

SAN ANTONIO WATER SYSTEM
ANDERSON PUMP STATION IMPROVEMENTS
SAWS JOB NO. 07-6007
SOLICITATION NO. B-11-002-DD

ADDENDUM NO. 2
May 2, 2011

To Bidder of Record:

This addendum, applicable to work designed above, is an amendment to the bidding documents and such will be a part of and included in the Contract. Acknowledge receipt of this addendum by the entering the addendum number in the space provided in submitted copies of the Bid Proposal.

PREBID MEETING MINUTES

Minutes from the April 26, 2011 prebid meeting are attached and made part of this Addendum No. 2.

A. QUESTIONS SUBMITTED TO SAWS

1. Please allow Minco bearing RTD's on pump bearings, in lieu of direct reading dial thermometer. RESPONSE: Not acceptable. Bid as specified.
2. Please clarify the guaranteed efficiency point for the pump. RESPONSE: As stated in the specification, the efficiency point is at the evaluated head of 105 feet.
3. Please allow the pump shaft material to be carbon steel 4340. RESPONSE: Acceptable. See changes to Specification Section 11110 included with this addendum.
4. Please confirm the balance grade required to achieve the HI vibration criteria. RESPONSE: See changes to Specification Section 11110 included with this addendum.
5. Split seals tend to leak a little when pump is pressurized and in a static mode. As long as SAWS is aware of this, we can proceed with the Flex-a-Seal two piece design. Otherwise, please approve a Chesterton mechanical seal for the pumps. RESPONSE: Bid as specified. See response to Question 20 in Addendum No. 1.

6. SAWS has always required oil-lubricated bearings on previous projects. Please delete the reference to grease lube bearings. RESPONSE: See changes to Specification Section 11110 included with this addendum.
7. Reference Article 2-7, specification Section 11110. Please clarify the use of computer data acquisition equipment during shop testing. Also please clarify if an NPSHR test is required. RESPONSE: See changes to Specification Section 11110 included with this addendum.
8. At the existing plant entrance at the gate, is there concrete paving? RESPONSE: Both plant entrances have existing asphalt pavement with concrete curbs.
9. The site gets cleared south of the existing 7.5 million gallon storage tank from about 50 feet south to 300 feet south, and from the asphalt drive (west edge of clearing to about 300 feet of the asphalt drive. How much work is involved? What is the average size of the trees and approximate spacing and are there just a few large ones (how many and size) with brush otherwise. RESPONSE: All trees within the designated area shown on Drawing G3 may be removed as necessary to construct and perform the Work. However, it is not necessary to clear all of this designated area, unless necessary to perform the Work. Contractor is responsible to make his own judgment regarding how much work is involved and the types/sizes of the trees and brush.
10. The marl/limestone probably outcrops down the slope. Is it pretty solid, or are there seams to able to rip it out? What is your opinion about how hard it will be to dig? Dynamiting is not allowed; will it take a larger machine to knock it out? RESPONSE: The boring logs and Geotechnical Report are made available for the general information of bidders and are not part of the Contract Documents. Contractor is responsible for any interpretation or conclusion that Contractor draws from the information included in the Geotechnical Report. Blasting is not permitted. Contractor is responsible to determine all means and methods for rock excavation and other construction work.
11. Can excess rock be wasted on site? If not, is there a City disposal site nearby? RESPONSE: No. See Article 3-8 in Specification Section 02200. Contractor is responsible to locate disposal site.
12. Can excess rock be crushed and left in place? RESPONSE: No. See Article 3-8 in Specification Section 02200.
13. Tank builder will require a 6-inch crush rock road around the tank for strand winding. Can this be treated with herbicides and left in place, or does it

need to be removed and seeded? RESPONSE: No. See Article 3-3 in Specification Section 02200 regarding fill material on outside of tank wall.

14. Does City want 6" x 6" curb at the drive or the 9 ½" by 11" curb? RESPONSE: Curb shall be 9 ½" x 11" as shown on the Machine Laid Curb Detail on Sheet S4.
15. Can the removed chain link fence be reused if kept in excellent shape or do we need to use all new? RESPONSE: All chain link fence shall be new.
16. In the soils report, there is mention of encapsulating the backfill material in a fabric, but this is not shown in the plans. Is the fabric required? RESPONSE: The Geotechnical Report is for general information only and is not part of the Contract Documents. The Contract Documents do not call for encapsulating the backfill material.
17. On Sheet 24 of plans, 4000 psi concrete is specified. Is this what will be used in the structures. RESPONSE: Concrete is specified in Section 03300. Structural concrete shall be Class A1 for liquid containing structures and Class A3 for non-liquid containing structures.
18. Will the masonry units be bought colored, or will they receive paint per the paint specification? RESPONSE: The split and ground-faced block will be integrally (bought) colored, as specified in Specification Section 04200, Article 2-1. Painting of the integrally colored split and ground-faced block is not required.
19. On sheet 8, upper right hand corner, are the safety end treatment installation units galvanized or painted? RESPONSE: Refer to the General Notes for the Safety End Treatment on sheet 8 (S5). All steel components shall be galvanized after fabrication.
20. What is the budget for the project? RESPONSE: Engineer's opinion of construction cost is \$10.2 million.
21. It looks like rock will be encountered in all excavations, including the tank as shown, the structures, trench, fence posts, light poles, and the like. Is this a reasonable conclusion? RESPONSE: The boring logs and Geotechnical Report are made available for the general information of bidders and are not part of the Contract Documents. Contractor is responsible for any interpretation or conclusion that Contractor draws from the information included in the Geotechnical Report.
22. Does the City want any of the items in the demolitions plans? RESPONSE: SAWS has the right to keep possession of materials or equipment scheduled for demolition. See Article 5 in Section 01015.

23. On Sheet 45, note 4, there is no concrete equipment base under the switchgear. On other drawings, such as sheet 49, there is indication of a base. Do we bid without a base? RESPONSE: A housekeeping/equipment pad is not required under the switchgear. This will also be clarified with changes to several sheets included with the addendum.
24. For the masonry insulation, are we to use perlite loose fill or cellular inserts? RESPONSE: Granular perlite loose fill, per Article 2-1, Specification Section 04200.
25. At the tops of the masonry wall, there is a treated wood nailer. What is the anchoring requirement? RESPONSE: See changes to Sheet D4 included with this addendum.
26. Is it the intent for the chlorine rep to provide all equipment including the chlorine panels also mentioned in the instrumentation specifications and instrumentation plans? RESPONSE: No. The specification does not require that the panels be furnished by the same supplier as the chlorine feed equipment.
27. Will the "red iron" on the metal canopy be painted? RESPONSE: See Specification Section 13122, Article 2-5. All steel parts which are not specified to be factory finished and which are not zinc coated shall be cleaned and shop primed. Field coating for such surfaces shall be as specified in Specification Section 09940.
28. When the equipment building is excavated, there will be some encroachment on the asphalt pavement. Can plant operators still get around to keep the plant operational? RESPONSE: We do not believe this will be an issue. There are two entrances and drives into the site. Also, there is sufficient space that Owner may drive around any encroachments on the asphalt pavement.
29. There are five stainless steel wallpipes in the top of the storage tank roof. The plans show a couple pipes. Are there supposed to be 7 pipes or 5 pipes in the roof? RESPONSE: There are two flanged roof sleeves, as shown on Sheet C1. The instrumentation drawings show the number of level probes, not the number of roof sleeves. The level probes shall be installed as shown on Detail C on Sheet 102 (IZ-1).
30. On sheet 91, the old valve limit switches are to be reset. Will this be performed by City personnel or will we need to call in the existing valve manufacturer's rep? RESPONSE: Note 7 on this sheet calls for the

Contractor to provide the necessary manufacturer's services from the valve manufacturer.

31. The contract documents call for Owner's personnel to program the instruments. Will this include software? How much help will the Owner need from the contractor or its rep? How about the O&M manuals for the software and programming? RESPONSE: Contractor is required to configure all instruments, as specified in Section 13300, Article 1.01B. Section 13320, Article 3.01D additionally requires Contractor to recalibrate existing instruments shown in Contract Documents. No software or software documentation will be provided by the Owner, as specified in Section 13300, Article 1.01B4.
32. There is a warranty period of 24 months. Will the performance bond be the 12 months or for the full 24 months? RESPONSE: An example copy of the performance bond is included in the Specifications and Documents. The performance bond must be in place for a period of 24 months.
33. Will the contractor be able to use Owner's water supply for flushing the storage tank and pipelines? How about water needed for sterilizing the tank and piping? Can the wasted chlorinated water be drained into an Owner's facility at measured amounts? RESPONSE: See changes to Specification Section 01500 included with this addendum. Contractor is responsible for disposal of chlorinated water in accordance with all city and state regulations.
34. At several steel pipe demolition sites, the pipe is removed at harnessed mechanical couplings. Will the existing harnessed mechanical couplings be reused? RESPONSE: New couplings and harness should be provided as shown on the drawings.
35. On sheet 11, elevation 2, there are flanges shown and at other connections a "rounded" type connection. Are those victaulic couplings? If so, is it the contractor's option to supply either flanged connections or victaulic? Does the same apply for the "Pressure Sustaining Valve Station – Section" on sheet 21? RESPONSE: The "rounded" connections are harnessed lugs for mechanical couplings. Victaulic couplings are not shown or allowed.
36. On sheet 33, at the Emergency Shower and Eye Wash – Section N, there are two 1½" treated water supply piping shown (one optional). What does "optional" mean? Also, what does the "FS" symbol mean? RESPONSE: The water supply piping to the shower may be routed from either the top or from the side (at Contractor's option). FS means flow switch.
37. What is the specification for the 60" butterfly valve shown on sheet 9, section 2? RESPONSE: Butterfly valves are specified in SAWS Standard Specification 830 (available through SAWS website at SAWS.org).

38. Does everything that gets heat traced get insulated? For example, pressure switches, pressure gages, pump suction and discharges, pumps themselves, storage tank sample pipes, etc. RESPONSE: The exposed, large diameter, pump suction and discharge piping is not heat-traced or insulated. Generally, all exposed small diameter piping for pressure gages, switches, etc. is heat-traced and insulated. See response to Question No. 58 below.
39. Can we be supplied a detail for the project sign (or reference)? RESPONSE: Sign details are specified in SAWS Standard Specification 869 (available through SAWS website at SAWS.org).
40. What is the extent of the onsite security personnel? Is this during contractor's working hours, or does it include nights, weekends and holidays? Is this requirement mainly to protect Owner's infrastructure or the contractor's facilities? Have there been previous problems, and if so, the extent or type? RESPONSE: Security guard is only required during contractor's working hours, as specified in Article 8, Section 01500. Primary purpose of security personnel is to protect Owner's infrastructure and chemicals at the site.
41. Is there a problem anticipated getting the electrical company to get its updates done in a timely manner for the contract? Does the Owner have influence that can be utilized? RESPONSE: There are no upgrades required by the electric company.
42. During start-up and during sequencing operations during the contract, will the Owner pay for electrical consumed? Such as in running the pumps, which will be for a long period of time for sequencing? During the commissioning of the instrumentation? How about chlorine used during operations and other chemicals? RESPONSE: Owner will pay for power and chlorine used during testing and commissioning of the equipment.
43. The contract documents call for 150 SF of inspector's space. Will this be required for sure? RESPONSE: Yes. Bid as specified.
44. Will the contract be executed quickly to protect the contractor from price escalations? RESPONSE: As outlined in the Invitation to Bidders (#16, Page IB-5), SAWS has 60 days to award the contract from the date of the bid opening. Bidders acknowledge and agree to this timeframe by signing the Proposal Certification document, which is submitted with the bid packet. SAWS anticipates to present this item to the Board of Directors for award on June 7, 2011. The contract would be executed shortly thereafter.
45. Will the Owner consider a cost index for fuel and imported crushed rock and asphalt? RESPONSE: No.

46. How about a fuel adjustment index for transporting materials to the jobsite?
RESPONSE: No.
47. Section 1 on drawing C1 is a cut section of the new tank feed. Sheet G2 also shows this tie-in between the existing and new tank. Drawings C1 and G2 indicate we are to tie into an existing 54-inch butterfly valve. Drawing I-3 is the P&ID for this work and indicates a new 54-inch butterfly valve near the tie-in point to the new tank. Specification Section 15020, Article 3-4.01, second paragraph states if there is a conflict between the mechanical drawings and the piping and instrumentation drawings (P&IDs), the P&ID shall take precedence. Please verify if a butterfly valve is required.
RESPONSE: The 54-inch butterfly valve is existing. See changes to Sheet I-3 included with this addendum.
48. Specification Section 03300, Article 2-3.02.03 indicates that Contractor shall hire an independent laboratory and perform concrete testing at Contractor's expense. However, Specification Section 01400, Article 1.02 indicates Owner shall provide for concrete testing services. Please confirm that concrete and shotcrete testing will be provided and paid for by the Owner.
RESPONSE: See revisions to Section 01400 included with this addendum. Contractor is responsible for all quality control testing, including field testing of materials. This shall supercede all references in the specifications which require Owner to provide and pay for quality control testing. Contractor quality control testing shall be in accordance with the requirements of governing authorities and specified standards. The Owner, at Owner's option, may perform additional tests as quality monitoring.
49. Specification Section 03300, Article 1-2.01A indicates structural concrete for liquid containing structures shall be Class A1 (4500 psi per Table A1). We recommend that the tank contractor be allowed to use its standard 3500 psi design mix for the concrete floor slab and pipe encasements and 4000 psi mix design for the structural concrete in walls and dome. Please verify if this is acceptable.
RESPONSE: The concrete specification allows Type D1 (3000 psi) concrete for pipe encasements. The Class A1 concrete will be revised to 4000 psi 28-day field strength as part of this addendum. Please note that all other requirements for Class A1 will remain unchanged. The use of 3500 psi mix for the concrete floor slab is not acceptable.
50. Please confirm that Owner will furnish and provide water for disinfection and water-tightness testing of the tank.
RESPONSE: Yes. See changes to Specification Section 01500 included with this addendum.
51. Reference Specification Section 13207, Page 5, Paragraph 2-2.01. Please confirm that tank contractor can design the membrane floor with a minimum thickness of 4-inches based on AWWA D110, ACI 350, and ACI 372.

RESPONSE: This is acceptable. Specification does not include a minimum thickness requirement.

52. Reference Drawing Sheet C-1, Ground Storage Tank Plan. It does not appear there is a means to access the roof hatch located near the tank overflow. Please indicate whether a means of access is required and if so, provide a detail indicating the specific means of access. RESPONSE: SAWS does not desire a ladder to access this roof hatch. SAWS has indicated their staff can access the overflow hatch using the east exterior ladder and walk across the tank roof to the overflow hatch.
53. Drawing Sheet C1, Section 4 shows the overflow drainage box located immediately adjacent to the tank foundation. We suggest that the overflow box be moved about 5 feet from the tank foundation so that undermining the tank foundation does not occur. RESPONSE: See change to Sheet C1 included with this addendum.
54. The specifications require the impeller to be either 316 stainless steel or nickel-aluminum-bronze (88% bronze, 4-7% aluminum, 3-5% nickel). I am having a hard time translating this into a bronze alloy. We typically supply nickel-aluminum-bronze alloy ASTM B148-958. Is this acceptable? RESPONSE: Yes. See change to Specification Section 11110 included with this addendum.
55. The motor specification requires only a short commercial test. However, the pump spec indicates that Owner intends to witness the factory performance (shop) tests of the pump and motor. What is unclear is whether the Owner intends to witness the pump/motor test at pump manufacturer's facility or if Owner intends to witness the short commercial test at motor manufacturer's facility. Please clarify. RESPONSE: Owner intends to witness the pump/motor test at pump manufacturer's facility.
56. The south entrance appears to be asphalt. Can we still put the sensing loops in this material? RESPONSE: Yes. See change to Sheet E33 included with this addendum.
57. The pressure sustaining valve has a bypass that seems to make the pad too small width-wise. Is this the intent? RESPONSE: Drawing D2 requires that the edges of the pad be located 3 feet from the centerline of the existing piping. Bid as shown.
58. Can the intent of the outside insulation and insulation cover clarified? RESPONSE: See Article 3-2, Specification Section 15250. The specification requires insulation and cover for all piping with heat tracing. The pipe with heat tracing is shown on Sheets C2 and EY16.

59. Did the Engineer generate a motor data sheet for the high service pump motor? RESPONSE: No. All information/data needed to define the motor requirements is included in the specifications.
60. Reference: Sheet E-5. Is #1 in duct bank H 2"? RESPONSE: Yes. See change to Sheet E-5 included with this addendum.
61. Reference: Sheet E-11. Are panels LA and LB main circuit breaker? If not, how are these panels protected. RESPONSE: Panels have 200A main circuit breakers, as shown on the panelboard schedule on Sheet E-11.
62. Reference: Sheet E-11. Transformer TX-LA and LB is fed from a 200AT; a standard size of 125A would be required to provide the required protection. RESPONSE: 200AT is appropriate based on NEC Table 450.3(B).
63. Reference: Sheet E-11. The feeder to panels LA and LB are not shown. RESPONSE: Acknowledged. See changes to Sheet E-11 included with this addendum.
64. Reference: Sheet E-11. Is HA-3G really HA-3A? RESPONSE: No. HA-3G is a separate circuit. See changes to Sheet E-11 included with this addendum.
65. Reference: Sheet E-11. It appears on the schedule that some circuits are lacking grounds and others are full size grounds. Is a standard size ground per NEC 250-95 sufficient? Also several circuits appear to be improperly marked HB in lieu of HA. RESPONSE: Provide full size grounds. See changes to Sheet E-11 included with this addendum. These changes will clarify which circuits require neutrals.
66. Reference: Sheet E-15. At plan northeast corner, is fixture Type A? Why is interior outlet WP GFI? RESPONSE: See changes to Sheet E-15 included with this addendum.
67. Reference: Sheet E-32. Is plan north cable tray existing? If not, what size. RESPONSE: The cable tray is not existing. See change to Sheet E-32 included with this addendum.
68. Reference: Sheet E-8. Note 6 states that "Trip Settings are required on the breakers. That note is attached to all breakers; however, the TIE and GEN breakers show no CT's or protective relays on the drawing. What relaying is required for these devices, ANSI 50/51 or other? RESPONSE: The TIE and GEN breakers do not require CT's or protective relaying, since they function as switching devices only.

69. Reference: Sheet E-8. Although the drawing does not show breaker amperage values, it does show 1200:5 MR CT's on the main breakers. The utility transformers calculate to a maximum available 693A. We assume the breakers are to be 1200A. RESPONSE: Provide 2000A circuit breakers to match the bus size. See changes to Sheet E-8 included with this addendum.
70. Reference: Sheet E-8. The drawing requires main bus capacity to be 2000A. The keylock scheme required ensures that only one utility or GEN breaker can be closed into the bus; therefore 2000A bus is not necessary since only 693A maximum is available per utility main. Should 2000A or 1250A bussing be provided? RESPONSE: Provide 2000A bussing, as shown on the drawings. This matches the existing bus size.
71. Reference: Sheet E-8. The control transformers seem considerably oversized since each one is only powering one relay and one light per 5 KV breaker. RESPONSE: Provide 15kVA breakers as shown on the drawings.
72. Reference: Sheet E-8. The drawing shows the CPT's connected to the line side of the main breakers. Some consideration should be put into the power control scheme for the future GEN scheme since the 240V control bus shown connected to the GEN breaker on the drawing would be unavailable if the utilities were without service. The GEN breaker would be completely manual operation as well as the tie breaker when in GEN MODE. Please note that pilot lights or control switches for the GEN breaker as well as the TIE breaker will not be available in the GEN mode without the 240V power control. It is possible to increase the size of the UPS and use it for temporary control power on the breaker close and charge functions as well as the pilot lights, but it is not currently shown the way on the drawings. RESPONSE: See changes to Sheet E-8 included with this addendum.
73. Reference: Detail A on Sheet D9. We have not located a reference for this detail on the plan sheets. Please verify this is a valid detail for this project. RESPONSE: This detail is not applicable and will be deleted as part of this addendum.
74. Will there be a Davis-Bacon wage scale issued for this project? RESPONSE: Since this project is not funded by state or federal funds, a Davis-Bacon wage scale is not required. Therefore, one will not be issued.
75. Will there be a fire alarm at the facility? RESPONSE: No fire alarm system will be provided. The alarm and tamper switches are wired to the SCADA system as specified in Sections 13311 and 13390.
76. Detail H of Sheet M4 directs us to see the plan for label, size, and location of fire sprinkler system backflow preventer. Detail Q of Sheet M4 calls for a

6-inch backflow preventer and allows size of overhead piping to be determined by sprinkler contractor. Based on Ordinary Hazard Group 2, the anticipated sprinkler demand would be about 170 gpm. Because fire sprinkler work is essentially performance-based and the anticipated sprinkler demand is relatively low, would it be acceptable for sprinkler contractor to also size the backflow preventer and sprinkler riser? RESPONSE: The supply pipe and backflow preventer size was determined per requirements of the International Fire Code for an automatic sprinkler system serving an Ordinary Hazard Group 2 area. No change to the supply pipe or backflow preventer will be acceptable. Detail H on Sheet M4 is shown for the purpose of indicating supports required at the backflow preventer. The piping downstream from the backflow preventer, including the sprinkler riser, shall be sized by the sprinkler system supplier.

77. Reference: Drawing G2. Please provide structural details for the footing at new Southeast sliding gate. RESPONSE: There is no “footing” for the gate. See gate electrical plan details on Sheet E-33. The electric-operated gate is specified in Section 02835.
78. Will a builder risk policy be required for this project? RESPONSE: No. See modifications to General Conditions included in this addendum.
79. Executive Order 11246 is missing from the documents. Does it need to be included with the bid? RESPONSE: Since this project is not funded by state or federal funds, Executive Order 11246 is not required. Therefore, it will not be necessary to submit this document with your bid.
80. Reference: Detail A on Sheet A4. Please identify the equipment shown as a circle to the left of the pressure gauge. RESPONSE: This is a ball valve, which is specified in Section 15091.
81. Can steel pipe be used for the tank inlet and outlet piping, coated with cement lining AWWA C205, tape-wrapped outside, with welded joints? RESPONSE: No. Bid as specified.
82. Specification Section 16461 is included in the Table of Contents, but is not in the specifications. RESPONSE: This section was included in the original specifications, but the footers are mis-numbered as Section 16430. A new Section 16461 with corrected page numbers is included in this addendum.

B. DRAWINGS.

1. Sheet G2 (2 of 102).
a. Delete Note 4.

2. Sheet C1 (9 of 102).
 - a. On Section 4, move the overflow drain box so that the outside edge of the concrete wall is 5 feet from the outside edge of the tank foundation footing.

3. Sheet C4 (12 of 102).
 - a. On Section 1, put a dimension of “4’0” minimum” between the east edge of the existing MCC and the support columns for the new metal canopy.

4. Sheet D2 (21 of 102).
 - a. On the Pressure Sustaining Valve – Section, add the following note beneath the concrete equipment pad:

“Provide compacted fill material to raise existing grade to allow for construction of the equipment pad at the elevation shown.”

5. Sheet D4 (22 of 102).
 - a. On Details A, B, C, and D, add the following text after the words “Solid Wood Blocking”:

“Attach blocking to masonry with ½-inch diameter 6” x 2” galvanized bent anchor bolts at 24-inch centers.”

6. Sheet D9 (28 of 102).
 - a. Delete Detail A.

7. Sheet M4 (33 of 102).
 - a. On Detail Q, delete the 1’-6” dimension from the floor to the centerline of the piping.

8. Sheet E-5 (40 of 102).
 - a. For Duct Bank H, label the size of conduit #1 as 2”.

9. Sheet E-7 (42 of 102)
 - a. On Detail 2, add a 304 SS double channel vertical support in the middle of the instrument rack.

10. Sheet E-8 (43 of 102)
 - a. Replace Sheet E-8 with new Sheet E-8 that is included with this addendum. Changes are shown in clouded areas.

11. Sheet E-10 (45 of 102)
 - a. Change the conductors for circuits TX1-HAP and TX2-HBP to 5-4/0.

 - b. Delete the housekeeping/equipment pad for the switchgear.

12. Sheet E-11 (46 of 108)
 - a. Replace Sheet E-11 with new Sheet E-11 that is included with this addendum. Changes are shown in clouded areas.
13. Sheet E-13 (48 of 108)
 - a. Delete the housekeeping/equipment pad for the switchgear.
14. Sheet E-14 (49 of 108)
 - a. Delete the housekeeping/equipment pad for the switchgear.
15. Sheet E-15 (50 of 108)
 - a. In the Electrical Building Plan, change the light fixture in the southeast corner of the building (near the large door) from type "AE" to "A".
 - b. In the Electrical Building Plan, delete the label "WP/GFI" for the interior receptacle at the southeast corner of the building.
 - c. Delete the housekeeping/equipment pad for the switchgear.
16. Sheet E-16 (51 of 108)
 - d. Delete the housekeeping/equipment pad for the switchgear.
17. Sheet E-17 (52 of 108)
 - e. Delete the housekeeping/equipment pad for the switchgear.
18. Sheet E-23 (58 of 108)
 - f. On Detail A, change the words "304SS unistrut" to "304SS double channel".
19. Sheet E-24 (59 of 108)
 - g. On Details C and D, change the words "316SS unistrut" to "304SS double channel".
 - h. On Detail B, change the words "316SS double unistrut" to "304SS double channel".
20. Sheet E-32 (67 of 108)
 - i. Add a label to indicate that the cable tray on the east wall is 36" wide.
21. Sheet E-33 (68 of 102).
 - a. Add the following note after note 7:
 - "8. The existing drive is asphalt. Contractor shall repair existing asphalt drive, if it is damaged during installation of the loop sensors and electronic gate."

22. Sheet EY-16 (85 of 102).
a. Add the following note:

 “1. Provide heat trace for all pipe and tubing less than 2-inches at the pressure-sustaining valve station.”

b. On schematic 2, add a reference to Note 1 adjacent to the text that says “heat trace at pressure sustaining valve process piping”.
23. Sheet I-3 (91 of 102).
a. Change the butterfly valve on the inlet piping to the new tank from new to existing.

b. Change the butterfly valves and pressure-sustaining valves (located just to the left of the new ground storage tank) from new to existing. The flow element (FE-170) should remain as new.
24. Sheet I-6 (94 of 102).
a. Change the butterfly valve on the inlet piping to the new tank from new to existing.

C. BIDDING AND CONTRACT REQUIREMENTS.

1. GENERAL CONDITIONS.

- a. Page 20, Article 5.7.1.8. Remove Section 5.7.1.8 in its entirety, as Builder’s Risk Insurance is not required for this project.

D. TECHNICAL SPECIFICATIONS.

1. Section 01400 – QUALITY CONTROL.

- a. Page 1, Article 1.01. Add the following paragraph before the last paragraph of this article:

“The Contractor is solely responsible for maintaining the quality of the work in accordance with the Contract Documents. In addition to the tests described above to determine the acceptability of proposed materials and batch mixtures, Contractor shall also provide testing services to maintain the quality of the work in connection with the following field tests:

- Concrete and shotcrete.

- Moisture-density (Proctor) tests and relative density tests on embedment, fill and backfill materials
- In-place field density tests on fills and backfills.
- Field control tests of masonry.
- Tests of masonry prisms.

Testing, including sampling, shall be performed by the testing firm's laboratory personnel in the general manner indicated in the specifications. Contractor shall furnish all sample materials and cooperate in the testing activities. Contractor shall be responsible for notifying and scheduling to assure that a certified technician from the testing laboratory is present during all sampling and testing procedures."

- b. Page 1, Article 1.02. Delete Article 1.02 in its entirety and replace with the following:

"1.02. Testing Services Provided by Owner. The Owner, at Owner's option may perform additional field tests as quality monitoring. Quality monitoring activities of the Owner in no way relieves Contractor of the obligation to provide field testing and to perform and furnish work and materials conforming with the Contract Documents.

Contractor shall furnish all sample materials and cooperate in the Owner's testing activities, including sampling.

2. Section 01500 – TEMPORARY FACILITIES.

- a. Page 1, Article 2. Add the following sentence at the beginning of the first paragraph:

"The Owner will provide all water needed for disinfection and testing of the ground storage tank."

In the first sentence, add the word "other" before the words "water required for"

- b. Page 3, Article 8. Add the following sentence after the first sentence of paragraph 1:

"The guard shall be on-site during all times work is being performed, even if Contractor's work extends beyond the original contract date."

3. Section 03300 – CAST-IN-PLACE CONCRETE.
 - a. Page 17, Table 1A. For Class A1 concrete, change the 28-day field compressive strength from 4,500 psi to 4,000 psi and the 7-day field compressive strength from 3,375 psi to 3,000 psi.

4. Section 11110 – HORIZONTAL SPLIT CASE CENTRIFUGAL PUMPS.
 - a. Page 4, Article 2-2. In the eleventh row, change the efficiency from 80.0% to 78.9%.
 - b. Page 5, Article 2-3. Change the shaft material to carbon steel, AISI 1045 or 4340.
 - c. Page 5, Article 2-3. Delete the words “bronze 88%, aluminum 4-7%, nickel 3-5%” and replace with “ASTM B148-958”.
 - d. Page 6, Article 2-4.02. In the first sentence of the first paragraph, change the word “statically” to “dynamically”.

Add the following sentence after the first sentence of the first paragraph:

“Impellers shall be balanced to ISO 1940 G2.5 or better.”

- e. Page 7, Article 2-4.07. In the first sentence of the first paragraph, delete the words “grease or”.
- f. Page 8, Article 2-7. Add the following sentence to the end of the third paragraph of this Article:

“Computers may be used to generate curves, but data for entry into the computer shall be collected manually based on an observed reading. Computers are not traceable to national standards and therefore are not considered certified.”

- g. Page 9, Article 2-7. Add the following sentence to the end of the fifth paragraph of this Article:

“NPSHA during the test should be recorded. There is no requirement to determine the NPSHR.”

5. Section 11960 – EMERGENCY GAS TREATMENT SYSTEM – DRY MEDIA TYPE.

- a. Page 7, Article 2-3. In the last line of the table under the Environmental Systems Division of Purafil column, change the removal capacity against Cl², percent by weight, from 10 to 15.
- b. Page 12, Article 2-7. Delete the last sentence of the second paragraph.

6. Section 13207 – WRAPPED PRESTRESSED CONCRETE TANK.

- a. Page 4, Article 2-2. In the second sentence of the first paragraph, delete the words “recommendations and”.

Add the following new paragraph at the end of Article 2-2:

“Subsurface information contained within the geotechnical report or indicated on the drawings was obtained by Owner solely for use by Engineer in establishing design criteria for the project. The accuracy and completeness of the information is not guaranteed and it is not to be construed as part of the Project Specifications governing construction of the project. The Contractor shall perform additional geotechnical investigation as he deems necessary for his construction activities. There shall not be any additional payment or contract time extension to Contractor for additional geotechnical investigations and resulting additional work that may be required to complete the project. Contractor shall review the available geotechnical report and boring logs and make his own determinations as to all subsurface conditions.”

7. Section 15091 – MISCELLANEOUS BALL VALVES.

- a. Page 2, Article 2-1.10. Delete the words “4 inch and smaller” for VB-10.

8. Section 16000 – ELECTRICAL GENERAL PROVISIONS.

- a. Page 7, Article 1.05.A.4. Delete and replace with the following:

“4. Provide non-metallic type, NEMA 4X enclosures, of PVC or fiberglass construction, for chlorine rooms.”

9. Section 16110 – RACEWAYS, BOXES, AND FITTINGS.

- a. Replace the entire specification with new Section 16110 that is included with this addendum.

10. Section 16151 – LARGE INDUCTION MOTORS.
 - a. Replace the entire specification with new Section 16151 that is included with this addendum.
11. Section 16195 – POWER METERING AND PROTECTIVE RELAYS.
 - a. Replace the entire specification with new Section 16195 that is included with this addendum.
12. Section 16200 – STANDBY GENERATOR SET
 - a. Page 6, Article 2.01.A. Add Kohler to the list of acceptable manufacturers.
 - b. Page 13, Article 2.09. Add the following to the end of this article:

“G. A Modbus TCP Ethernet port shall be provided for customer interface”.
 - c. Page 13, Article 2.12A. In the second sentence, change the heater voltage from 480V to 208V.
 - d. Page 16, Part 3. Delete the text “NOTE: Select as required” at the beginning of Part 3.
13. Section 16345 – MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR AND MEDIUM VOLTAGE MOTOR CONTROLLERS.
 - a. Replace the entire specification with new Section 16345 that is included with this addendum.
14. Section 16461 – DISTRIBUTION DRY-TYPE TRANSFORMERS.
 - a. Replace the entire specification with new Section 16461 that is included with this addendum.
15. Section 16475 – LOW VOLTAGE ENCLOSED CIRCUIT BREAKERS AND DISCONNECT SWITCHCES.
 - a. Page 6, Article 2.03B.2. In the first sentence, change the words “sheet aluminum” to “painted sheet steel”.

16. Section 16476 – LOW VOLTAGE ENCLOSED AUTOMATIC TRANSFER SWITCHES (ATS)
 - a. Page 8, Article 2.03.B.2. In the first sentence, change the words “sheet aluminum” to “painted steel”.

17. Section 16487 – ELECTRICAL MANUFACTURER’S PROVIDED CONTROL PANELS (OEMs)
 - a. Page 21, Article 3.03.B. In the first sentence, delete the word “aluminum”.

18. Section 16600 – UNDERGROUND SYSTEM
 - a. Page 3, Article 2.01.A.2. In the first and second sentences, change the word “aluminum” to “steel”.
 - b. Page 6, Article 3.01.B. In the second sentence, change the word “aluminum” to “steel”.

19. Section 16660 – GROUNDING SYSTEM
 - a. Page 3, Article 3.01.C. In the third sentence, change the word “aluminum” to “steel”.

20. Section 16859 – ELECTRICAL HEAT TRACING
 - a. Page 6, Article 3.01.C. In the last sentence, change the word “aluminum” to “steel”.

ACKNOWLEDGEMENT BY BIDDER

Each bidder shall acknowledge receipt of this addendum in the space provided in the Bid Proposal.

May 2, 2011

Black & Veatch Corporation



(ANDERSON PUMP STATION)
 (SAWS JOB NO. 07-6007)
 (161472)

AD2-19

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**SAN ANTONIO WATER SYSTEM
ANDERSON PUMP STATION IMPROVEMENTS
SAWS JOB NO. 07-6007**

PREBID MEETING MINUTES

The prebid meeting for the Anderson Pump Station Improvements Project was held at 9:00 a.m. on April 26, 2011. A copy of the attendance list is attached.

The following topics were addressed by representatives of SAWS and Black & Veatch:

1. The Engineer's Opinion of Construction Cost is \$10.2 million.
2. The contract completion time is 460 calendar days.
3. SAWS intends to present this item before the Board of Directors for award on June 7.
4. Contractors were advised that only bidders who signed in at the prebid meeting will be allowed to submit bids for this project.
5. Contractors were reminded that the SMWB goals for this project is 17%. Contractors may contact Marisol Robles, SMWB Manager for assistance when completing their Good Faith Effort Plan at 210-233-3420.
6. A maximum of 10 percent is allowed for the Mobilization bid item.
7. Contractors should circle the prestressed tank manufacturer (Preload or Natgun) located at the bottom of the bid proposal.
8. All addendums should be acknowledged in the space provided in the bid proposal.
9. A sample insurance certificate or letter from the insurance company should be submitted with the bid.
10. Pay special attention to the General Conditions and Special Conditions included in the Contract Documents.
11. Bidders should include a completed W-9 form with their bid packet.
12. Project sequencing was discussed. Reference was made to the Project Sequencing and Allowable Shutdown Conditions in Article 8 of Specification Section 01500. All pumps shall remain in service during the months of May through August. During all other months, the Contractor may remove only one pump from service at a time to install new pumps and associated piping.

QUESTIONS DURING PREBID MEETING:

1. Are Aurora pumps acceptable? **RESPONSE:** This was addressed in Question #15 of Addendum No. 1. Bidders were advised that "equal" pumps would be acceptable, but they must meet all the specified requirements, and will not be reviewed or considered prior to the bid opening date. Bidders were advised that pump has a large specified operating head range and

they should carefully check the proposed pump curve to make sure it can operate as specified over this range.

2. When will the security guard be required to be onsite? RESPONSE: Security guard is required only during contractor's working hours.
3. Will SAWS want to salvage the existing pumps? RESPONSE: Yes. At the option of SAWS, other equipment scheduled for removal or demolition may also be salvaged by SAWS, as covered in the specifications.
4. Are site visits available at other times? RESPONSE: No.

SECTION 16110

RACEWAYS, BOXES AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.
- B. Raceways and conductors that are listed on the raceway and conductor schedules are generally not shown on the Drawings, except where they are required to pass through a restricted or designated space. Conduits indicated to be run exposed on the schedules shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches, etc. Conduits indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.

1.02 RELATED WORK

- A. Section 16000 Electrical – General Provisions
- B. Section 16120 Wires and Cables (600 Volt Maximum)
- C. Section 16600 Underground System
- D. Section 16121 Medium Voltage Cable

1.03 SUBMITTALS

- A. Submit to the Owner/Engineer, in accordance with Division 1, the manufacturers' names and product designation or catalog numbers of all materials specified.

1.04 REFERENCE CODES AND STANDARDS

- A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NFPA 70 – National Electrical Code (NEC)
 2. NFPA 70E – Standard For Electrical Safety in the Workplace
 3. UL 6A – Electrical Rigid Metal Conduit
 3. UL 514B – Outlet Bodies
- B. All equipment components and completed assemblies specified in this section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.05 QUALITY ASSURANCE

- A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer.

1.06 DELIVERY STORAGE AND HANDLING

- A. Materials shall be handled and stored in accordance with manufacturer's instructions. Materials shall not be stored exposed to sunlight. Such materials shall be completely covered. Materials showing signs of previous or jobsite exposure will be rejected.

1.07 WARRANTY

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 1 year from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition.

PART 2 PRODUCTS

2.01 CONDUIT

- A. PVC Coated Rigid Galvanized Steel Conduit

1. PVC coated rigid steel conduit shall have a minimum 0.040-in thick, polyvinyl chloride coating permanently bonded to rigid steel conduit and an internal chemically cured urethane or enamel coating. Rigid steel conduit shall be as manufactured by the Allied Tube and Conduit Corp.; Wheatland Tube Co.; Triangle PWC Inc. or equal. The ends of all couplings, fittings, etc. shall have a minimum of one pipe diameter in length of PVC overlap. PVC coated conduit and fittings shall be as manufactured by Perma-Cote, Robroy Industries, Triangle PWC Inc. or Ocal.
2. Elbows and couplings shall be PVC coated by the same manufacturer supplying the conduit PVC coating system. Elbows and couplings used with PVC coated conduit shall be furnished with a PVC coating bonded to the steel, the same thickness as used on the coated steel conduit.

B. Liquidtight Steel Flexible Metal Conduit

1. Liquidtight steel flexible metal conduit shall have an interlocked steel core, PVC jacket rated for 80 degrees C., meeting NEC Article 350, as manufactured by Ultratite AEF by Southwire, the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co.; ALFLEX or equal.
2. Fittings used with liquidtight flexible metal conduit shall be extruded from 6063 alloy in temper designation T-1 with maximum 0.1% copper content and shall conform to ANSI C80.1, and UL-6.

C. Steel Flexible Metal Conduit

1. Flexible metal conduit shall have an interlocked steel core, meeting NEC Article 348, as manufactured by Southwire, the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.
2. Fittings used with steel flexible metal conduit shall be extruded from AA 6063 alloy in temper designation T-1 and shall conform to FEDSPEC WW-C-540C ANSI C80.5, and UL-6.

D. Rigid steel conduit 1 shall be hot-dip galvanized steel meeting ANSI C80.1 Standard. Threads shall be hot galvanized after cutting. Conduit shall be Allied Tube and Conduit, or approved equal.

E. Rigid PVC Schedule 40 Conduit

1. Schedule 40 PVC Rigid Nonmetallic Conduit (RNC) shall be designed for use underground as described in the NEC, resistant to sunlight. The

conduits and fittings shall be manufactured to NEMA TC-2, Federal Specification WC1094A and UL 651 specifications. Fittings shall be manufactured to NEMA TC-3, Federal Specification WC1094A and UL 514B. Conduit shall have a UL Label. Conduit shall be Carlon, Kraloy, or approved equal.

2.02 RACEWAY BOXES

- A. Boxes specified herein are for use with raceway systems only, but including those switch, receptacle and lighting housings which are an integral part of the raceway system. Boxes used for housing electrical and instrumentation equipment shall be as described elsewhere in these Specifications.
- B. For all raceway boxes, the distance between each raceway entry inside the box and the opposite wall of the box shall not be less than six times the metric designator (trade size) of the largest raceway in a row. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries in the same row on the same wall of the box. Each row shall be calculated individually, and the single row that provides the maximum distance shall be used.
- C. NEMA 12 Areas: Terminal boxes, junction boxes, pull boxes, etc, shall be NEMA Type 12, of factory gray painted steel, with mounting lugs suitable for wall mounting. Box bodies shall not have concentric knockouts. Boxes shall not be less than .080 in. thick, gauge metal. All boxes shall have continuous hinged, gasketed doors with handle latch, 3-point above 20" x 20". Boxes shall be Concept Series as manufactured by Hoffman Engineering Co. or equal.
- D. NEMA 4X Areas: Terminal boxes, junction boxes, pull boxes etc, shall be NEMA Type 4X of 316 stainless steel with mounting lugs or brackets, suitable for wall mounting, or have mounting feet where self-standing. Boxes shall have continuously welded seams. Welds shall be ground smooth. Box bodies shall not be less than 16ga. All boxes shall have hinged, gasketed doors with handle latch, with 3-point type above 20" x 20". Boxes shall be Concept Series as manufactured by Hoffman Engineering Co. or equal. If boxes provided require clamp type latches, provide stainless steel quick-release luggage type latches.
- E. Chlorine and Caustic Areas: Boxes shall be NEMA 4X, non-metallic, made of PVC or fiberglass reinforced polyester. Construction shall be the same as specified for NEMA 4X terminal boxes, junction boxes, pull boxes etc. as specified above. Non-metallic boxes shall have UV inhibitors, but not

mounted in direct sunlight. Where clamp type latches are required, provide quick- release luggage type latches.

F. Malleable iron boxes shall not be used.

2.03 CONDUIT OUTLET BODIES

A. For conduits up to and including 2-1/2", conduit outlet bodies and covers shall be galvanized steel, with captive screw-clamp cover, neoprene gasket and stainless steel screws and clamps, Cooper Crouse-Hinds Form 7 with Mark 7 wedge-nut cover, Appleton, or approved equal. For conduits larger than 2-1/2", junction boxes shall be used.

2.04 CONDUIT HUBS

A. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded die cast zinc, insulated throat, with stainless steel grounding screw, as manufactured by T&B HGTZ Series, or equal.

2.05 GROUNDING BUSHINGS

A. Grounding bushings shall be insulated lay-in lug grounding bushings with tin-plated copper grounding path. Bushings shall have integrally molded noncombustible phenolic insulated surfaces rated 150°C. Each bushing shall be furnished with a plastic insert cap. The size of the lug shall be sufficient to accommodate the maximum ground wire size required by the NEC for the application. Bushings shall be O-Z/Gedney Type ABLG, or approved equal.

2.06 RACEWAY SEALANT

A. Raceway sealant for use in the sealing of raceway hubs, entering or terminating in boxes or enclosures where such sealing is shown or specified, shall be 3M 1000NS Watertight Sealant.

2.07 CONDUIT PENETRATION SEALS

A. Conduit wall seals for new concrete walls below grade shall be O.Z./Gedney Co. type WSK, or equal.

B. Conduit wall seals for cored holes shall be type CSML as manufactured by the O.Z./Gedney Co., or equal.

C. Conduit wall and floor seals for sleeved openings shall be type CSMI as manufactured by the O.Z./Gedney Co., or equal.

D. Conduit sealing bushings shall be O.Z./Gedney Type CSB Series, or equal.

2.08 EXPANSION-DEFLECTION FITTINGS

- A. Combination expansion-deflection fittings embedded in concrete, or exposed, with internal grounding, 4" movement, shall be stainless steel/cast iron, Type XJGD as manufactured by the Crouse-Hinds Co., or equal.

2.09 EXPANSION FITTINGS

- A. Expansion fittings shall be electrogalvanized steel, 8" movement, Type XJG as manufactured by Crouse-Hinds Co., or equal, with internal grounding.

2.10 KELLUMS GRIPS

- A. Kellums grips to support cables shall be of 316 stainless steel.

2.11 CONDUIT MOUNTING EQUIPMENT

- A. All pull and junction box supports, spacers, conduit support rods, clamps, hangers, channel, nut, bolts, washers, etc. and shall be made of 316 stainless steel.

2.12 CONDUIT IDENTIFICATION TAGGING

- A. The Contractor shall use the tagging formats for conduits as shown on the Drawings. Where modifications or additions are made to existing equipment, the Contractor shall replace existing tags with new modified tags.
- B. Conduit identification plates shall be embossed stainless steel with stainless steel band, permanently secured to the conduit without screws.
- C. Identification plates shall be as manufactured by the Panduit Corp. or equal.

2.13 WIREWAYS

- A. All wireways shall be constructed of painted steel for interior applications and NEMA 4X 304 stainless steel for all other locations, with gasketed hinged covers and stainless steel screws. Wireway shall be as manufactured by Hoffman or equal.

PART 3 EXECUTION

3.01 INSTALLER'S QUALIFICATIONS

- A. Installer shall be specialized in installing PVC coated conduit with minimum 5 years documented experience. Experience documentation shall include training. Training shall be submitted for approval prior to beginning work on this project.

3.02 RACEWAY APPLICATIONS

- A. Unless exact locations are shown on the Drawings, the Contractor shall coordinate the placement of conduit and related components with other trades and existing installations.
- B. Unless shown on the drawings or specified otherwise, the conduit type installed with respect to the location shall be as follows:

Conduit Type	Location
1. Rigid Aluminum Conduit	Not acceptable for use on this Project.
2. PVC Coated Steel Conduit	All embedded conduit bends, underground duct bank bends of more than 20 degrees, all conduit stub-ups to a minimum of 6" above finished floor or grade and in Chlorine and Caustic rooms.
3. Liquidtight Flexible Steel Conduit	Raceway connection to vibrating equipment only, in all areas.
4. Rigid Non-metallic, Schedule 40 PVC Conduit	Underground encased in red dyed reinforced concrete.
5. Flexible Steel Conduit	Fixture whip connection to lighting fixtures in NEMA 12 areas (maximum 3-ft). BX or AC type prefabricated cables are not permitted.
6. Galvanized Rigid Metal Conduit	All above grade areas, except for concrete embedded and those areas described in Locations 2 through 5 above.

- C. All conduit of a given type shall be the product of one manufacturer.

3.03 BOX APPLICATIONS

- A. Boxes installed in dry areas may be of NEMA 12 painted steel construction. All other boxes shall be of Type 316 stainless steel.
- B. Exposed switch, receptacle and lighting outlet boxes and conduit fittings shall be electrogalvanized steel.
- C. Junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16000.

- D. All boxes shall be provided with factory mounting lugs. Drilling through the back of any box or enclosure is prohibited, and if so installed, shall be removed and replaced, with no increase in the Contract Price or Construction Schedule.

3.04 CONDUIT OUTLET BODIES APPLICATIONS

- A. Conduit outlet bodies may be used on conduits up to and including 2-1/2", except where junction boxes are shown or otherwise specified. For conduits larger than 2-1/2", junction boxes shall be used.

3.05 CONDUIT HUB APPLICATIONS

- A. Unless specifically stated herein or described on the Drawings, all raceways shall terminate at an outlet with a conduit hub. Locknut or double locknut termination will not be permitted.

3.06 CONDUIT FITTINGS APPLICATIONS

- A. Combination expansion-deflection fittings shall be installed where conduits cross structure expansion joints, on conduit transitions from underground to above ground, and where installed in exposed conduit runs such that the distance between expansion-deflection fittings does not exceed one hundred fifty (150) feet of conduit run.
- B. On exposed conduit transitions from underground to above ground, where the earth has been disturbed to a depth of more than ten (10) feet, an expansion fitting, with a minimum of 6" available movement, shall be installed on the exposed side of the transition, in lieu of a combination expansion-deflection fitting.

3.05 CONDUIT OUTLET BODIES APPLICATIONS

- A. Conduit outlet bodies may be used on conduits up to and including 2-1/2", except where junction boxes are shown or otherwise specified. For conduits larger than 2-1/2", junction boxes shall be used.

3.06 CONDUIT PENETRATION SEALS APPLICATIONS

- A. Conduit wall seals shall be used where underground conduits penetrate walls or at other locations shown on the Drawings.
- B. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

3.06 CONDUIT TAG APPLICATIONS

- A. All conduits shall be tagged within 1ft. of the entry of equipment, and wall and floor penetrations.
- B. The Contractor shall tag all underground conduits and ducts at all locations, exiting and entering from underground, including manholes and handholes.

3.07 RACEWAY SEALING

- A. Where raceways enter junction boxes or control panels containing electrical or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant, or approved equal.
- B. This requirement shall be strictly adhered to for all raceways in the conduit system.

3.08 RACEWAY INSTALLATION

- A. No conduit smaller than 3/4-in electrical trade size, shall be used, nor shall any have more than the equivalent of three 90 degree bends in any one run. Pull boxes shall be provided as necessary.
- B. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.
- C. All raceways, installed underground, shall be installed in accordance with Section 16600 Underground System.
- D. Where raceways enter or leave the raceway system, where the raceway origin or termination, could be subjected to the entry of moisture, rain or liquid of any type, particularly where the termination of such raceways terminate in any equipment, new or existing at a lower elevation, such raceways shall be tightly sealed at the higher elevation, both before and after the installation of cables, such that there shall be no entry of water or moisture to the Raceway System at any time. Any damage to new or existing equipment, due to the entrance of moisture from unsealed raceways, shall be corrected by complete replacement of such equipment, at no cost to the Owner. Cleaning or drying of such equipment will not be acceptable. Sealant shall be 3M 1000NS Watertight Sealant, or approved equal.
- E. Conduit supports, other than for underground raceways, shall be spaced at intervals of 8-ft or less, as required to obtain rigid construction.

- F. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.
- G. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete inserts of the spot type shall be provided.
- H. All conduits on exposed work shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduit shall be run perfectly straight and true.
- I. Conduits terminated into enclosures shall be perpendicular to the walls where flexible liquidtight or rigid conduits are required. The use of short sealtight elbow fittings for such terminations will not be permitted, except for connections to instrumentation transmitters, where multiple penetrations are required.
- J. Conduits containing equipment grounding conductors and terminating in boxes shall have insulated throat grounding bushings. The wire shall be grounded to the box.
- K. Conduits shall be installed using threaded fittings. Running threads will not be permitted.
- L. All conduit fittings on PVC conduit shall be of the glued type.
- M. Liquidtight flexible conduit shall be used for the primary and secondary of transformers, generator terminations and other equipment where vibration is present. Use in other locations is not permitted, except for connections to instrumentation transmitters, where multiple penetrations are required. Liquidtight flexible conduit shall have a maximum length not greater than that of a factory manufactured long radius elbow of the conduit size being used. The maximum bending radius shall not be less than that shown in the NEC Chapter 9, Table 2, "Other Bends". BX or AC type prefabricated cables will not be permitted.
- N. Where conduits pass through openings in walls or floor slabs, the remaining openings shall be sealed against the passage of flame and smoke.

- O. Conduit ends exposed to the weather or corrosive gases shall be sealed with conduit sealing bushings.
- P. Raceways terminating in Control Panels, or boxes containing electrical equipment, shall not enter from the top of the panel or box, and the raceway shall be sealed with a removable silicone sealant, as specified herein.
- Q. All conduits from external sources entering or leaving a multiple compartment enclosure shall be stubbed up into the bottom horizontal wireway or other manufacturer designated area, directly below the vertical section in which the conductors are to be terminated. Conduits entering from cable tray shall be stubbed into the upper section.
- R. Conduit sealing and drain fittings shall be installed in areas designated as NEMA 4X or 7.
- S. A conduit identification plate shall be installed on all power, instrumentation, alarm and control conduits at each end of the run and at intermediate junction boxes, manholes, etc. Conduit plates shall be installed before conductors are pulled into conduits. Exact identification plate location shall be coordinated with the Owner/Engineer at the time of installation to provide uniformity of placement and ease of reading. Conduit numbers shall be exactly as shown on the Drawings.
- T. Mandrels shall be pulled through all existing conduits that will be reused and through all new conduits 2-in in diameter and larger prior to installing conductors.
- U. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment.
- V. All conduit that may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc, shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits at the point of attachment to the equipment.
- W. Conduits shall not cross pipe shafts, access hatches or vent duct openings. They shall be routed to avoid such present or future openings in floor or ceiling construction.
- X. The use of running threads is prohibited. Where such threads are necessary, a 3-piece union shall be used.
- Y. Conduits passing from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc, shall be sealed with 3M 1000NS Watertight Sealant, or approved equal.

Z. Conduits shall be located a minimum of 3-in from steam or hot water piping. Where crossings are unavoidable, the conduit shall be kept at least 1-in from the covering of the pipe crossed.

AA. Conduits terminating at a cable tray shall be supported independently from the cable tray. Provide a conduit support within 1-ft of the cable tray. The weight of the conduit shall not bear on the cable tray.

AB. All changes of direction on PVC coated steel conduit greater than 20 degrees shall be accomplished using long radius bends. Any field bends shall be made using equipment designed to prevent damage to the PVC coating.

END OF SECTION

SECTION 16151

LARGE INDUCTION MOTORS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This section specifies the requirements for custom-built, premium electric motors as specified. Unless otherwise shown or specified, the motors shall be single speed, single winding, in strict compliance with the requirements specified herein. The driven equipment manufacturer shall select the exact motor speed.

B. Medium Voltage Induction Motors

1. The provisions of this Section shall apply to all medium voltage AC squirrel cage induction motors.

C. Low Voltage Non-NEMA Frame Induction Motors

1. The provisions of this Section shall also apply to all non-NEMA frame, low voltage induction motors, as defined by NEMA MG1 Part 20.1, except as indicated otherwise. A list of applicable low voltage motors is as follows:

<u>Synchronous Speed</u>	<u>Low Voltage Motors, HP</u>
3600	Greater than 350
1800	Greater than 350
1200	Greater than 350
900	Greater than 250
720	Greater than 200
600	Greater than 150
514	Greater than 125
450 and slower	All motors

1.02 RELATED WORK

A. Section 16000 Electrical – General Provisions

B. Section 16105 Power System Study

C. Section 16121 Medium Voltage Cables

D. Section 16195 Power Metering and Protective Relays

- E. Section 16480 - Low Voltage Motor Control Centers
- F. Section 16481 - Low Voltage Motor Controllers
- G. Section 16345 - Medium Voltage Metal-Clad Switchgear
- H. Section 16487 – Electrical Manufacturer’s Provided Control Panels (OEM’s)
- I. Appropriate Mechanical Sections

1.03 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000 and as specified herein.
- B. Shop Drawings and Product Data. For each motor specified under this Section, submit the following information:
 - 1. Manufacturer.
 - 2. Rated full load horsepower.
 - 3. Rated volts.
 - 4. Number of phases.
 - 5. Frequency in hertz.
 - 6. Full load amperes (FLA).
 - 7. No load amperes.
 - 8. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.
 - 9. Synchronous speed (srpm).
 - 10. NEMA insulation system classification and description of manufacturer's method of application.
 - 11. Temperature rise at rated full load, by resistance temperature detector.
 - 12. Maximum ambient temperature for which motor is designed.
 - 13. Service factor.

14. Frame size, outline dimensions, net weight and weight of rotating element. Include surge protection dimensions and weight.
15. NEMA machine type (ODP, WP-1, TEFC, etc.).
16. Bearing size and calculation, based on L10 life.
17. Lubrication (compatible with pump manufacture).
18. Safe stall time.
19. Maximum acceleration time with NEMA standard Wk2 value, at rated voltage and at 90% of rated voltage.
20. Number of safe starts in succession when starting from a 40 degree Celsius ambient, intermediate waiting periods and other conditions for driving equipment with a NEMA standard wk2 value.
21. Efficiency at 1/4, 1/2, 3/4, full load, and service factor.
22. Power factor at 3/4 and full load.
23. Space heater voltage and wattage.
24. Surge protection information, including mounting details.
25. Platinum resistance temperature detector (RTD) literature with wiring diagram.
26. Motor Damage Curve and safe stall time at 100% and 80% of motor rated terminal voltage.
27. Data to be included on nameplate.
28. Dimensions and internal arrangements of terminal boxes.
29. Locations and sizes of lubrication connections, vents, drains, etc.
30. Speed-torque curve at 100% and 80% of rated voltage.
31. Speed-current curve at 100% and 80% of rated voltage.
32. Acceleration time at 100% and 80% of rated voltage.
33. Locked rotor withstand time.

34. Schematic and interconnection diagrams.
 35. Instruction manual.
 36. Maximum sound power per NEMA MG-1.
- C. Factory Tests. Submittals shall be made for factory tests specified herein.
- D. Field Test Reports. Submittals shall be made for field tests specified herein. Also submit rotation records per 1.07 E.
- E. Operation and Maintenance Manuals.
1. Manufacturer's contact address and telephone number for parts and service.
 2. Project record drawings clearly indicating operating features and including as-built shop drawings, outline drawings, and schematic and wiring diagrams.
 3. Instructions for erection, alignment (including tolerances), and preparation for use.
 4. Complete description of safety equipment, safety procedures, and safety precautions.
 5. Normal starting, running and shutdown procedures, as well as emergency shutdown procedures.
 6. Recommended number of starts in any 24-hour period.
 7. Normal maintenance, inspection and lubrication procedures.
 8. Recommended spare parts list.
 9. Recommended renewal parts list
 10. Record Documents for the information required by the submittals above.

1.04 REFERENCE STANDARDS

- A. Motors shall be designed, built, and tested in accordance with the latest revision of the following standards:
1. National Electrical Manufacturers Association Inc. (NEMA)

- a. NEMA MG1 Part 20 – Large Machines.
 - b. NEMA MG2 - Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
 - c. NEMA MG3 - Sound Level Prediction for Installed Rotating Electrical Machines.
2. National Fire Protection Association (NFPA)
 - a. NFPA-70 - National Electrical Code.
 3. Underwriters Laboratories, Inc. (UL)
 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 - a. IEEE Std 1 - General Principles for Temperature Limits in the Rating of Electric Equipment.
 - b. IEEE Std 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - c. IEEE Std 85 - Test Procedures for Airborne Sound Measurements on Rotating Electric Machinery.
 - d. IEEE Std 112 – Standard Test Procedure for Polyphase Induction Motors and Generators.
 - e. IEEE Std 275 - Recommended Practice for Thermal Evaluation of Insulation Systems for AC Electric Machinery Employing Form-wound Pre-insulated Stator Coils, Machines Rated 6,900 V and Below.
 - f. IEEE Std 429 - Standard Test Procedure for the Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form-wound Stator Coils.
 5. Anti-Friction Bearing Manufacturer's Association Inc. (AFBMA):
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 DEFINITIONS

- A. Motors specified herein are three-phase, squirrel cage induction type, except as specifically specified elsewhere in these Specifications.

- B. The word "Drive" shall be construed to mean the driven equipment, i.e. pump, hoist, fan, compressor, or adjustable frequency drive connected with the motor.
- C. If there is inconsistency of size on different Drawing sheets or between Drawings and other sections of Specifications, relating to the horsepower designation, then the larger size shall be required.

1.06 QUALITY ASSURANCE

- A. Unit Responsibility. The electric motor shall be furnished guaranteed by the driven equipment manufacturer, to assure single unit responsibility.
- B. When motors are furnished with driven equipment, the driven equipment supplier shall be responsible for mounting the motor and driven equipment as a complete unit, correctly aligned and coupled with the coupling or sheave specified on the driven equipment data sheet, and for designing vibration, special, or unbalanced forces resulting from equipment operation.
- C. The Contractor, at no additional cost to the Owner, shall make structural, mechanical and electrical changes that are necessitated because the Contractor selects equipment with dimensional, power or mechanical differences from that shown on the Drawings. All engineering costs associated with revisions shall also be borne by the Contractor.
- D. Motor Compatibility. The Contractor shall satisfy himself that the motor included with the drive is compatible with driven equipment and complies with these Specifications. In the event that the motors described in these Specifications can not be applied to the application or equipment offered, the Contractor may submit an exception, stating clearly the deviations and the reasons for such deviations. The acceptance or rejection of such deviations shall be at the sole discretion of the Owner/Engineer.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Protect equipment during shipment, handling, and storage by suitable complete enclosures. Protect equipment from exposure to the elements and keep thoroughly dry.
- B. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces to the satisfaction of the Owner/Engineer.
- C. Equipment shall be installed in its permanent finished location shown on the Drawings within fourteen (14) calendar days of arriving onsite. If the equipment cannot be installed within fourteen (14) calendar days, the

equipment shall not be delivered to the site, but stored offsite, at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.

- D. Where space heaters are provided in motors, provide temporary electrical power and operate space heaters, during jobsite storage and after motors are installed in permanent location, until equipment is placed in service.
- E. The motor shaft shall be rotated on a monthly basis, if such is recommended or required by the motor manufacturer; the date recorded, and copies of the record provided to the Owner/Engineer and the manufacturer. The manufacturer shall confirm receipt of the rotation record.

1.08 WARRANTY

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for the same warranty period as specified for the associated mechanical equipment, but not less than 2 years from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers or equal are acceptable:
 - 1. General Electric
 - 2. Siemens
 - 3. Reliance
 - 4. TECO – Westinghouse
 - 5. US Motors
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 GENERAL REQUIREMENTS

- A. Each motor provided shall have an Identification Tag Number, conforming to the numbering system and equipment name shown on the Drawings.
- B. Specific motor data such as HP, RPM, enclosure type, etc., is specified under the detailed specification for the mechanical equipment with which the motor is supplied.
- C. Motors shall have sufficient horsepower and torque capacity to drive the equipment without overloading under all conditions, without exceeding the nameplate rating of the motor and without use of the service factor.
- D. Motors shall be NEMA Design B standard, unless otherwise specified.
- E. All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient, unless specified otherwise.
- F. The motors shall be bi-directional. If the motor must be uni-directional, it shall be the motor manufacturer's responsibility to obtain the direction required from the drive manufacturer.
- G. Each motor shall have couplings keyed to shafts. Coordinate with the driven equipment manufacturer with regard to finished product.
- H. Where frequent starting occurs, the design for frequent starting duty shall be equal to the duty service required by the driven equipment.
- I. Altitude: Less than 3300 FT.
- J. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1, as applicable, including but not limited to the following information:
 - 1. Main Nameplate
 - a. Horsepower (output).
 - b. RPM at full load.
 - c. Time rating.
 - d. Frequency.

- e. Number of phases.
 - f. Model number.
 - g. Rated voltage.
 - h. Service factor.
 - i. Full load amps.
 - j. Insulation class.
 - k. NEMA design letter.
 - l. NEMA code letter.
 - m. Temperature Rise.
 - n. Manufacturer's Frame size.
 - o. Date of manufacture.
 - p. Direction of rotation (if uni-directional).
 - q. Thermal protection.
 - r. Motor Weight
2. Heater Nameplate.
- a. Voltage and wattage.
 - b. UL Listing
3. RTD Nameplate
- a. UL Listing
 - b. Type and resistant.
4. Bearings Nameplate.
- a. Bearing manufacturer's name, identification, and recommended lubricant.

- 5. Dynamic Balance Nameplate.
 - a. Furnish and mounted on motor.
- K. Motors shall have a breather drain in each end bracket of a TEFC motor enclosure. Stainless steel automatic breather drains shall be provided in the lowest part of both end brackets to allow drainage of condensation.
- L. Motors shall have an oversized, gasketed, cast iron conduit box, field adjustable in 90-degree increments unless the box contains equipment, diagonally split with tapped NPT threaded conduit entrance hole, and shall exceed the minimum volumes defined in IEEE 841-2001. Neoprene conduit box cover gasket and neoprene lead seal gasket with flexible nipples to ensure the seal is maintained as the leads are moved shall be furnished. Provision for grounding shall be provided in the conduit box utilizing a mounted clamp-type lug.
- M. Provide separate accessory lead conduit boxes. Minimum size entrance hub shall be $\frac{3}{4}$ "C. Resistance temperature detector leads shall not occupy the same box with any other type of power or monitoring leads.
- N. Provide lifting lugs on the motor frame.

2.03 RATING

- A. Description. Unless otherwise specified, the motors shall be induction motors, single speed. The driven equipment manufacturer shall determine the speeds. Nameplate horsepower of the motor shall not be less than that shown on the Drawings, and as specified herein.
- B. Nameplate horsepower rating of motor shall be equal to or greater than the total horsepower requirement for the driven equipment. Motor shall be designed in accordance with applicable provisions of the latest NEMA Standard Publication for Motors and Generators, MG-1, Part 20, subject to modifications and additions as herein set forth.
- C. All motors shall have a service factor of 1.15.
 - 1. In sizing motors, no portion of a motor's service factor above 1.0 shall be used in normal continuous operation of the motor.
- D. All motors shall have Class F insulation and shall be rated at the following temperature rises:
 - 1. The motor windings shall be capable of operating continually at 115% of nameplate horsepower, with rated voltage and frequency applied, and with

a temperature rise by embedded detector not exceeding 90 C over a 40 C ambient temperature.

2. The ambient air temperature shall be defined as air immediately surrounding the motor.
- E. Voltage: Motor voltage, phase and frequency shall be as shown on the Drawings and as specified with the driven equipment.
- F. Power Factor: Greater than 0.85.
- G. Starting Voltage: Each motor shall be capable of producing the required starting torque, as required by the driven equipment manufacturer, utilizing the starting voltage as shown on the Drawings and as specified for the associated motor controller. Motors shall be capable of bringing the driven equipment up to speed, without motor overload, under the conditions specified in the driven equipment specification.
- H. Locked Rotor Current: The locked rotor current of the motor shall be limited in accordance with the National Electrical Code and NEMA MG-1 standards, to a maximum of Code Letter F or G. The code letter shall be clearly shown on the nameplate.
- I. Acceleration Time: Provide calculated acceleration time of the combined motor and driven load and rated voltage and at 90% of rated voltage, as specified in the Submittal paragraphs.
- J. Safe Stall Time: Safe stall time shall not be less than 4 seconds more than the acceleration time when hot, unless approved by the Owner/Engineer. The motor manufacturer shall coordinate with the supplier of the driven equipment to obtain inertia data, and shall calculate the acceleration times when starting across the line. Include calculations with 100 % of the rated name plate motor voltage, (I.E. 4000 volts for a motor on a 4160 volt system), 90% and 80% present at the motor terminals. The Contractor shall submit acceleration curves plotting time vs speed, and calculations to the Owner/Engineer for approval, as specified in the Submittal requirements of this Section.
- K. Noise Measurement: The noise level as measured by IEEE Standard 85, shall be coordinated with pump manufacturer, and submitted for approval.
- L. Slip: The full load RPM shall match or exceed the pump design RPM.
- M. The Contractor shall coordinate with the motor manufacturer and Division 16 motor control manufacturer to provide the correct capacitor kVAR to correct the power factor as specified.

- O. Efficiency: Motor efficiency shall be evaluated and determined by the pump manufacturer to achieve and guarantee the overall wire-to-water efficiency of the pumping unit, for pumping applications. All motors shall have the efficiency evaluated with pump. Motor efficiency shall not be less than 95% when operating at maximum speed, service factor load and rated voltage and frequency.

2.04 STATOR

- A. The stator core shall be built up with high grade, non-aging laminated silicon steel. C5 or better. Each lamination core shall be plated to minimize eddy current losses. The laminations shall be adequately secured to the stator frame and securely held in place at each end. There shall be no perceptible buzzing of laminations during operation. Provide slot wedges for rigidity.
- B. The motor stator winding shall be provided with premium grade full Class F insulation or better. Silicone rubber insulation is not acceptable
 - 1. A VPI insulation system shall be used to provide high resistance to moisture and other contaminates.
 - 2. All windings shall be copper; assembled using form wound coils of the same size and shape. Random wound coils are not acceptable.
 - 3. The form wound coils shall be constructed with copper wire. The stator construction method shall accommodate VIP treatment. The coils shall be covered with strand insulation consisting of Dacron polyester glass fiber film or other high temperature insulating film.
 - 4. Provide full length slot liners rated 5000 volts minimum which extend beyond the stator core iron to reduce the possibility of tracking to ground.
 - 5. Coil insulation shall be tightly applied to eliminate all air voids.
 - 6. Coils shall be tightly inserted into the stator slots without damage. Coils shall be secured to surge ring or treated rope and securely laced to one another as necessary to prevent distortion and expansion.
 - 7. The end turns shall be blocked top, sides and bottom. The surge ring shall be designed and installed to prevent movement during starting and short circuit conditions.
 - 8. The entire stator shall be oven cured to provide a completely sealed insulation system.

2.05 ROTOR

- A. The shaft shall be steel, accurately machined, smoothly finished, with sufficient strength to withstand all stresses resulting from normal operation at any speed up to and including a 25% over-speed condition. Provide shaft end details coordinated with pump and shafting as specified.
- B. The core shall be built up with high-grade non-aging silicon steel, each single piece lamination core plated to minimize eddy current losses. Core mechanical integrity shall not rely on any electrically active component
- C. Rotor bars and end ring shall be copper or copper alloy with uniform resistance characteristics so as to equalize thermal stresses. The bars shall be rectangular or shaped to meet motor starting and running torque requirements. Each copper rotor bar shall be mechanically locked or secured in the rotor pole slots to minimize movement and vibration. Rotor end rings shall be free of circumferential joints and shall be 100% swaged to the rotor bars by an induction or torch brazing process.
- D. Rotors shall be statically and dynamically balanced prior to assembly. Balancing shall be checked after assembly with the motor running at rated speed. Run out on the shaft shall be checked and in no case shall they exceed 0.001 inch measured with a precision indicator with the reading taken at the end of the shaft.
- E. The cage bars shall be copper or a copper alloy with uniform resistance characteristics so as to equalize thermal stresses. ALUMINUM ROTOR BARS ARE NOT ACCEPTABLE. Rotor bar shall be in tension at all times and shall be brazed at the end ring connections. Fabricated aluminum rotors are unacceptable.

2.06 BEARINGS

- A. Horizontal Motors
 - 1. Motors shall have anti-friction open or single-shield, vacuum-degassed steel ball or roller bearings, electric motor quality, with extended pipe zerk fitting and 1/2-lb relief fitting for external lubrication while machine is in operation. The bearing shield shall be on the motor winding side of the bearing unless the design is a flow through system. If so, the bearings shall not be shielded.
 - 2. Unless otherwise specified, bearings for motors 2000 HP 900 RPM and larger shall have oil-lubricated sleeve bearings of the spherically seated type.

3. Heavy brackets mounted from the motor frame shall support the bearing housings.
4. The bearings shall have a rated fatigue life of L10 100,000 hours for direct coupled applications, minimum.
5. When a continuous axial thrust condition exists, the motor shall be provided with a supplement thrust bearing or two anti-friction bearings of adequate size to handle the momentary and continuous thrust conditions specified.
6. A high quality bearing seal shall be provided to prevent moisture and contaminants from entering the shaft end into the bearing, and provided with means of flushing old lubricant and introducing new lubricant. This shall be supplied in addition to tight mechanical bearing housing fits.
7. The rotor end play limits and the shaft position, when magnetically centered shall be scribed on the shaft and a suitable reference point shall be indicated on the sleeve bearing housing. The pump supplier shall provide a limited end float coupling. A minimum of ½-inch total shaft end float is required.
8. To protect against circulating currents, bearings shall be insulated. Bearing temperature detectors shall also be insulated. A ground brush shall be used on the drive end to bleed currents to ground.

2.07 LEADS

- A. Motor Leads. Use ASTM B 173, Class G, stranded copper.
- B. Provide permanent identification numbers on leads according to NEMA MG 1-2.02. Provide each lead with additional identification within six inches of the stator frame. Use crimp-on, solderless copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals.
- C. The motor leads shall have the same class of insulation as the motor stator windings. Leads shall be numbered for clockwise rotation when facing the opposite the shaft end.

2.08 ENCLOSURE

- A. Unless otherwise specified, motor enclosure shall be TEFC as specified herein and be in compliance with NEMA MG-1.
- B. The manufacturer shall arrange the intake and discharge air outlets such as to minimize the intake of air from the discharge of an adjacent motor.

- C. Air inlets and outlets shall be protected by vermin-proof, corrosion resistant louvers. The air inlets shall be located on end or side as required by the application.

2.09 HARDWARE

- A. Use structural bolts, washers, nuts, pins, and similar items manufactured of high-strength stainless steel. Use only hexagon-head bolts and hexagon nuts.

2.10 TERMINAL BOXES

- A. Description. Provide custom built, gasketed, oversized conduit boxes and terminal housing cabinets for all wiring connections to motor. The cable entrance to the boxes shall be from the bottom side. Unless otherwise shown on the Drawings, All terminal boxes shall be located on the same side of the motor. Verify exact location of cable entry, before design, from the Contract Drawings.
- B. Main Terminal Housing. The main terminal box shall be custom designed to accommodate all conductors and specified accessories located in the Terminal Housing.
 - 1. Provide NEMA multiple-hole pads with standoff insulators, as defined in NEMA MG 1 Table 20.3 to terminate the incoming motor leads.
 - 2. The motor terminal box shall be sized to accommodate prefabricated shrink-on cable terminators as manufactured by 3-M or RayChem.
 - 3. Motor leads shall be marked for permanent identification.
 - 4. Provide grounding lug in box for incoming equipment grounding conductor(s). The main terminal box shall be installed integral with the motor.
- C. Space Heater Terminal Box: Provide a separate terminal box on the motor for termination of wires on strap screw or tubular clamp terminal blocks.
- D. RTD Terminal Box: Provide a separate terminal box on the motor for termination of motor, bearing and ambient RTD leads for termination of wires on tubular screw clamp terminal blocks. Box shall accommodate a 2-1/2" C minimum.
- E. Provide a separate NEMA 3R floor mounted box to contain the power factor correction capacitors.

- F. Signal leads using low voltage or current shall not be housed in the same connection box as leads carrying 120 volts or currents in excess of ½ ampere.
- G. Leads shall be suitably marked and identified with heat shrink markers.
- H. Accessories boxes shall have stainless steel nameplates, attached with stainless steel screws. The nameplates shall say “SPACE HEATER”, “BEARING RTD’s”, “WINDING RTD’s”, etc.
- I. Accessories boxes shall be bottom entry.
- J. Use only corrosion-resistant materials.
- K. Permanently identify all leads and terminals.
- L. All wires and electrical connections shall be copper.
- M. All wiring penetrating the motor frame shall be protected against chaffing with grommets.

2.11 GROUNDING MEANS

- A. Provide a grounding lug threaded into the motor frame within the motor terminal box and other motor conduit boxes. Lug shall be similar and equal to Burndy KC Servit. Provide two NEMA 2-hole ground pads located near the base of the motor mounted 180° apart.

2.12 SPACE HEATERS

- A. Type. Electric resistance, 120 volts, silicon rubber clad or rubber epoxy or equivalent non-oxidizing exterior, with maximum surface temperature of 130 degrees C (266 degrees F).
- B. Alternatively, provide two stainless-steel-sheathed conventional space heaters, each with rated watts at the specified voltage equal to twice the required value, and connect in series.
- C. Space heaters shall maintain the internal temperature above dew point when motor is not operating.
- D. Heaters shall not be located directly in access opening where they may pose a danger of burn or shock to servicemen.
- E. Space heater wiring shall be routed to prevent wire being between the frame and space heater.

2.13 RESISTANCE TEMPERATURE DETECTORS (RTD's)

- A. Type: 120ohm nickel
- B. Quantity.
 - 1. Six: Two per phase for the motor windings.

2.14 CAPACITORS

- A. Provide Capacitors in NEMA 3R enclosures for installation near the motor.
- B. Include Capacitor fuses.
- C. Include inductor to reduce inrush.
- D. Include discharge resistor.
- E. Provide non-PCB, non-toxic, biodegradable impregnation fluid.
- F. Tolerance: 0% to 10%
- G. LIL Approved for outdoor use.
- H. Operating temperature: -40% to 115° F.
- I. Provide self heating dielectric system.
- J. Construct in accordance with IEEE 18, NEMA CP-1, and IEC 871-1.
- K. Permissible overloads: Current 135%, voltage 110%.

2.15 SPARE PARTS

- A. One (1) spare fuse of each type and size for the power factor correction capacitors.
- B. Manufacturer's standard shop paints for prime and finish coats are acceptable. Include one pint of finish paint for each motor. If environmental regulations prohibit paint shipment, the Contractor may supply the same paint type and color from a local source.

2.16 SPECIAL TOOLS

- A. Furnish with the equipment, one (1) set of any special tools or devices required for the assembly, operation, and maintenance of all equipment furnished.

2.17 LUBRICANT

- A. Furnish with the equipment, oil of the recommended type and grade, in sufficient quantity for initial filling and for operation during acceptance tests and installation.
- B. The Manufacturer shall provide a list of lubricants available sources. In addition provide the Owner with a sufficient quantity of lubricant for required service during the first 12 months after start-up.

2.18 FACTORY TESTS

- A. Perform Routine Factory Tests for Polyphase Medium Induction Motors and the tests specified herein: The method of testing shall be in accordance with IEEE Std 112, and shall be in accordance with MG1-12.55. The following routine tests shall be done at the factory on the motors provided, and certified test reports shall be submitted.
 - 1. Measurement of winding resistance.
 - 2. No-load readings of current and speed at normal voltage and frequency.
 - 3. Current input at rated frequency and voltage, with rotor at standstill for squirrel-cage motors.
 - 4. High-potential test per MG1-20.18 and IEEE Std 43.
- B. Following completion of factory tests, the Vendor shall furnish to the Owner/Engineer for review and approval four (4) certified copies of all test data and test curves for each motor. The Owner/Engineer shall review test data and, upon determining that the motor meets contract requirements, authorization will be given for shipment. Shipment shall not be made without written approval of test data by the Owner/Engineer, except at the risk of the Vendor.

PART 3 EXECUTION

3.01 INSTALLATION

3.02 MOTOR MANUFACTURER SERVICE ENGINEER: FIELD TESTING

- A. The motor manufacturer shall furnish the services of a competent service engineer, who shall have had a minimum of five years experience in the installation, adjustment, and operation of the equipment that is being furnished under this contract. This service is to ensure proper installation and adjustment of the motor, instruct personnel in proper operation, maintenance, and care of the equipment, for making operation tests of equipment, and recommendations for obtaining the most efficient use thereof.
- B. The service engineer shall arrive at the site after the motor installation but prior to testing and start-up. He shall verify the proper installation, alignment, wiring, lubrication, and connection of all appurtenances prior to start-up. He shall be present during testing, and start-up and shall certify to the Owner in writing that the motors have been properly installed and operate satisfactorily.
- C. The minimum time required to be on-site, not including travel time, is as follows:
1. Check motor installation 2 days(2 trips minimum)
 2. Pump start-up and testing 4 days(2 trips minimum)
 3. Troubleshooting 2 days(3 trips minimum)
 4. Personnel training 1 days (1 trip minimum)
- D. Field-Testing: The following tests shall be performed on the motors after installation in the field.
1. Polarization Index Test: Measure and record the motor's insulation resistance polarization index (10 minute \ 1 minute ratio), at 2500 VDC, per IEEE Standard 43. Minimum acceptable polarization index ration shall be greater than 2.0 (>2.0).
 2. Motors shall have a 1-hour run-in while uncoupled from the driven load. The motor temperatures shall be monitored and recorded, every 5 minuets from just before start to the end of the hour test. Record operating amps, voltage, and vibration levels.
 3. Monitor motors during startup and commissioning to record operating amps, voltage and operating vibration levels.
 4. Submit test report and all recorded field data. Submit copies of the raw data recorded in the field, signed by the person recording the data, and typewritten reports certified by the Contractor. The motors will not be accepted until the reports are submitted and approved.

- E. Inspect for unusual mechanical or electrical noise or signs of overheating during initial test run.

3.03 EQUIPMENT PROTECTION AND RESTORATION

- A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.04 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's engineer shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide three (3) copies of the manufacturer's service engineer's certification.

3.05 TRAINING

- A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment furnished under this Section.
- B. The training shall be for a period of not less than two (2) hours.
- C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the equipment being supplied.
- D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.
- E. The training session shall be conducted by a manufacturer's qualified representative.
- F. The Owner shall have the right to videotape the training for the Owner's use.

END OF SECTION

SECTION 16195

POWER METERING AND PROTECTIVE RELAYS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section of the Specifications describes the requirements for power metering and protective relays to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.
- B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.02 RELATED WORK

- A. Section 16000 Electrical – General Provisions
- B. Section 16105 Power System Study
- C. Section 16345 Medium Voltage Metal-Clad Switchgear
- E. Section 16480 Motor Control Centers

1.03 SUBMITTALS

- A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned unreviewed.
- B. Submit catalog data for all items supplied from this specification section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the meter or relay provides every specified requirement. Any options or exceptions shall be clearly indicated.
- C. Operation and Maintenance Manuals.
 - 1. Operation and Maintenance manuals shall include the following information:

- a. Manufacturer's contact address and telephone number for parts and service.
- b. Instruction books and/or leaflets
- c. Recommended renewal parts list
- d. Record Documents for the information required by the Submittals above.

1.04 REFERENCE CODES AND STANDARDS

- A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
 - 1. NEMA/ISCI – 109 Transient Overvoltage Withstand Test
 - 2. IEEE Std. 472/ANSI C37.90A Surge Withstand Capability Tests
- B. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.
- C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.05 QUALITY ASSURANCE

- A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 1 year from date of acceptance of the equipment containing the items specified in this Section. Within such period

of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 PRODUCTS

2.01 FEEDER PROTECTION SYSTEM (FP1)

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. GE/Multilin Model 750 to match existing SAWS standards at other stations.
 - 2. No Equal
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. General
 - 1. Digital relay for management and primary protection of feeders, and management and backup protection of buses, transformers and transmission lines
 - 2. The unit shall provide protection, control, and monitoring functions with both local and remote human interfaces.
 - 3. The relay shall be of drawout construction.
 - 4. All circuit boards shall have a harsh environment conformal coating to resist H₂S gas and other corrosive agents, including humidity.
 - 5. All components, except terminating hardware, shall be mounted inside the relay.
 - 6. The unit shall be suitable for semi-flush mounting in a panel.
 - 7. It shall be equipped with a front panel display and keypad for programming and monitoring.

D. Protection

1. The relay shall have the following protective functions:
 - a. Time phase overcurrent elements for all phases with level detectors.
 - 1) The phase time overcurrent element shall be capable of dynamic adjustment of the pickup setting from manual close blocking, cold load pickup and voltage restrained overcurrent features;
 - b. Time ground overcurrent elements with level detectors.
 - c. Directional control of both phase and ground overcurrent elements.
 - d. Two independent elements each for:
 - 1) Undervoltage
 - 2) Overvoltage
 - 3) Underfrequency

E. Control

1. The relay shall be able to trip and close an associated circuit breaker and track the breaker position. The relay shall include a Red breaker closed LED.
2. Closing operations shall be supervised by a synchro-check scheme, with voltage source level or manual override provisions.
3. The relay shall be able to control the overcurrent elements in a cold load pickup or manual closing operating mode.
4. The relay shall have a minimum of 14 programmable logic inputs for manual commands or feature control
 - a. Inputs shall be able to operate from internal and external dc power supplies.

F. Metering

1. The unit shall be able to measure / calculate and display:
 - a. Line voltage
 - b. Differentials between bus and line voltages

- c. Frequency
 - d. Current
 - e. Real, reactive and apparent power
 - f. Power factor
 - g. Watt-hour and var hour consumption
 - h. Demand for current and power measurements
2. The relay shall have an input channel for measuring a 0-1 mA, 0-5 mA, 0-20 mA, or 4-20 mA (programmable) signal from an external transducer.
 3. The relay shall have eight internal transducers, with 4-20 mA output signals to represent various measured / calculated parameters.
 - a. Output channels shall be programmable to represent, as a minimum:
 - 1) Voltage
 - 2) Frequency
 - 3) Current
 - 4) Power
 - 5) Demand
 - 6) The distance to the most recently detected overcurrent fault.

G. Monitoring

1. The relay shall have measuring elements with programmable outputs to monitor:
 - a. Breaker trip and close coil continuity
 - b. Over frequency
 - c. Demand levels
 - d. Power factor

- e. Summed breaker arcing current
- 2. The relay shall be able to display automatically at least 10 user-programmed protection settings or measured / calculated parameters.

H. System/Relay Operations and Maintenance

- 1. The relay shall have a sequence of events record and oscillographic capture of important events with a time base in 1 ms increments.
 - a. The event record shall store a minimum of 64 events.
 - b. The oscillograph shall capture a minimum of eight events.
 - 2. The relay shall have a distance-to-fault feature that stores a minimum of eight faults.
 - 3. The relay shall have a simulation feature to test the device without external injection of voltage and current signals.
 - 4. Device firmware shall be stored in non-volatile flash memory, so that relay upgrades can be performed by downloading programs from a PC.
- I. Control Power - The relay shall be suitable for HI or LO ranges of available control power.
- 1. HI Range: DC: 88-300 VDC; AC: 70-265 VAC, 48 to 62 Hz.
 - 2. LO Range: DC: 20-60 VDC; AC: 20-48 VAC, 48 to 62 Hz.
- J. Communication - Relay shall have three independent communications ports, one RS 485/422 port, one front RS 232 port, and one 10BaseT RJ45 Ethernet port.
- K. Protocol – The RS485/422 and RS232 ports shall support the Modbus RTU protocol. The Ethernet port shall support Modbus TCP protocol.

2.02 MOTOR PROTECTION SYSTEM (MP4)

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
- 1. GE Multilin 469 to match existing SAWS standards at other stations.
 - 2. No Equal

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General

1. All circuit boards shall have a harsh environment conformal coating to resist H₂S gas and other corrosive agents, including humidity.

D. Protection and Control

1. Thermal model biased with RTD and negative sequence current feedback
2. Start supervision and inhibit
3. Locked rotor / mechanical jam
 - a. The relay shall protect the rotor during stall and acceleration. The stall/acceleration curve shall be voltage compensated and a speed switch input shall be available. The stator protective thermal model shall combine inputs from positive and negative sequence currents and RTD winding feedback. The model shall be dynamic in nature in order to follow the loading and temperature of the motor.
4. Voltage compensated acceleration
5. Undervoltage, overvoltage
6. Underfrequency
7. Stator differential protection
 - a. Differential protection using CT inputs (6) from both sides of the machine winding Voltage transformer inputs shall be used to provide over voltage, under voltage, voltage phase reversal, over frequency and under frequency functions.
8. Thermal overload
9. Overtemperature 12 RTD's
10. Phase and ground overcurrent
11. Current unbalance

12. Power Elements

- a. Power factor
- b. Reactive power
- c. Underpower
- d. Reverse active power
- e. Overtorque

13. Torque protection

14. Reduced voltage starting control

E. Monitoring and Metering

1. Metering Functions

- a. A, V, W, Var, VA, PF, Hz, Wh ,varh, demand
- b. The system shall include complete power metering. An event record shall store the last 40 events. Sixteen cycles of waveform data shall be stored each time a trip occurs. A simulation feature shall be available for testing the function.

2. Torque, temperature

3. Event recorder

4. Oscillography and data logger

5. Statistical information and learned motor data

6. Motor starting reports

F. Inputs and Outputs

1. 12 RTD's, programmable
2. Five predefined and four assignable digital inputs
3. Six output relays
4. Four analog inputs

5. Four programmable analog outputs

G. Memory

1. Memory shall be non-volatile and programming shall remain intact upon power failure.
2. Interface software shall be provided in a Windows® format.

H. User Interface

1. A 40 character LCD display and associated keypad to provide access to actual values and set points.

I. Control Power:

1. Range of available control power: DC: 90-300 VDC; AC: 70-265 VAC, 48 to 62 Hz.
2. LO Range: DC: 20-60 VDC; AC: 20-48 VAC, 48 to 62 Hz.

J. Communication - Relay shall have three independent communications ports, one RS 485/422 port, one front RS 232 port, and one 10BaseT RJ45 Ethernet port.

K. Protocol – The RS485/422 and RS232 ports shall support the Modbus RTU protocol. The Ethernet port shall support Modbus TCP protocol.

L. The relay shall have a draw-out construction to facilitate testing, maintenance and interchange flexibility.

2.03 ACCESSORIES

A. Furnish nameplates for each device as indicated in drawings. Color schemes shall be as indicated on Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

(ANDERSON PUMP STATION)
(SAWS JOB NO. 07-6007)
(B&V PN 161472)

16195
-10-

SECTION 16345

MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR AND MEDIUM VOLTAGE MOTOR CONTROLLERS AND FEEDERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish and install assemblies of medium voltage metal-clad switchgear, and medium voltage motor controllers and feeders, together with appurtenances, complete and operable, as specified herein and as shown on the Contract Drawings.

1.02 RELATED WORK

- A. Section 16000 Electrical – General Provisions
- B. Section 16120 Wires and Cables (600 Volt Maximum)
- C. Section 16121 Medium Voltage Cables
- D. Section 16195 Power Metering and Protective Relays

1.03 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000 and as specified herein.
- B. Submittals for equipment and materials, furnished under this Section of the Specifications, will not be accepted prior to approval of the Power System Study specified under Section 16105. Submittals made prior to such approval will be returned unreviewed.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned unreviewed.
- D. The original equipment manufacturer shall create all equipment shop drawings, including all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment

manufacturer's logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturer's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

- E. Submit to the Owner/Engineer, shop drawings and product data, for the following:
1. Product data sheets and catalog numbers for overcurrent protective trip devices on circuit breakers and switches, relaying, meters, pilot lights, etc. The manufacturer's name shall be clearly visible on the each cut sheet submitted. List all options, trip adjustments and accessories furnished specifically for this project. Clearly mark each sheet to indicate which items apply and/or those items that do not apply.
 2. Provide control systems engineering to produce custom unit elementary drawings showing interwiring and interlocking between components and to remotely mounted devices. Include and identify all connecting equipment and remote devices on the schematics. The notation "Remote Device" will not be acceptable. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.
 3. Provide plan and elevation drawings of each controller or enclosure, with dimensions, exterior and interior views, showing component layouts, controls, terminal blocks, etc.
 4. Schematic diagram
 5. Nameplate schedule
 6. UL Listing of the completed assembly.
 7. Component list with detailed component information, including original manufacturer's part number.
 8. Conduit entry/exit locations
 9. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 10. Major component ratings including:

- a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
11. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.
12. Key interlock scheme drawing and sequence of operations
13. Instruction and renewal parts books.
- F. Factory Tests. Submittals shall be made for factory tests specified herein.
- G. Field Test Reports. Submittals shall be made for field tests specified herein.
- H. Operation and Maintenance Manuals.
- 1. Operation and maintenance manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record Documents for the information required by the Submittals paragraph above.

1.04 REFERENCE CODES AND STANDARDS

- A. The medium voltage switchgear and protection devices in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
- 1. ANSI C37.06-2000, Switchgear - AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities
 - 2. ANSI/IEEE C37.04 and C 37.06, Standard ratings and Preferred Ratings for Indoor AC Medium-Voltage Circuit Breakers used in Metal-Clad Switchgear

3. ANSI / IEEE C37.09, Standard Design and Production Testing
 4. ANSI/IEEE C37.20.2, Standard for Metal-Clad Switchgear
 5. ANSI/IEEE C37.11, Requirements for Electrical Control for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis or Total Current Basis
 6. ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.
 7. ANSI / Z55.1, Gray Finishes for Industrial Apparatus and Equipment
 8. NEMA SG 2, High Voltage Fuses
 9. NEMA SG 4, Alternating - Current High Voltage Circuit Breaker
 10. NEMA SG 5, Power Switchgear Assemblies
 11. International Electrochemical Commission (IEC)
 12. IEC 56, High Voltage Alternating Current Circuit Breakers
- B. The medium voltage motor controllers, transformer feeders and all components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
1. ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.
 2. IEEE C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus
 3. NEMA SG 2, High Voltage Fuses
 4. ANSI/NEMA ICS 6 – Enclosures for Industrial Controls and Systems
 5. NEMA ICS 1 – General Standard for Industrial Control Systems
 6. NEMA ICS 3, Part 2
 7. UL 347 – High Voltage Industrial Control Equipment
 8. NFPA 70 – National Electrical Code (NEC)
 9. NFPA 70E – Standard for Electrical Safety in the Workplace

- C. All equipment components and completed assemblies specified in this section of the Specifications shall bear the appropriate label of Underwriters Laboratories.
- D. All equipment components and completed assemblies specified in this section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.05 QUALITY ASSURANCE

- A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer.
- C. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.
- D. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 DELIVERY STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner.
- B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
- C. Switchgear shall be equipped to be handled by crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.
- D. Equipment shall be installed in its permanent finished location shown on the Drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.

- E. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters, during jobsite storage and after the equipment is installed in permanent location, until equipment is placed in service.

1.07 WARRANTY

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 3 years from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. General Electric Co.
 - 2. Siemens
 - 3. Eaton Cutler-Hammer
 - 4. Square D
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS - SWITCHGEAR

- A. The switchgear described in this specification shall be designed for operation on the voltage systems as shown on the Drawings. Each circuit breaker shall have the following ratings:

1. Maximum Voltage	<u>15KV</u>	<u>5KV</u>
2. BIL Rated	95kV	60kV

3. Continuous Current	As shown	As shown
4. Short-Circuit Current, At Rated Maximum kV	31.5kA	31.5kA
5. Closing and Latching Capability	82kA Peak	82kA Peak
6. Rated Interrupting Time	Five cycles	Five cycles

2.03 CONSTRUCTION - SWITCHGEAR

A. General

1. The switchgear described in this specification shall contain factory assembled and operational tested circuit breakers and accessories and be self-supporting in a manner to be installed on a level concrete pad.
2. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
3. Switchgear units shall be arranged as shown on the Drawings.
4. Furnish and install a weather-resistant non-conducting rubber floor mat, minimum ¾ inch thick by 4 feet wide, and extending the full length of the equipment lineup.

B. Enclosures

1. Enclosures shall be indoor, freestanding, metal enclosed medium voltage switchgear assemblies, consisting of dead front, completely metal enclosed vertical sections. In each unit, major primary circuit parts (breaker, buses, transformers) shall be completely enclosed by grounded metal barriers, including a front barrier as part of the circuit breaker. Two rear covers shall be furnished for each vertical section for circuit isolation and ease of handling. Refer to drawings for any size limitations.
2. Where bus transition sections are shown, the sections shall; be of the same construction, size and rating, as the other switchgear sections. Entries to the front and rear of the sections shall be of bolted construction. Bus construction and insulation shall be identical to the switchgear bus construction until the bus is in alignment with the bus of the motor controller lineups.

3. Cubicles designated as future on the one line diagram shall be furnished with vertical bus, multiple-ratio current transformers, metering and relaying as shown on the one line diagram. The cubicle shall be equipped for a future breaker element.
4. All the space heaters within each assembly shall be controlled by one thermostat and furnished with a single pole circuit breaker for supply disconnect. The entire circuit shall be wired to an accessible terminal block provided for a single connection for the external power source.
5. All metal work shall be free from burrs and sharp edges.
6. Interlock(s) shall be provided to prevent racking a circuit breaker into a compartment with the door in the open position. This interlock may be manually circumvented for maintenance purposes by a deliberate act on the part of the operator. This override shall require a minimum of two separate and distinct operations, neither of which is considered to be part of normal operations.
7. Interlock(s) shall be provided to prevent opening the compartment door unless the circuit breaker is in the disconnected position and safety shutters are closed. This interlock may be manually circumvented for maintenance purposes by a deliberate act on the part of the operator. This override shall require a minimum of two separate and distinct operations, neither of which is considered to be part of normal operations. This interlock shall reset should the compartment door be closed following maintenance after circumvention.
8. The switchgear shall be capable of extension from either end at a future date without modification to existing structural members.
9. The depth of the finished equipment shall be sufficient to allow for entrance, bending, and termination of power cables. Individual units shall be provided for top or bottom entrance as specified. A minimum of 33 inches of clearance between terminal pads and the cable entrance shall be provided.
10. Nameplates
 - a. External
 - 1) Furnish nameplates for each device as indicated in drawings. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. There shall be a master nameplate that indicates equipment ratings, manufacturer's name, shop order number and general information. Cubicle

nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.

b. Control

- 1) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

c. Special

- 1) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

- d. The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer's suppliers and sub-suppliers.

11. Control Devices and Indicators

- a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls shall be clearly labeled to indicate function and shall be NEMA 12 oiltight rated, and in accordance with the electrical area classification specified in Section 16000. Controls installed outdoors, on NEMA 3R, NEMA 4X enclosures, or corrosion resistant enclosures, shall have a rating of NEMA 4/4X/13 without booted covers. Auxiliary contacts shall be provided for remote ON indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
- b. Indicator lamps shall be 30 mm heavy duty, LED, with nameplates. Lens color shall be green for OPEN, red for CLOSED, and amber for FAIL or ALARM. For all control applications, except NEMA 7, indicator lamps shall incorporate a push-to-test feature. A separate single lamp test push-button shall be incorporated on NEMA 7 control panels.
- c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc) shall be heavy duty, 30 mm, as shown on the Drawings, with nameplates. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.

- d. Pushbuttons, shall be heavy-duty, 30 mm, red for CLOSE and black for OPEN, with momentary or maintained contacts as required by the Drawings, with nameplates.

12. Where Type 86 relays are specified or shown on the Drawings, the relay shall be a door mounted, high speed multicontact relay for trip and/or block close breaker control and contact multiplication. Contacts shall be electrically separate. Relay shall be electrical trip and manually reset. A black target shall indicate the Reset position and an orange target the Tripped position. Where the relay is shown as an output of a Main or Feeder Breaker Protective System, the Type 86 Relay functions may be incorporated into the associated Breaker Protective System, if the Protective System can provide all of the relay functions and capabilities specified above.

C. Finish

1. All steel structure members shall be cleaned, rinsed, and phosphatized prior to painting.
2. The switchgear shall be painted with an electrostatically applied polyester powder with final baked on average thickness between 1.5 and 2.0 mils and meet ANSI requirements for indoor equipment.
3. All exterior surfaces of the switchgear assembly shall be given final finish coats of ANSI 61 gray as standard.
4. Finish shall have a minimum pencil hardness of 2H as tested per ASTM D3363 and shall pass the SATM B117 Salt spray test for a minimum of 500 hours.

D. Busses and Bus Supports

1. Busses shall be tin plated copper and rated as shown on the Drawings. Bus bars shall have a continuous current rating, as shown on the Drawings, based on temperature rise and documented by design tests. All joints shall be tin plated with at least 2 bolts per joint. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Buses shall have provisions for future extension. All bus joints shall be plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers.

E. Ground Bus

1. A tin plated ground bus (1/4 by 2 inch copper) shall extend throughout assembly with connections to each breaker grounding contact and cable compartment ground terminal. Joints shall be made up as indicated in drawings. Station ground connection points shall be located in each end section. Bus bars shall have fluidized bed epoxy flame retardant and non-hydroscopic insulation.

F. External Wiring Connections

1. Preparation for the incoming and outgoing cables, to be connected to the switchgear, the lugs, terminators, etc., shall be in accordance with Section 16120 for 600 Volt cables and Section 16121 for medium and high voltage cables.

G. Wiring/Terminations

1. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminal connections shall be provided. One control circuit cutout device shall be provided for each circuit breaker housing. Switchgear secondary control wire shall be (minimum) #14 AWG (#12 for CT circuits) type SIS, 41 strand extra flexible, stranded copper or larger rated 600 volt, 90 degrees C, furnished with wire markers at each termination. All control wiring shall be UL listed and have a VW-1 flame retardant rating. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.
2. Exposed wiring shall be suitably protected against contact with sharp edges. Throughout the assembly it must be neatly bundled and secured with nylon wire ties. Where control wiring passes from cubicle to door, it must be wrapped with suitable protection to prevent damage. Holes, cut to allow control wires to pass from cubicle to cubicle, shall have a grommet for protection.
3. Each control wire shall be marked at both terminations to agree with wiring diagrams. Plastic wire markers of either the slip on or heat shrink variety shall be provided.
4. Incoming line and feeder cable lugs of the type and size indicated elsewhere shall be furnished.

H. Circuit Breakers

1. The circuit breakers shall be horizontal draw out type, capable of being withdrawn on rails. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.
2. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit, which can be removed easily. The vacuum interrupter pole unit shall be mounted on glass polyester supports for 5 and 15 kV class, and epoxy supports for 27 and 38 kV class. Provision shall be made for checking contact wear gap on each vacuum interrupter, visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.
3. Circuit breaker compartments shall be designed to house removable-element circuit breakers. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A mechanism shall be provided for checking of contact wear. A metal or lexan shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell.
4. Circuit breakers shall be rated as indicated in drawings. Circuit breakers of equal rating shall be interchangeable. Circuit breakers shall be operated by an electrically charged, mechanically and electrically trip-free, stored-energy spring.
5. Circuit breakers shall be equipped with secondary disconnecting contacts which shall automatically engage in the connected position.
6. Each breaker compartment with breaker shall be designed to permit remote racking of the breaker between the connected and disconnected positions. The compartment design shall permit a control box to be connected to the operator with a minimum thirty-foot cable, permitting control from a remote location. The operator attachment method shall provide for racking of the breaker when the compartment door is fully closed. The remote racking operator shall be portable with a 120 VAC power cord. It shall not be possible to install the remote racking operator when the breaker is closed and the breaker cannot be closed with the remote racking operator in place.

7. An indicator shall show breaker position when racking breakers in or out of their connected positions
8. Interlocks shall prevent moving breaker to or from operating position unless main contacts are open. Operating springs shall be discharged automatically when breaker is rolled fully into connected or disconnected position. Rackout device shall have provisions to padlock in connected or disconnected position. When locked in disconnected position, breaker shall be removable from compartment using portable lifting device. Padlock shall not interfere with breaker operation.
9. Automatic shutters shall cover primary disconnect stabs when breaker is withdrawn to test/disconnect position. Shutters shall be positively driven by linkages connected to racking mechanism. A stationary barrier shall be located in front of the shutters for additional safety.
10. Breaker control voltage shall be 120 VAC. Breaker tripping power shall be provided from a 120V A-C capacitor trip unit. Control power source shall be from the CPT auto throw over source as specified herein.

I. Circuit Breaker Control and Interlocking Functions

1. Control

- a. Loss of normal service voltage as determined by the protective relaying on a main circuit breaker shall not cause that circuit breaker to trip open.
- b. Close and trip circuits shall be separately fused. Fuse blocks shall be dead front, pull-out type.
- c. Each breaker shall be complete with control switch and red and green indicating lights, and mechanical indication to indicate breaker contact position.
- d. Each breaker shall have a minimum of 4 normally open and 4 normally closed spare auxiliary contacts wired to accessible terminal blocks.
- e. Where a Control Power Auto Transfer System is shown on the Drawings, the system shall consist of a relay operated arrangement which shall have a selectable primary source of CPT. Upon loss of the primary control power the system shall transfer to the secondary CPT. System shall revert upon resumption of the primary source.

2. Interlocks

- a. Where a main bus tie breaker is shown, the main bus tie breaker cannot be closed unless one of the main breakers is open. It shall not be possible to close both main circuit breakers with the main bus tie breaker closed. The key-interlock (two keys for three breakers) shall be provided. Kirk bodies shall be of stainless steel.

J. Control Power Transformers

1. Control power transformers shall be as shown on the Drawings. Transformer mechanical ratings shall equal the BIL and momentary rating of the circuit breakers. Transformers, when mounted in switchgear assemblies, shall be rated for the full voltage of the switchgear.
2. All control power transformers shall have vacuum cast primary and secondary coils using epoxy resin. Voltage and control power transformers of the quantity and ratings indicated. Voltage transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. The voltage transformer primary connections shall utilize epoxy insulated bus bar. Rails shall be provided for each drawer to permit easy inspection, testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

K. Current Transformers

1. Current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The standard location for the current transformers on the bus side and line side of the breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

L. Instrument Transformers

1. All instrument transformers shall be vacuum cast using polyurethane resin.
2. Transformers shall be as shown on the Drawings. Transformer mechanical ratings shall equal the BIL and momentary rating of the circuit

breakers. Transformers, when mounted in switchgear assemblies, shall be rated for the full voltage of the switchgear.

3. For rigidity during fault conditions all connections to roll-out potential transformer trays and control power transformer trays shall be rigid bus bars insulated to full voltage rating of switchgear assembly.
4. Voltage transformers shall be draw out type, with current-limiting fuses and with BIL rating equal to the switchgear. Transformers shall be as shown on the Drawings.
5. Secondary control wiring shall be No. 14, extra flexible, stranded, tinned-copper control wire, Type SIS cross-linked polyethylene, rated 600 volts, except for specific circuits requiring larger wire. Crimp-type, uninsulated spade terminals shall be furnished on all wire ends, except where non-insulated ring terminals are used to connect to fuse blocks, and instrument transformer studs. Secondary control wires shall be armored where they pass through primary compartments.

2.04 FEEDER MANAGEMENT RELAYS - MAIN BREAKERS AND FEEDER BREAKERS

- A. Furnish where shown on the Drawings, a Feeder Protection System, for feeder monitoring and protection, for each Main and Feeder Breaker, and as specified in Section 16195 Power Metering and Protective Relays.
- B. A 100VA minimum UPS shall be provided, powered from the control power transformer to provide control power to the feeder management relays and power quality meters as shown on the drawings.

2.05 RATINGS – MEDIUM VOLTAGE MOTOR CONTROLLERS AND TRANSFORMER FEEDER LINEUPS

- A. The voltage, current and short circuit current ratings of the motor control centers shall be as shown on the Drawings.
- B. Fused contactor ratings shall be as follows:

System Voltage	Enclosed	Ind. Motor	HP Rating (3 Phase)
	Continuous Rating	Interrupting Capacity	
2300	360A	200 MVA	1500
2300	720A	200 MVA	3000
4000	360A	350 MVA	2500
4000	720	350 MVA	5500

C. Main and Feeder ratings shall be as follows:

Max. Volts (KV)	BIL Rating (kV)	Continuous Current (Amperes)	Interr Cap (Amps)		Momem 10 Cy	Curr 4 Sec	Fault Closing Current Asym. Amps.
			at 0.8 PF	at 1.0 PF			
5.5	60	600	600	80	40,000	25,000	40,000
5.5	60	1200	1600	300	61,000	38,000	61,000

D. The vacuum contactor ratings shall be as follows:

<u>7200V Max.</u>	<u>400 Amperes</u>	<u>800 Amperes</u>
Max. Interrupting Current (3 Ops)	8500 Amps	12,500 Amps
Rated Current – Enclosed	400 Amps	720 Amps
Rated Current – Open	400 Amps	800 Amps
Short Time Current		
30 Sec.	2400 A	4320 A
1 Sec	6000 A	10,800 A
0.5 Cycle	63kA Peak	86kA Peak
Impulse Withstand	60kV	60kV

E. Motor and transformer feeders, including devices, shall be designed for continuous operation at rated current in a 40 degree C ambient temperature.

F. For additional ratings and construction notes, refer to the Drawings.

2.06 CONSTRUCTION – MEDIUM VOLTAGE MOTOR CONTROLLERS AND TRANSFORMER FEEDER LINEUPS

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
2. Control Power Transformers
 - a. Control power transformer ratios shall be as required for the control circuit voltage. Transformer mechanical ratings shall equal the BIL and momentary rating of the medium voltage motor controller lineup. Transformers shall be rated for the full voltage of the motor controller lineup.

- b. All control power transformers shall have vacuum cast primary and secondary coils using epoxy resin.

3. Instrument Transformers

- a. All instrument transformers shall be vacuum cast using polyurethane resin.
- b. Current transformers shall be as shown on the Drawings. Transformer mechanical ratings shall equal the BIL and momentary rating of the motor controller lineup. Transformers shall be rated for the full voltage of the motor controller lineup.

B. Enclosure

1. Enclosures shall be NEMA Type 1A unless noted otherwise on the Drawings.
2. Enclosures shall be 90 inches high, 36 inches wide and 30 inches deep, completely front connected.
3. All cables shall enter and exit underground from the bottom of the cubicle, unless otherwise shown on the Drawings.
4. Controllers shall be mounted not more than one high or be provided with a truck to handle the controller if in a two high construction. Controllers shall not be more than two high.
5. Interlocks shall be furnished to prevent operation of the isolating mechanism under load, operating of the high voltage compartment before the controller is isolated, and closing of the line contactors while the door is opened.
6. Finish shall be ANSI Z55.1, No. 61 light gray enamel over rust resistant primer
7. Each starter shall have a print pocket containing a laminated copy of all schematics related to the starter.
8. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls shall be clearly labeled to indicate function and shall be NEMA 12 oiltight rated, and in accordance with the electrical area classification specified in Section 16000. Controls installed outdoors, on NEMA 3R, NEMA 4X enclosures, or corrosion resistant enclosures, shall have a rating of NEMA 4/4X/13 without boot covers.

Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.

- a. Indicator lamps shall be 30 mm heavy duty, LED, with nameplates. Lens color shall be green for OFF, red for ON and amber for FAIL or ALARM. For all control applications, except NEMA 7, indicator lamps shall incorporate a push-to-test feature. A separate single lamp test push-button shall be incorporated on NEMA 7 control panels.
- b. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, PUMP SELECTOR, LEAD-LAG, etc) shall be heavy duty, 30 mm, as shown on the Drawings, with nameplates. Units shall have the number of positions and contact arrangements, as required. Each HOA, LOR switch shall have an extra dry contact for remote monitoring.
- c. Push-button, shall be heavy-duty, 30 mm, with momentary or maintained contacts as required by the Drawings, with nameplates. Button color shall be red for EMERGENCY STOP or START and black for STOP. Contact arrangement shall be as required.
- d. A six digit, non-resettable elapsed time meter shall be connected to each motor starter. Meter shall be Bulletin 705, HK Series by Eagle Signal or equal.

C. Construction

1. Isolating switch and contactor assemblies, including current limiting fuses, shall be of the component-to-component design with a minimum amount of interconnecting cables. The isolating switch shall be easily removable from the enclosure. Line and load cable terminations shall be completely accessible from the front.
2. The isolating switch shall be an externally operated manual three-pole drawout type, such that in the open position it grounds and isolates the starter from the line connectors with an isolating shutter leaving no exposed high-voltage components. Integral mechanical interlocks shall prevent entry into the high-voltage areas while the starter is energized and shall block accidental opening or closing of the isolating switch when the door is open or the contactor is closed. The isolating switch handle shall have provisions for padlocking in the open position. The isolating switch shall have a mechanical blown fuse indicating device.

3. Current limiting power fuses shall be provided with special fatigue proof elements that allow the elements to absorb the expansions and contractions created by the heating and cooling associated with severe cycling as is typical with motor starting. The fuses shall include visible fuse condition indicators. The fuses shall incorporate special time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum motor protection. This coordination shall be such that under a low-fault condition the interrupting rating and dropout time of the contactor shall be properly coordinated with all possible fuse sizes to eliminate contactor racing. The power fuses shall be mounted to permit easy inspection and replacement without starter disassembly.
4. The vacuum contactor shall be of the slide-out or roll-out and magnetically-held design, rated for the motor it serves. Contactor shall have single-break high-pressure type main contacts with weld-resistant alloy contact faces. The vacuum contactor contact wear shall be such that the gap can be checked with the use of a "go/no-go" feeler gauge.
5. A built-in test circuit shall be included to permit checking of the starter control and pilot circuit, with the high voltage de-energized and isolated, and the contactor in its normal position or in the drawout position. The control circuit shall be capable of being energized through a polarized plug connector from an external 115-volt supply while in the test mode.
6. The low voltage control compartment shall be isolated and barriered from the high voltage area and mounted on a panel with a separate low voltage access door. The low voltage control components shall be accessible by the use of a low voltage control compartment.
7. Each starter cell shall contain a vertical and horizontal low voltage wireway.

D. Busses

1. When starters are grouped together in a lineup, the horizontal main bus shall be located in its own separate, 12-inch high enclosure and isolated from the starters. Each phase shall be insulated. To allow for ease of maintenance or extension of lineups without disassembling starters, the main bus shall be front, top and side accessible.
2. Starters shall be connected by an insulated vertical bus.
3. All bus bars shall be tin-plated copper, rated as shown on the Drawings

4. Provide a 1/4 x 2-inch ground bus throughout the entire lineup. Ground bus shall also be supplied in upper compartments of 2-high starters and be bus connected to the ground bus supplied in the lower compartments.

E. Wiring

1. All control wire shall be UL/CSA approved.
2. Standard control wire shall be 14GA, stranded, tin-plated, red, dual-rated type XLPE (3173) 125 degrees C, SIS 90 degrees C.
3. Current transformer circuits shall utilize #12 wire with the same characteristics as above. Provide shorting blocks for all current transformers.
4. Provide "plug-in" terminal blocks, rated 600 V, 50 A with "clamping collar."
5. Wire markers shall be a molded plastic "clip-sleeve" type.
6. "Clamping-collar" type terminals shall be used to terminate control wiring. Current transformer circuits shall be provided with ring-type terminals where applicable.
7. All field wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal.

2.07 MOTOR CONTROLLERS

A. General

1. The starters shall be designed to accommodate motors of the size and type as shown on the Drawings.
2. The starters shall be non-reversing to accommodate the following motor types:
 - a. Induction Motor Full-Voltage Start

B. Assemblies

1. The following equipment shall be provided for the starter type indicated above.

a. Each induction motor full voltage starter shall include:

1) Medium Voltage Section

- a) One – Fixed portion isolating switch with shutter mechanism
- b) One – Removable portion isolating switch with blown fuse indication
- c) Three – Clip-in Current-limiting power fuses
- d) One – Stab-in three-pole main vacuum contactor assembly
- e) One – Control circuit transformer
- f) Two – Control circuit primary current limiting fuses
- g) One – Control circuit secondary fuse
- h) One – Run-test circuit
- i) Four – Electrical interlocks
- j). One 3-phase current transformer suitable for use with the motor protection relay
- k). Three – Current transformers
- l). One – Zero sequence ground fault current transformer

2) Low Voltage Compartment and Door

- a) One – Motor Protection Relay as shown on the Drawings
- b) One – Interposing control relay
- c) One – Set of control circuit terminal blocks
- d) . Two – PT's, Open Delta,
- e) Isolation switch viewing window to verify switch position

- f) One – CT shorting terminal block

2.08 MOTOR AND TRANSFORMER FEEDERS

A. General

- 1. The feeders shall be designed to accommodate loads of the size and type as shown on the Drawings.

B. Assemblies

- 1. The following equipment shall be provided for each feeder section.

- a. Medium Voltage Section

- 1) One – Fixed portion isolating switch with shutter mechanism
- 2) One – Removable portion isolating switch with blown fuse indication
- 3) Three – Clip-in Current-limiting power fuses
- 4) One – Stab-in three-pole main vacuum, mechanically-latched, contactor assembly
- 5) One – Control circuit transformer
- 6) Two – Control circuit primary current limiting fuses
- 7) One – Control circuit secondary fuse
- 8) One – On-test circuit
- 9) Four – Electrical interlocks
- 10) One 3-phase current transformer suitable for use with the Ground Fault Relay

- b) Low Voltage Compartment and Door

- a) One – Ground Fault Current Relay
- b) Interposing control relays
- c) One – Set of control circuit terminal blocks

- d) Two – PT's, Open Delta,
- e) Isolation switch viewing window to verify switch position
- f) One – CT shorting terminal block

2.9 MECHANICALLY-LATCHED CONTACTOR

- A. Mechanically-latched contactor, where shown on the drawings, shall be provided. The contactor shall remain closed, if there is a loss of voltage or a reduced-voltage condition.
- B. Mechanically-latched contactor shall be closed electrically from a local or remote CLOSE pushbutton, and tripped by a mechanical linkage to an externally operated manual trip device.
- C. An electrically-operated solenoid shall be supplied to trip the contactor as indicated on the Drawings.

2.10 COMMUNICATION

- A. For the equipment, connect all remote connections, (i.e. control, statuses, alarms, metering) to a terminal strip for outgoing wiring to a PLC as shown on the Drawings.
- B. Where all remote connections are multiplexed into a communications network, as shown on the Drawings, the connections from the metering and control devices shall be “daisy chained” from device to device, with the chain leaving the Section as a RS485 as shown.
- C. Where a RS485/Ethernet Converter is shown, furnish an Ethernet Converter, to convert the communications from RS485 to Ethernet.
 - 1. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
 - 2. Operating limits shall be 0-60 degrees C, with humidity range minimum of 5-90 percent. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
 - 3. Displays shall have LED status for serial, signals, power and Ethernet.

4. The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable, The converter shall have DB-9M port connection, with screw terminals, to the input.

5. Converter shall be Digi One IAP, or approved equal.

2.11 ACCESSORIES

A. Provide the following accessories:

1. 1 – Breaker lifting truck.
2. 1 – Breaker test equipment.
3. 1 – Remote racking device of each type required for all equipment that can be racked in and out.

2.12 SPARE PARTS

A. Provide the following spare parts:

1. 1 – Complete breaker assembly for each type and size of breaker.
2. 3 – Control fuses of each type used
3. 3 – Control fuses of type used.
4. One dozen each of cover bolts, spring nuts and door fasteners.
5. One quart of touch-up paint.

B. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number

2.13 FACTORY TESTING - SWITCHGEAR

A. The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.

1. Alignment test with master cell to verify all interfaces and interchangeability
2. Circuit breakers operated over the range of minimum to maximum control voltage
3. Factory setting of contact gap
4. One-minute dielectric test per ANSI standards
5. Final inspections and quality checks

- B. The following production test shall be performed on each breaker housing:
 - 1. Alignment test with master breaker to verify interfaces
 - 2. One-minute dielectric test per ANSI standards on primary and secondary circuits
 - 3. Operation of wiring, relays and other devices verified by an operational sequence test
 - 4. Final inspection and quality check.

- C. Equipment SB Testing and Inspection
 - 1. Continuity checks of all wiring installed.
 - 2. Operational check of all supplier furnished and installed electrical apparatuses.
 - 3. Switchgear shipping sections' bus shall be respliced, torqued and meggered.
 - 4. A certified test report shall be provided.

- D. The manufacturer shall provide three (3) certified copies of factory test reports.

2.14 FACTORY TESTING – MOTOR CONTROLLERS, MOTOR FEEDERS AND TRANSFORMER FEEDERS

- A. The motor controllers shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

- B. Prior to factory testing, the manufacturer shall check to see that all selections and settings required by the Power System Study Engineer have been performed.

- C. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.

- D. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

- E. The manufacturer shall provide three (3) certified copies of factory test reports as specified herein.

PART 3 EXECUTION

3.01 MANUFACTURER'S REPRESENTATIVE

- A. Provide the services of a qualified factory-trained manufacturer's field engineer to assist the Contractor in installation and start-up of the equipment specified under this section for a period of not less than 10 working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.

3.02 METERING AND PROTECTIVE RELAYS INSTALLATION

- A. The Contractor shall provide the services of a Multilin factory trained Contractor to make changes to the existing plantwide Multilin based HMI system, as specified in Section 16000 Electrical – General Provisions.

3.03 INSTALLER'S QUALIFICATIONS

- A. Installer shall be specialized in installing medium voltage metal clad switchgear with minimum 5 years documented experience.

3.04 EXAMINATION

- A. Examine installation area to assure there is enough clearance to install the switchgear.
- B. Check concrete pads for uniformity and level surface.
- C. Verify that medium voltage metal clad switchgear is ready to install.
- D. Verify field measurements are as instructed by manufacturer.

3.05 INSTALLATION

- A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.
- B. Contractor shall be responsible for applying tape insulation to each cable termination at each breaker section
- C. Installed required safety labels.

3.06 FIELD QUALITY CONTROL

- A. Inspect installed switchgear for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.07 FIELD ADJUSTING

- A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.
- B. The Power Monitoring, Protective Relays, and Ground Fault Relay shall be set in the field by a qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system as required in Section 16105 Power System Study.
- C. Return "odd" Kirk keys to the Owner after final acceptance.

3.08 FIELD TESTING - SWITCHGEAR

- A. Megger and record phase to phase and phase to ground insulation resistance of each bus section. Megger for 1 minute for each measurement at minimum voltage of 5000 VDC. Measured Insulation resistance shall be at least 1000 megohms.
- B. Test each key interlock system for proper functioning.

3.09 FIELD TESTING – MOTOR CONTROLLERS AND TRANSFORMER FEEDERS

- A. The manufacturer's field engineer shall make all electrical field tests recommended by the manufacturer, and including the following tests.
- B. Verify tightness of all bolted connections by calibrated torque-wrench in accordance with manufacturer's published data.
- C. Confirm the correct application of manufacturer's recommended lubricants.
- D. Perform a contact resistance test.
- E. Perform an insulation-resistance test on all control wiring at 1000 volts dc. Disconnect all connections to solid-state equipment prior to testing.

- F. Perform an insulation-resistance test on all other wiring and current carrying parts at a minimum dc test voltage of 2500 volts dc, pole-to-pole, pole-to-ground, and across open poles. Minimum values shall not be less than 5,000 Megohms. In no case shall the manufacturer's maximum test voltages be exceeded.
- G. The tests must adhere to manufacturer's testing recommendations for the proper testing methods and test voltage levels for each piece of equipment. Readings that fall below manufacturer's recommended values will not be acceptable and the Contractor shall be required to perform any necessary remedial action before the busing is energized. A data sheet shall be submitted to the Owner/Engineer for the medium voltage motor controllers. The test report shall include the following equipment information:
1. Name and Number:
 2. Manufacturer:
 3. Nameplate Data:
 - a. Volts:
 - b. Horizontal Bus Amps:
 - c. Insulation Test (measured):
 - 1) Phase A-B:
 - 2) Phase B-C:
 - 3) Phase C-A:
 - 4) Phase A-G:
 - 5) Phase B-G:
 - 6) Phase C-G:
 - d. Equipment disconnect during test:
 - e. Date of Test:
 - f. Tested by:
- H. Where test reports show unsatisfactory results, the Owner/Engineer may require the removal of all defective or suspected materials, equipment and/or apparatus, and their replacement with new items, all at no cost to the Owner. The Contractor shall bear all costs for any retesting.

3.10 CLEANING

- A. Clean interiors of switchgear, switchboards, panels, separate enclosures to remove construction debris, dirt, shipping materials.

3.11 EQUIPMENT PROTECTION AND RESTORATION

- A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.12 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.13 TRAINING

- A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment furnished under this Section.
- B. The training shall be for a period of not less than one (1) eight hour day.
- C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.
- D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.
- E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, metering, and other major components.
- F. The Owner shall have the right to record a videotape of the training for the Owner's use.

END OF SECTION

(ANDERSON PUMP STATION)
(SAWS JOB NO. 07-6007)
(B&V PN 161472)

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SECTION 16461

DISTRIBUTION DRY-TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install single-phase and three-phase general purpose individually mounted dry-type transformers of the two-windings type, self-cooled as specified herein, and as shown on the Drawings.
- B. The provisions of this Section shall apply to all dry-type distribution transformers, except as indicated otherwise.

1.02 RELATED WORK

- A. Section 16000 Electrical – General Provisions
- B. Section 16105 Power System Study

1.03 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000 and as specified herein.
- B. Submittals for equipment and materials, furnished under this Section of the Specifications, will not be accepted prior to approval of the Power System Study specified under Section 16105. Submittals made prior to such approval will be returned unreviewed.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned unreviewed.
- D. All equipment supplied under this Section of the Specifications shall be products of the same Manufacturer, and shall be contained in one single submittal. Partial submittals will be returned unreviewed. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections listed in the Related Work

paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned unreviewed.

- E. Equipment specified in Divisions 11 and 15, and supplied as an integral part of a process equipment manufacturer's package, but referred to this Section for component details, shall be submitted with the manufacturer's package submittal under Division 11 and 15.
- F. Shop Drawings and Product Data. For each transformer specified under this Section, submit the following information:
 - 1. Outline dimensions and weights
 - 2. Technical certification sheet
 - 3. Transformer ratings including:
 - a. kVA
 - b. Primary and secondary voltage
 - c. Taps
 - d. Basic impulse level (BIL) for equipment over 600 volts
 - e. Design impedance
 - f. Insulation class and temperature rise
 - g. Sound level.
 - 4. Product data sheets
 - 5. Connection diagrams
 - 6. Installation information
 - 7. Date of manufacture for each transformer
 - 8. Where applicable the following additional information shall be submitted to the Engineer:
 - a. Specified accessories

G. Operation and Maintenance Manuals.

1. Operation and Maintenance Manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record Drawings of information required by the Submittals part of this Section.
 - e. Project record drawings clearly indicating operating features and including as-built shop drawings, outline drawings, and schematic and wiring diagrams.

1.04 REFERENCE STANDARDS

- A. The dry-type transformer(s) and all components shall be designed, manufactured and tested in accordance with the latest applicable NEMA and ANSI standards as follows;
 1. NEMA TP1 2002 Standards for Energy Efficiency
 2. ANSI C57.96 2004 Guide for Loading Dry-Type Distribution and Power Transformers
 3. ASTM D635 – Standard Test Method for Insulation Materials

1.05 QUALITY ASSURANCE

- A. Manufacturer shall be ISO 9002 or later certified.
- B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- C. The Contractor, at no additional cost to the Owner, shall make structural, mechanical and electrical changes that are necessitated because the Contractor selects equipment with dimensional, power or mechanical differences from that shown on the Drawings. All engineering costs associated with revisions shall also be borne by the Contractor.

- D. Transformers manufactured more than twenty four (24) months prior to the date of this Contract will not be acceptable.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner.
- B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
- C. Equipment shall be equipped to be handled by crane. Where cranes are not available, equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.
- D. Equipment shall be installed in its permanent finished location shown on the Drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.
- E. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during jobsite storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.07 WARRANTY

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 1 year from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

(ANDERSON PUMP STATION)
(SAWS JOB NO. 07-6007)
(B&V PN 161472)

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1. General Electric
 2. Cutler Hammer
 3. Siemens
 4. Square D
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS

- A. The ratings of the transformer shall be as follows:
1. kVA Rating: As shown on the Drawings.
 2. Impedance: ANSI Standard Tolerance
 3. HV: As shown on the Drawings.
 4. LV: As shown on the Drawings.
 5. LV: As shown on the Drawings.

2.03 CONSTRUCTION

- A. Insulation Systems
1. Transformer insulation system shall be as follows:
 - a. 5 – 15 kVA, three-phase and single-phase: 185 degrees C insulation system with 115 degree C rise, encapsulated design; 15 kVA and above, three-phase and single-phase: 150 degrees three-phase and single phase: 220 degrees C insulation system with 150 degrees C rise, ventilated design.
 2. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient, and a 24-hour average ambient of 30 degrees C
 3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

B. Core and Coil Assemblies

1. Transformer core shall be constructed with high-grade, nonaging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade copper with continuous wound construction.
2. On single and three-phase units rated 15 kVA and below, the core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moisture proof, shock-resistant seal. The core and coil encapsulation system shall minimize the sound level. Enclosure construction shall be encapsulated, totally enclosed, non-ventilated, NEMA 3R, with lifting eyes.
3. On single and three-phase units rated 15 kVA and above, the core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. Enclosure construction shall be ventilated, NEMA 3R, rain-tight, with lifting holes. All ventilation openings shall be protected against falling dirt. The assembly shall be installed on vibration-absorbing pads.

C. Taps

1. Three-phase transformers rated 15 through 500 kVA shall be provided with six 2-1/2% taps, two above and four below rated primary voltage
2. All single-phase transformers, and three-phase transformers rated below 15 kVA and above 500 kVA, shall be provided with the manufacturer's standard tap configuration.

D. Isolation Pad

1. Each transformer, pad, bracket mounted, or suspended, shall utilize double deflecting neoprene mounting vibration isolators as manufactured by Mason Industries Type ND, sized according to rated capacities.

E. Finish

1. Enclosures shall be finished with ANSI Gray color, weather-resistant enamel.

F. Accessories

1. On ventilated outdoor units provide suitable weather shields over ventilation openings.
2. Lug kits shall be provided by the Manufacturer of the transformer.

2.04 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest applicable ANSI and NEMA standards.
1. Ratio tests at the rated voltage connection and at all tap connections
 2. Polarity and phase relation tests on the rated voltage connection
 3. Applied potential tests
 4. Induced potential test
 5. No-load and excitation current at rated voltage on the rated voltage connection

PART 3 EXECUTION

3.01 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.
- B. Securely connect all neutrals and transformer enclosures to ground.

3.02 FIELD ADJUSTMENTS

- A. Adjust taps to deliver appropriate secondary voltage.

3.03 FIELD TESTING

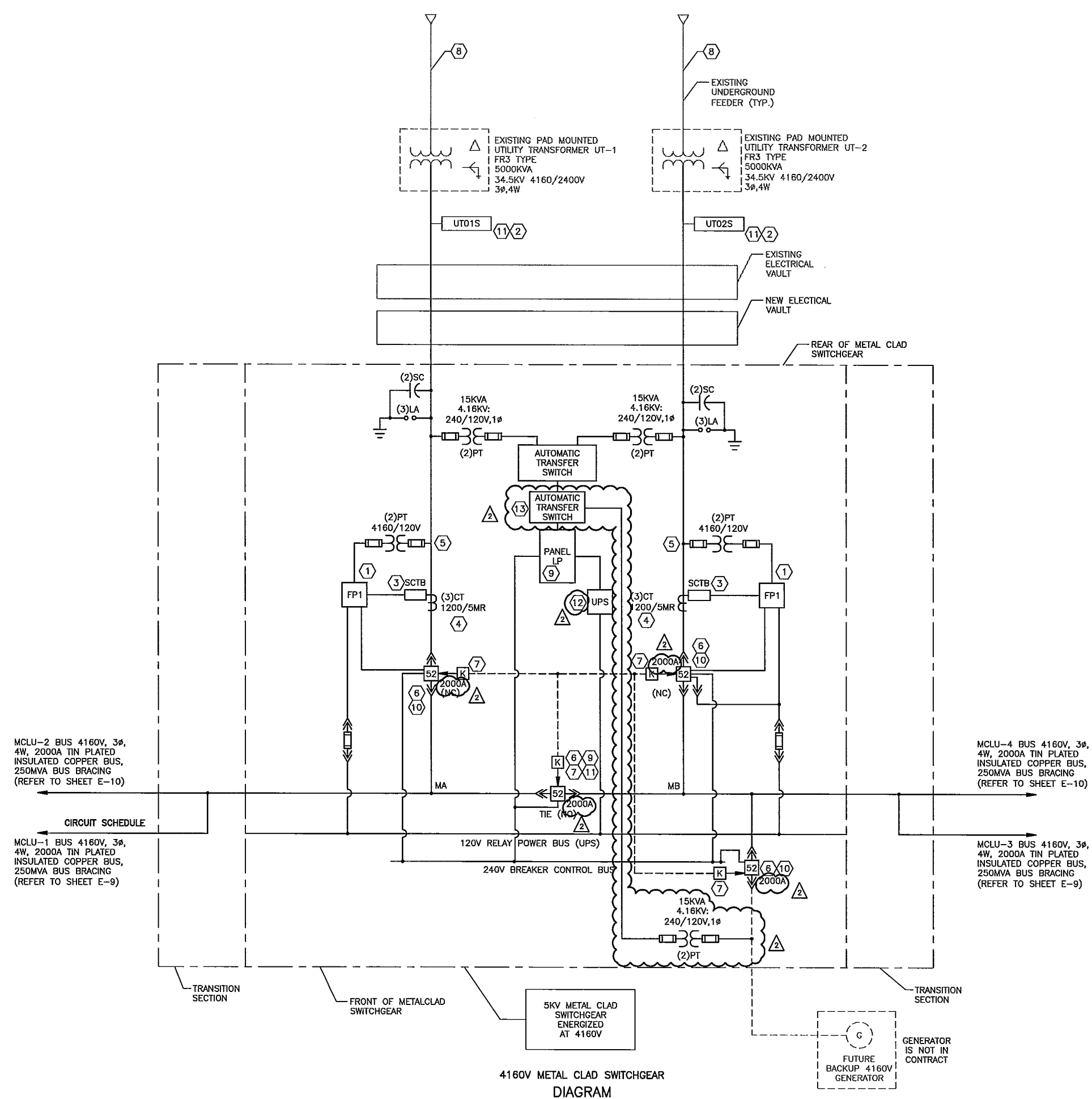
- A. Measure primary and secondary voltages for proper tap settings.

END OF SECTION

(ANDERSON PUMP STATION)
(SAWS JOB NO. 07-6007)
(B&V PN 161472)

16461
-8-

Y:\Construction_projects\1918C_Anderson_Pump_Station\Construction\Addenda\ADDENDUM NO.2[E]-08.dwg, 4/28/2011 5:20:29 PM, HP LaserJet 5100 PCL 6, ER, PD161472, 2/16/1472



- NOTES:
- FEEDER MANAGEMENT RELAY TYPE FP1 PER SPECIFICATIONS. CONNECT TO SCADA VIA ETHERNET PORT. INCLUDE LOCKOUT FUNCTION 86.
 - PROVIDE 8KV MV-105 PHASE CONDUCTORS AND XHHW-2 GROUND CONDUCTOR.
 - SHORTING TYPE TERMINAL BLOCK AND FLEXITEST SWITCH (SCTB).
 - PROVIDE 3 METERING ACCURACY CTS.
 - PROVIDE 2 RELAYING ACCURACY PTS.
 - ALL TRIP RATINGS SHALL BE SET BY CONTRACTOR PER POWER COORDINATION STUDY.
 - PROVIDE KIRK KEY SYSTEM SIMILAR TO KIRK KEY SCHEME 36. NOTE THAT ONE OF THE GENERATORS SHOWN IN SCHEME 36 IS NOT IMPLEMENTED IN THIS SWITCHGEAR.
 - EXISTING UTILITY FEEDERS. DO NOT REPLACE.
 - SWITCHGEAR MANUFACTURER SHALL PROVIDE 120V PANEL OF ADEQUATE SIZE AND BRACING WITH ADEQUATE QUANTITY AND SIZE OF CIRCUIT BREAKERS.
 - PROVIDE REMOTE RACKING DEVICE FOR CIRCUIT BREAKERS.
 - INSTALL NEW 5" CONDUITS AND WIRING BETWEEN EXISTING ELECTRICAL VAULT AND NEW ELECTRICAL VAULT. INSTALL WIRING IN EXISTING CONDUITS BETWEEN EXISTING ELECTRICAL VAULT AND THE TRANSFORMERS.
 - SIZE UPS FOR A 60 MINUTE OUTAGE.
 - IF EITHER FEEDER IS ON, PROVIDE CONTROL POWER FROM THE FEEDER THAT IS ON. IF BOTH FEEDERS ARE OFF, PROVIDE CONTROL POWER FROM THE GENERATOR.

CIRCUIT	WIRE SIZE	CONDUIT SIZE
UT01S	6 SETS OF 3-#500 & 1-3/0 G	11
UT02S	6 SETS OF 3-#500 & 1-3/0 G	2

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GAI
Grupe & Associates, Inc.
San Antonio, Texas

SAN ANTONIO WATER SYSTEM
ANDERSON PUMP STATION IMPROVEMENTS

4160V ELECTRICAL ONE-LINE DIAGRAM - I

DESIGNED: BRR
DETAILED: JH
CHECKED: YKG
APPROVED: BRR
DATE:

B&V PROJECT NO.
161472

SAWS JOB NO.
07-6007

E-8
SHEET
43 OF 102

4/28/11

ADDENDA NO.2

REV. NO. BY DATE

2 BRR

REVISIONS AND RECORD OF ISSUE

CYBNET ID: 161472-3000-C-100077500 XREF1:MSFS_MST1.dwg XREF2:

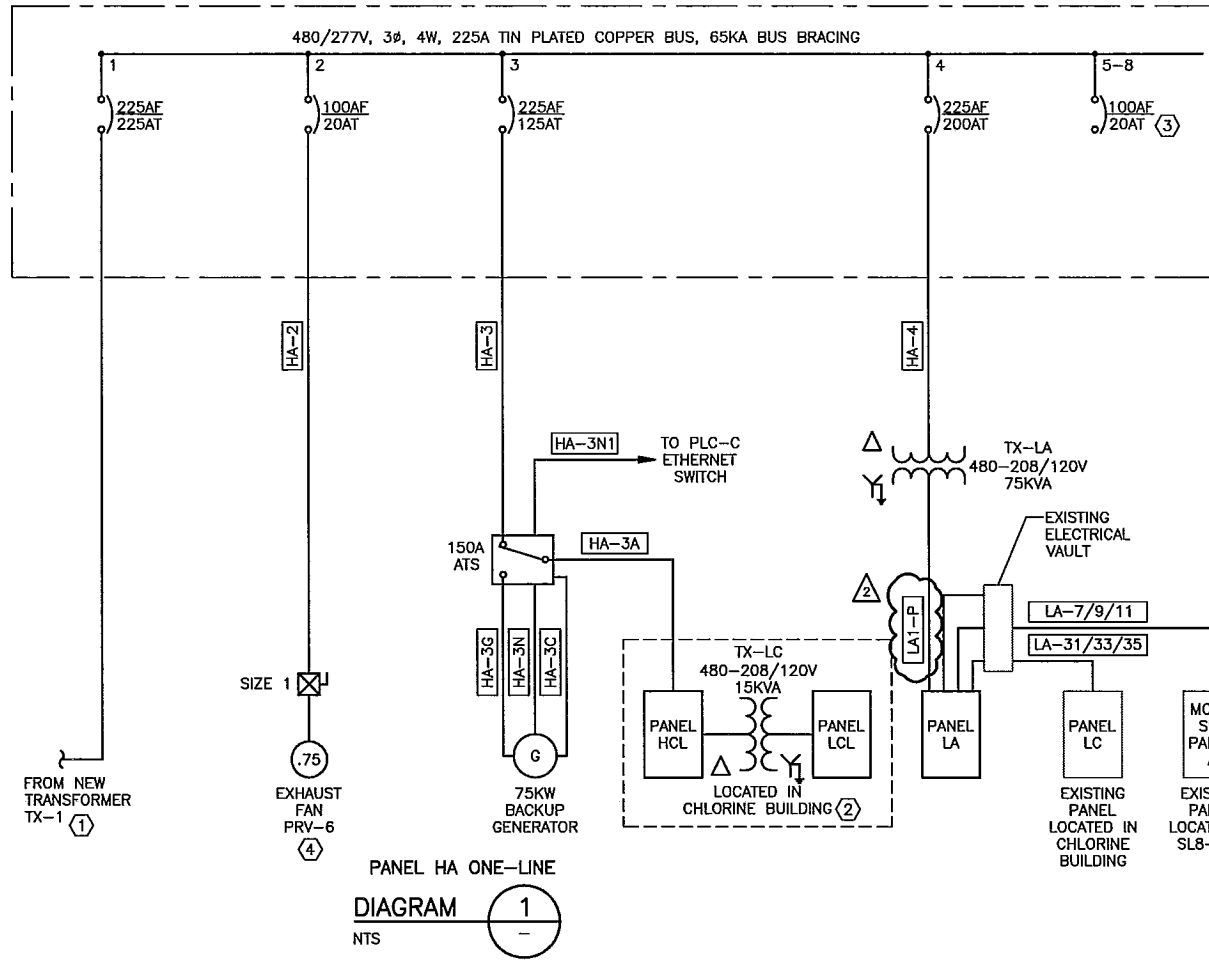
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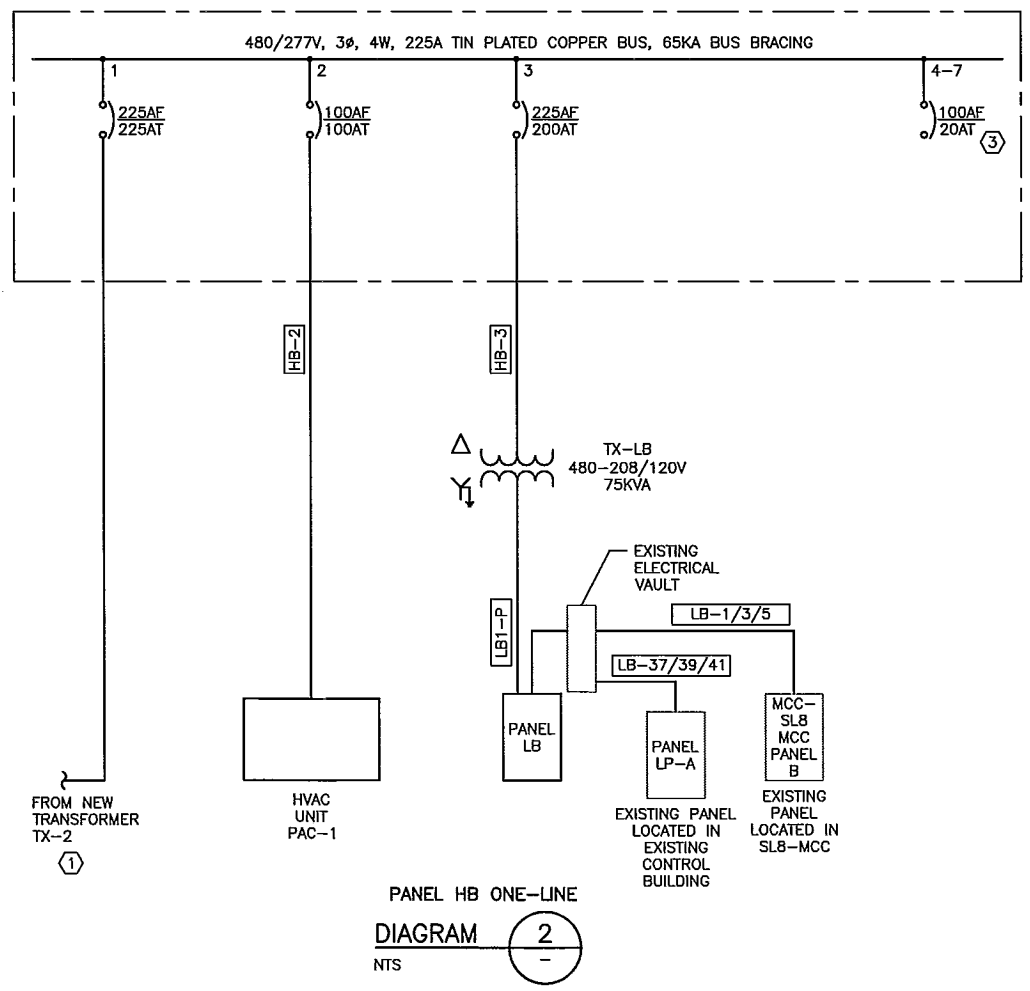
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USER: PAM12044 DWG VER: 1.3 XREF6:

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- NOTES:
- ① REFER TO SHEET E-10.
 - ② REFER TO SHEET E-25 FOR ONE-LINE DIAGRAM AND DETAIL.
 - ③ PROVIDE FOUR 20A SPARES.
 - ④ REFER TO SCHEMATIC 6 ON SHEET EY-14.
 - ⑤ USE LARGER DIAMETER CONDUIT WHERE SHOWN ON PLANS. USE 2" MINIMUM CONDUIT FOR DUCTBANKS UNLESS NOTED OTHERWISE.



CIRCUIT	CONDUCTORS	CONDUIT SIZE
HA-2	4/C #12 TC	3/4" C
HA-3	4/C 1/0 + 1/0G TC	2" C
HA-3G	4/C 1/0 + 1/0G TC	2" C
HA-4	4/C 4/0 TC	3" C
LA1-P	4/C 4/0 + 4/0G	2-1/2" C
HB-2	4/C #2 TC	2" C
HB-3	4/C 4/0 TC	3" C
HA-3A	5 1/0	2" C
HA-3C	12#14	1-1/2" C
HA-3N	CAT-5e	1-1/2" C
HA-3N1	CAT-5e	3/4" C
LB1-P	4/C 4/0 + 4/0G	2-1/2" C

PANEL BOARD: LA		BUS: COPPER		MAINS: 200A					
SERVICE: 120/208V, 3Ø, 4W		RATING: 200A		LOCATION: CHLORINE BUILDING					
MOUNTING: SURFACE - NEMA 1		FEED: TOP		⑤					
CKT #	BRKR SIZE	COND SIZE	WIRES	LOAD	LOAD	WIRES	COND SIZE	BRKR SIZE	CKT #
1	20/1	3/4"	3#12	ELECTRICAL ROOM OUTLETS (14.2A)	ELECTRICAL ROOM LIGHTS (7A)	3#12	3/4"	20/1	2
3	20/1	3/4"	3#12	OUTSIDE OUTLETS (7.9A)	ELECTRICAL VAULT LIGHTS (7A)	3#12	3/4"	20/1	4
5	20/1	3/4"	3#12	SUMP PUMP SSP-1 (7.2A)	FIBER PATCH PANEL (1A)	3#12	3/4"	20/1	6
7	100				EXIT SIGNS (0.1A)	3#12	3/4"	20/1	8
9		2"	4#4/0	MCC-SLB PANEL A (75.0A)	TANK HEAT TRACE (20A)	3#10	3/4"	20/1	10
11	3				WP-3 SPACE HEATER (15A)	3#10	3/4"	20/1	12
13	20				WP-4 SPACE HEATER (15A)	3#10	3/4"	20/1	14
15		3/4"	4#10	HSP7-1 VALVE POWER (2A)	WP-5 SPACE HEATER (15A)	3#10	3/4"	20/1	16
17	3				FIT-110/120/130 (3A)	3#12	3/4"	20/1	18
19	20				HSP7-1/2/3 HEAT TRACE (10A)	3#12	3/4"	20/1	20
21		3/4"	4#10	HSP7-2 VALVE POWER (2A)	HSP7-1 MOTOR SPACE HEATER	3#12	3/4"	20/1	22
23	3				HSP7-2 MOTOR SPACE HEATER	3#12	3/4"	20/1	24
25	20				HSP7-3 MOTOR SPACE HEATER	3#12	3/4"	20/1	26
27		3/4"	4#10	HSP7-3 VALVE POWER (2A)	CAMERAS	3#12	3/4"	20/1	28
29	3				SPARE	-	-	20/1	30
31	50				SPARE	-	-	20/1	32
33		2"	4#1/0	CHLORINE PANELBOARD LC (20.8A)	SPARE	-	-	20/1	34
35	3				SPARE	-	-	20/1	36
37	100				SPARE	-	-	30/1	38
39					SPARE	-	-	20/1	40
41	3				SPARE	-	-	20/1	42

PANEL BOARD: LB		BUS: COPPER		MAINS: 200A					
SERVICE: 120/208V, 3Ø, 4W		RATING: 200A		LOCATION: CHLORINE BUILDING					
MOUNTING: SURFACE - NEMA 1		FEED: TOP		⑤					
CKT #	BRKR SIZE	COND SIZE	WIRES	LOAD	LOAD	WIRES	COND SIZE	BRKR SIZE	CKT #
1	100				SL7 NORTH LIGHTS (5A)	3#10	3/4"	20/1	2
3		2"	4#4/0	MCC-SLB PANEL B (75.0A)	SL7 SOUTH LIGHTS (5A)	3#10	3/4"	20/1	4
5	3				SL7 PUMPS RECEPTACLES (10A)	3#10	3/4"	20/1	6
7	20				WP-1 SPACE HEATER (15A)	3#10	3/4"	20/1	8
9		3/4"	4#10	HSP7-4 VALVE POWER (2A)	WP-2 SPACE HEATER (15A)	3#10	3/4"	20/1	10
11	3				SPARE	-	-	20/1	12
13	20				WALL PACKS (2.5A)	3#12	3/4"	20/1	14
15		3/4"	4#10	HSP7-5 VALVE POWER (2A)	FIT-140/150/160 (3A)	3#12	3/4"	20/1	16
17	3				AIT-201 (1A)	3#12	3/4"	20/1	18
19	20				PRESSURE SUSTAINING VALVE LCP-171	3#12	3/4"	20/1	20
21		3/4"	4#10	HSP7-6 VALVE POWER (2A)	HSP7-4/5/6 HEAT TRACE (10A)	3#12	3/4"	20/1	22
23	3				HSP7-4 MOTOR SPACE HEATER	3#12	3/4"	20/1	24
25	20				HSP7-5 MOTOR SPACE HEATER	3#12	3/4"	20/1	26
27					HSP7-6 MOTOR SPACE HEATER	3#12	3/4"	20/1	28
29	3				FIT-170	3#12	3/4"	20/1	30
31	100				GATE SECURITY MINI POWER CENTER LG	4#4	1-1/4"	20/2	32
33					SPARE	-	-	30/1	34
35	3				SPARE	-	-	30/1	36
37	100				SPARE	-	-	50	38
39					SPARE	-	-	20/1	40
41	3	2"	4#1/0	INSTRUMENTATION ROOM PANELBOARD LP-A (50A)	SPARE	-	-	3	42

PANELBOARD: LG (MINI POWER CENTER)		BUS: COPPER		MAINS: 300A					
SERVICE: 480-240/120V		RATING: 100A, 5KVA XFMR		LOCATION: GATE					
MOUNTING: SURFACE - NEMA 1		FEED: TOP		⑤					
CKT #	BRKR SIZE	COND. SIZE	WIRE SIZE	LOAD	LOAD	WIRE SIZE	COND. SIZE	BRKR SIZE	CKT #
1	20/2	1.5"	3#12	GATE (2A)	LIGHTING (2A)	3#12	1.5"	20/1	2
3					RECEPTACLE (2A)	3#12	3/4"	20/1	4
5	20/1			SECURITY PANEL (1A)	SPARE	-	-	20/1	6
7	20/1			SPARE	SPARE	-	-	20/1	8
9	20/1			SPARE	SPARE	-	-	20/1	10

REVISIONS AND RECORD OF ISSUE

NO.	BY	DATE	DESCRIPTION
2	BRR	4/28/11	ADDENDA NO.2

DATE: 4/28/11
 DRAWN: BRR
 CHECKED: VJK
 APPROVED: BRR

DESIGNED: BRR
 DETAILED: JH
 CHECKED: VJK
 APPROVED: BRR
 DATE:

B&V PROJECT NO. 161472
 SAWS JOB NO. 07-6007
 E-11 SHEET 46 OF 102

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SAN ANTONIO WATER SYSTEM
 ANDERSON PUMP STATION IMPROVEMENTS

PANEL HA & HB ONE-LINE DIAGRAMS
 & PANELBOARD SCHEDULES