13.1. All engineering data provided for the equipment shall show equipment as specified and ordered. Engineering data, as listed below, shall be supplied in the quantities shown on the supplier's quotation.
- 13.2. Standard Class I drawings shall consist of a system single line drawing; front view; floor plan and section view drawing. Standard Class II drawings shall consist of Class I drawings plus 3-phase elementary and schematic diagrams, nameplate drawing, instrument layout and bills of material.
- 13.3. Drawings shall indicate all equipment, but only such equipment, as is actually in the switchgear scope of supply. All user connection and interface points shall be clearly marked, including primary and secondary cable entrances and connection points, installation details, generic interframe assembly and generic connection details for shipping splits.
- 13.4. Drawing Requirements
 - 13.4.1. AutoCad Version 2000 or greater supplied for all drawings.
 - 13.4.2. Electronic drawing PDF format files for approval shall be supplied. Where possible, typical drawings shall be supplied as PDF files for class 1 and either PDF files or AutoCAD files for class 2.

13.4.2.1. Structural Drawings, with critical dimensions, showing:

- 13.4.2.1.1. Arrangement.
- 13.4.2.1.2. Plan, front view, and elevation section views.
- 13.4.2.1.3. Required clearances for opening doors and for removing breakers.
- 13.4.2.1.4. Conduit or cable trays entrance locations and dimensions for both top and bottom entrance.
- 13.4.2.1.5. Bus bar locations and configurations.
- 13.4.2.1.6. Incoming and outgoing power cable terminator positions.
- 13.4.2.1.7. Anchor bolt locations.
- 13.4.2.1.8. Grounding connections.
- 13.4.2.1.9. Weight of equipment.

13.4.2.2. Elementary Three-Line Diagrams

13.4.2.2.1. Three line diagrams, with ANSI device function numbers used throughout, shall show all:

- 13.4.2.2.1.1. Instrument transformers.
- 13.4.2.2.1.2. Relays.
- 13.4.2.2.1.3. Meters and meter switches.
- 13.4.2.2.1.4. Breakers and other pertinent devices.

13.4.2.3. Schematic Diagrams

- 13.4.2.3.1. Schematic diagrams shall be furnished for the electrically-operated breaker / relay control scheme.
- 13.4.2.3.2. Each schematic diagram shall show all control devices and device contact, each of which shall be labeled with its proper ANSI device function number.
- 13.4.2.3.3. Each schematic diagram shall show device and terminal block terminal numbers for customer connections.
- 13.4.2.3.4. Provide control switch development tables.

13.4.2.4. Detailed Connection (Wiring) Diagrams showing, submitted for record only:

- 13.4.2.4.1. Approximate physical location of all items in each unit.

- 13.4.2.4.2. All wiring within each unit.
- 13.4.2.4.3. All interconnecting wiring between units.
- 13.4.2.4.4. Identification of all terminals, terminal blocks, and wires.

13.4.2.5. Provide one set of drawings shipped with the switchgear for start-up use.

13.5. Material List

13.5.1. An electrical bill of material list shall be furnished listing the quantity, rating, type, and manufacturer's catalog number of all equipment on each unit.

13.6. Installation, Operating, and Maintenance Instructions

13.6.1. Installation, operating, and maintenance instructions shall cover switchgear, breakers, relays, meters and devices requiring installation, programming and / or maintenance.

13.6.2. The breaker operating mechanism shall be front-accessible, and all routine maintenance shall be performed with the breaker in an upright position. The interrupters shall be completely sealed requiring no interphase barriers. Breakers shall be designed for easy insertion, removal and transport on flat indoor surfaces. A breaker lift truck shall be furnished with each switchgear assembly.

14. PREPARATION FOR SHIPMENT

14.1. Preparation for Shipment shall be in accordance with manufacturer's standards, unless otherwise noted on the Request for Quotation and/or Purchase Order. The manufacturer shall be solely responsible for the adequacy of the Preparation for Shipment provision employed in respect of materials and application, to provide materials and their destination in ex-works condition when handled by commercial carrier systems.

15. SHIPPING

15.1. Instructions for receiving, handling, and storage shall be provided with the switchgear shipment.

15.2. Circuit breakers shall not be shipped installed in the switchgear assembly to avoid damage.

15.3. Each "shipping section" of stationary structures shall be provided with a permanently-attached, readily-visible identification tag bearing the equipment number of the assembly of which it is a part.

15.4. The switchgear shall be split in the most efficient manner for shipping.

15.5. If shipped in sections the wiring between the units shall be terminated on terminal blocks on each side of the shipping split. Jumpers shall be provided and marked for convenient connection in the field.

15.6. All accessory items shall be shipped with the switchgear. Boxes and crates containing accessories shall be clearly marked with the contents.

15.6.1. Accessories include:

- 15.6.1.1. A breaker lifting truck device to allow a circuit breaker, or auxiliary draw-out unit to be elevated and then inserted or withdrawn from upper or lower compartments.
- 15.6.1.2. Circuit breaker accessories, including a hand crank for manually operating the breaker, PT/CPT/draw-out fuse racking system and/or a handle for manually charging the stored energy system on circuit breakers.
- 15.6.1.3. An electrical test jumper for connecting the breaker to the switchgear control circuit while the breaker is completely out of the cell.
- 15.6.1.4. Optional - An electrical test cabinet with door-mounted open and close pushbuttons for testing the circuit breaker away from the switchgear.
- 15.6.1.5. Optional - Vendor's standard, manually operated Ground & Test device – 3-terminal or 6-terminal.
- 15.6.1.6. Optional - Relay/test plug for each type of device, as applicable.

16. PROVISIONS FOR HANDLING AND FIELD ERECTION

- 16.1. Each assembly order shall be furnished with one set of channel base extensions suitable for crane hooks or slings.
- 16.2. Each shipping split shall be furnished with removable steel shipping channels that permit the use of pipe rollers or dollies without damaging the frame steel of the equipment.

EXHIBIT C

FORMS APPENDIX

The following forms shall be completed and submitted with each Job Order.

LIST OF SUBCONTRACTORS	SB-1
STATUTORY PERFORMANCE BOND	PB-1
STATUTORY PAYMENT BOND	PB-3
AFFIDAVIT OF COMPLIANCE WITH TEMPE CITY CODE	AD-1

STATUTORY PERFORMANCE BOND
PURSUANT TO TITLE 34,
CHAPTER 6, OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That _____ (“Principal”) and _____,
a corporation organized and existing under the laws of the State of _____, with
its principal office in the City of _____ (“Surety”), are held and firmly bound
unto _____ (“Obligee”) in the amount of _____ Dollars
(\$ _____), for the payment whereof, the said Principal and Surety bind themselves,
and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by
these presents.

WHEREAS, the Principal has entered into a certain written Contract with the
Obligee, dated the 22nd day of September, 2016, to complete Project No. 3207142, which
Contract is hereby referred to and made a part hereof as fully and to the same extent as if copied
at length herein.

NOW, THEREFORE, the condition of this obligation is such, that if the principal
faithfully performs and fulfills all of the undertakings, covenants, terms, conditions and
agreements of the contract during the original term of the contract and any extension of the
contract, with or without notice to the surety, and during the life of any guaranty required under
the contract, and also performs and fulfills all of the undertakings, covenants, terms, conditions
and agreements of all duly authorized modifications of the contract that may hereafter be made,
notice of which modifications to the surety being hereby waived, the above obligation is void.
Otherwise it remains in full force and effect.

STATUTORY PAYMENT BOND
PURSUANT TO TITLE 34,
CHAPTER 6, OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That _____ (“Principal”) and _____,
a corporation organized and existing under the laws of the State of _____,
with its principal office in the City of _____ (“Surety”), as held and firmly
bound unto _____ (“Obligee”) in the amount of _____
Dollars (\$_____), for the payment whereof, the said Principal and Surety bind
themselves, and their heirs, administrators, executors, successors and assigns, jointly and
severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the
Obligee, dated the 22nd day of September, 2016, to complete Project No. 3207142, which
Contract is hereby referred to and made a part hereof as fully and to the same extent as if copied
at length herein.

NOW, THEREFORE, the condition of this obligation is such, that if the
principal promptly pays all monies due to all persons supplying labor or materials to the principal
or the principal's subcontractors in the prosecution of the work provided for in the contract, this
obligation is void. Otherwise it remains in full force and effect.

Provided, however, that this bond is executed pursuant to the provisions of title
34, chapter 2, article 2, Arizona Revised Statutes, and all liabilities on this bond shall be
determined in accordance with the provisions, conditions and limitations of title 34, chapter 2,

**CITY OF TEMPE DEPARTMENT OF PUBLIC WORKS
UNCONDITIONAL WAIVER AND RELEASE
FOR CONTRACTOR'S PAYMENT
AND SETTLEMENT OF CLAIMS**

Upon receipt of payment from the City of Tempe, the undersigned:

Contractor's Name: _____

Contractor's Address: _____

The undersigned has been paid and acknowledges having received final payment from the City of Tempe in the amount of \$ _____ [state dollar amount for final, total contract amount] for full and final payment of all work, services, equipment, labor, skill and material furnished, delivered and performed by the undersigned for the city or anyone in the construction [or other services] for **SWITCHGEAR REPLACEMENT – JOHNNY G. MARTINEZ WATER TREATMENT PLANT** and **PROJECT NO. 3207142** at the location of 255 E. Marigold Lane, Tempe, AZ; and does hereby waive and release any and all rights to mechanic's liens, any state or federal statutory bond right, any private bond right, any claim for payment and any and all rights under any applicable federal, state or local laws related to claim or payment rights for persons in the undersigned's position held on the above-referenced project against the City of Tempe, for this value received. The undersigned further agrees to defend, indemnify and hold harmless the City of Tempe against any and all liens, claims, suits, actions, damages, charges and expenses whatsoever, which the City may incur arising out of the failure or the undersigned to pay in full for all work, services, equipment, labor, skill and material furnished with regard to the project.

The undersigned, in consideration of the payment acknowledged, hereby warrants that he has already paid or will pay using the monies received from this final payment to promptly pay in full all of his contractors, subcontractors, laborers, materialmen and suppliers for all work, materials, equipment or services provided to the above-referenced project.

Contractor Signature

Date

By (Print Name and Title)

Notice: This document waives rights unconditionally and states that you have been paid for giving up those rights. This document is enforceable against you if signed, even if you have not been paid. If you have not been paid in full, use a conditional release form.

[NOTARY SEAL TO FOLLOW]

STATE OF ARIZONA)
COUNTY OF MARICOPA)

On ___ day of _____, 2016, _____ personally appeared before me, and proved by lawful identification documents to be the person who signed the preceding document in my presence, and who affirmed to me that the contents therein are truthful and accurate to the best of his/her knowledge and belief.

Notary Seal

Notary Public

Printed Name

My Commission Expires:
