Illinois Department of Transportation
2300 South Dirksen Parkway / Springfield, Illinois / 62764

June 6, 2012

SUBJECT: FAP Route 338 (IL 59)
Project ACNHF-0338 (044)
Section 2011-035 I
DuPage County
Contract No. 60P41
Item No. 009, June 15, 2012 Letting
Addendum B

NOTICE TO PROSPECTIVE BIDDERS:

Attached is an addendum to the plans or proposal. This addendum involves revised and/or added material.

1. Replaced the Schedule of Prices.
2. Revised page iv of the Table of Contents to the Special Provisions.
3. Revised pages 218-240, 283-295, 315-330, 410-453 & 454-455 of the Special Provisions.
4. Added pages 646-660 to the Special Provisions.
5. Revised sheets 1, 2, 6A, 6B, 6C, 126-156, 158, 159, 161, 162, 165, 171-177 and 180 of the Plans.
6. Added sheet 156A, 156B, 156C & 156D to the Plans.

Prime contractors must utilize the enclosed material when preparing their bid and must include any Schedule of Prices changes in their bidding proposal.

Bidders using computer-generated bids are cautioned to reflect any and all Schedule of Prices changes, if involved, into their computer programs.

Very truly yours,

John D. Baranzelli, P. E.
Acting Engineer of Design and Environment

By: Ted B. Walschleger, P. E.
Engineer of Project Management

cc: John Fortmann, Region 1, District 1; Mike Renner; D.Carl Puzey; Estimates

TBW/MS/lll

ILLINOIS DEPARTMENT OF TRANSPORTATION
SCHEDULE OF PRICES
CONTRACT NUMBER - 60P41

State Job # - C-91-538-11

Project Number ACNHF-0338/044/

Route FAP 338

County Name - DUPAGE- -
Code - 43 - -
District - 1 - -
Section Number - 2011-035-I

*REVISED: JUNE 4, 2012

Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
X0301028	PUMP STA SCADA EQUIP	L SUM	1.000				
X0322121	SHEET WAT PRF MEM SYS	SQ YD	600.000				
X0322719	TEMP DRAINAGE CONNECT	EACH	1.000				
X0323002	TEMP ELECT SERV CONN	EACH	1.000				
*REV X0324455	DRILL/SET SOLD P SOIL	CU FT	16,230.000				
*ADD X0324456	DRILL/SET SOLD P ROCK	CU FT	6,600.000				
X0325405	FILL EX STORM SEWERS	CU YD	67.000				
X0326694	PLUG EX STORM SEWERS	CU YD	0.500				
X0327394	HEAT VENTILATION WORK	L SUM	1.000				
X0335700	P.S. GENERAL WORK	L SUM	1.000				
X0783300	P.S. ELECTRICAL WORK	L SUM	1.000				
X0783500	P.S. MECHANICAL WORK	L SUM	1.000				
X2020502	BRACED EXCAVATION	CU YD	2,730.000				
X4402302	CURB REMOVAL PART	FOOT	170.000				
X5051100	BRIDGE CRANE	L SUM	1.000				

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Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
X6028050	TEMPORARY MANHOLE	EACH	5.000				
X6640308	CH LK GATES SPL	EACH	3.000				
X6640570	CH LK FENCE 8 SPL	FOOT	143.000				
X6640585	CH LK FENC ATT STR SP	FOOT	105.000				
*ADD X6700410	ENGR FLD OFF A SPL	CAL MO	20.000				
X7010216	TRAF CONT & PROT SPL	L SUM	1.000				
Z0004522	HMA DRIVEWAY PAVT 6	SQ YD	356.000				
Z0007118	UNTREATED TIMBER LAG	SQ FT	4,881.000				
Z0007601	BLDG REMOV NO 1	L SUM	1.000				
Z0013798	CONSTRUCTION LAYOUT	L SUM	1.000				
Z0026402	FUR SOLDIER PILES HP	FOOT	828.000				
Z0026404	FUR SOLDIER PILES WS	FOOT	3,041.000				
Z0030240	IMP ATTN TEMP NRD TL2	EACH	1.000				
Z0030850	TEMP INFO SIGNING	SQ FT	50.000				
Z0046304	P UNDR FOR STRUCT 4	FOOT	495.000				

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Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
Z0048665	RR PROT LIABILITY INS	L SUM	1.000				
20200100	EARTH EXCAVATION	CU YD	701.000				
20800150	TRENCH BACKFILL	CU YD	989.000				
21101605	TOPSOIL F & P 2	SQ YD	1,253.000				
25000210	SEEDING CL 2A	ACRE	0.260				
25100115	MULCH METHOD 2	ACRE	0.260				
28000250	TEMP EROS CONTR SEED	POUND	26.000				
28000400	PERIMETER EROS BAR	FOOT	1,104.000				
28000510	INLET FILTERS	EACH	5.000				
30300108	AGG SUBGRADE IMPR 8	SQ YD	943.000				
42300400	PCC DRIVEWAY PAVT 8	SQ YD	943.000				
44000200	DRIVE PAVEMENT REM	SQ YD	704.000				
44000500	COMB CURB GUTTER REM	FOOT	60.000				
44201359	CL C PATCH T4 10	SQ YD	27.000				
48100500	AGGREGATE SHLDS A 6	SQ YD	622.000				

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Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
50200100	STRUCTURE EXCAVATION	CU YD	416.000				
50300225	CONC STRUCT	CU YD	900.000				
50300285	FORM LINER TEX SURF	SQ FT	4,263.000				
50300300	PROTECTIVE COAT	SQ YD	611.000				
50500505	STUD SHEAR CONNECTORS	EACH	1,548.000				
50800205	REINF BARS, EPOXY CTD	POUND	96,760.000				
50800515	BAR SPLICERS	EACH	12.000				
50901750	PARAPET RAILING	FOOT	344.000				
5422C030	P CUL CL C 2 30 TEMP	FOOT	38.000				
5422C036	P CUL CL C 2 36 TEMP	FOOT	12.000				
5422C048	P CUL CL C 2 48 TEMP	FOOT	109.000				
550A0190	STORM SEW CL A 1 48	FOOT	40.000				
550A0450	STORM SEW CL A 2 36	FOOT	499.000				
550A0470	STORM SEW CL A 2 42	FOOT	16.000				
550A0480	STORM SEW CL A 2 48	FOOT	516.000				

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Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
550B0380	STORM SEW CL B 2 18	FOOT	7.000				
550B0430	STORM SEW CL B 2 30	FOOT	24.000				
550B0450	STORM SEW CL B 2 36	FOOT	29.000				
55100500	STORM SEWER REM 12	FOOT	10.000				
55100900	STORM SEWER REM 18	FOOT	10.000				
55101400	STORM SEWER REM 30	FOOT	566.000				
55101600	STORM SEWER REM 36	FOOT	647.000				
55201600	STORM SEWERS JKD 48	FOOT	110.000				
59100100	GEOCOMPOSITE WALL DR	SQ YD	543.000				
59300100	CONTR LOW-STRENG MATL	CU YD	129.000				
60221100	MAN TA 5 DIA T1F CL	EACH	5.000				
60223800	MAN TA 6 DIA T1F CL	EACH	1.000				
60224445	MAN TA 7 DIA T1F OL	EACH	5.000				
60224446	MAN TA 7 DIA T1F CL	EACH	2.000				
60500040	REMOV MANHOLES	EACH	8.000				

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Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
60500105	FILL MANHOLES	EACH	1.000				
60604400	COMB CC&G TB6.18	FOOT	60.000				
*ADD 66900200	NON SPL WASTE DISPOSL	CU YD	5,850.000				
*ADD 66900450	SPL WASTE PLNS/REPORT	L SUM	1.000				
*ADD 66900530	SOIL DISPOSAL ANALY	EACH	1.000				
*DELETE ~~67000400~~	~~ENGR FIELD OFFICE A~~	~~CAL MO~~	~~20.000~~				
67100100	MOBILIZATION	L SUM	1.000				
70103815	TR CONT SURVEILLANCE	CAL DA	400.000				
70400100	TEMP CONC BARRIER	FOOT	750.000				
70400200	REL TEMP CONC BARRIER	FOOT	600.000				
78200530	BAR WALL MKR TYPE C	EACH	80.000				
*REV 80400200	ELECT UTIL SERV CONN	L SUM	1.000		255,000.000		255,000.000

Revised 06/06/12

DIVISION 26 – ELECTRICAL

SECTION 26 05 11 REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The scope of work under this Section shall generally be all electrical work required for the project work as specified or as indicated on the drawings.

B. The electrical work shall include the furnishing and installing of various items of electrical equipment and, unless otherwise indicated, shall also include the electrical connection of various items such as electric pump motors, fan motors and similar items furnished under other Sections. The Contractor shall be responsible for ascertaining the extent of electrical connections required for items furnished under other Sections and for coordination the electrical work accordingly.

C. Provide pedestal pads & metering cabinet pads per the Naperville Public Utilities Department for the two (2) 3 Phase services and install on 12" compacted crushed rock base.

D. The pedestals shall be furnished and installed by Naperville Public Utilities. The primary feeders will be installed by others. This contractor shall make secondary feeder connections to pedestals as required by Naperville Public Utilities.

E. The specifications and drawings are intended to generally define the work required, but they do not include every equipment and installation detail. The work shall include all items and appurtenances required to fully complete the work, whether specifically identified or not, such that the electrical systems are complete and operational.

F. Refer to Division 1 for other requirements relating to the furnishing and installing of work which shall apply to the work under this Division.

1.2 CODE COMPLIANCE

A. Unless otherwise indicated, in the absence of more stringent requirements in the Specifications or on the Drawings, the work shall be in compliance with the requirements of the National Electrical Code.

1.3 STANDARDS

A. Wherever the following abbreviations are used in these Specifications or on the Drawings, they are to be construed the same as the respective expressions represented:

AASHTO	American Association of State Highways and Transportation Officials
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
FM	Factory Mutual
ICEA	Insulated Power Cable Engineers Association
IES	Illuminating Engineering Society of North America
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Assoc.
NESC	National Electrical Safety Code
UL	Underwriters' Laboratories

B. Wherever a reference is made to a standard or standard specification, the reference shall be to the edition current at the time of bidding, including any revisions or amendments.

1.4 VERIFICATION OF CONTRACT DRAWINGS

A. The Contractor shall familiarize himself with the details of the total construction insofar as they may affect the work under this Division, including floor elevations, physical dimensions of structures, materials of construction and the nature of work required under other Divisions. No additional compensation will be granted for failure to consider the total project work.

B. The contract drawings (Drawings) for electrical work are generally diagrammatic and do not necessarily depict all items to scale. The Drawings indicate the general locations of major elements of the electrical system, outlets, fixtures, pull boxes and the like, however, field conditions or interferences, may require changes in the installation. The Contractor shall coordinate his work to avoid interferences and shall obtain the approval of the Engineer prior to making any changes from the installation shown.

C. Prior to installation, the Engineer may make reasonable minor changes in the locations of the installation without additional cost to the Owner.

1.5 COORDINATION

A. The Contractor shall coordinate the work under this Division with the work of other trades. This shall include an orderly exchange of information and shall be accomplished such that the total work is not delayed and that interferences are avoided. The Contractor shall coordinate all electrical systems into a complete operational package. The Contractor shall assign one contact person for all such co-ordination work, has an understanding and working knowledge of the electrical control systems on this project. This person shall oversee and assume proper operation of the complete electrical control system including all testing and calibration as outlined herein. The Contractor shall provide the name and phone numbers of this individual at the preconstruction inspection. This cost shall be included in PUMP STATION ELECTRICAL WORK..

1.6 WORKMANSHIP

A. The electrical work shall be performed in a neat and workmanlike manner in accordance with the best practices of the trade.

B. Unless otherwise indicated, all materials and equipment shall be installed in accordance with the manufacturer's recommendations.

1.7 TESTING

A. All electrical equipment and systems provided under this Division shall be adjusted and tested. The Contractor shall adjust, repair or replace faulty or improper Division 26 work or equipment discovered during testing.

B. In addition, all electrical items provided under other Divisions and connected and/or adjusted under this Division shall be tested and if a failure occurs due to the connecting or adjusting methods used, the failure shall be remedied under this Division by repair, replacement, or change, as determined by the Engineer, at no additional cost to the Owner.

C. Tests may be made progressively as portions of the work are complete.

D. Tests shall be made in the presence of the Engineer.

E. A written record of tests shall be maintained by the Contractor and, when complete, it shall be submitted to the Engineer for the record.

F. Independent Contractor shall perform all tests necessary to assure proper functioning of materials and equipment. As a minimum, the tests shall include the following:

1. Before making final connections check the insulation resistance of all cables of 3-phase circuits that operate above 150 volts.
2. Check wiring for proper phase sequencing including buses, feeder cables and transformers and assure proper connection at motors for proper rotation.
3. Measure and record the line-to-line and line-to-neutral voltages at the line side of the service entrance, all panel buses or main terminals and at the primary and secondary terminals of all transformers furnished under this Division except for control transformers which are integral to motor starter units. Set the taps on transformers as required or as directed by the Engineer.
4. Check and record the motor nameplate data for each 3-phase motor. Check the ratings of motor circuit protective devices and assure compatibility of the devices for the connected motors. In particular, assure that the motor starter overload elements are proper for the motor nameplate full load amperes.
5. Set control relays, protective relays and instruments in accordance with manufacturer's recommendations. Record the set points.
6. Check all control circuits for proper functioning of all devices and check all switches, contactors, pushbuttons, limit switches, thermostats, circuit breakers and the like for proper operation.
7. Check all alarm circuits for proper operation and proper set points, as applicable. Record any appropriate set points.
8. Measure and record the line currents of each phase of each 3-phase motor under load.
9. Align and adjust lighting fixtures and assure proper operation of all controls, ballasts and lamps.
10. All equipment must be properly calibrated for proper operation of the system.
11. See paragraph 3.9 of this Section for further testing requirements.

G. Testing must be complete prior to final inspection. All instruments, tools, etc., required for the tests shall be provided by the Contractor. All equipment shall be properly calibrated for proper operation of the complete system. Additional testing may be requested by the Engineer during final inspection to spot-check test results or to demonstrate proper functioning of the systems. These tests shall be performed by the Contractor at no additional cost to the Owner.

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H. The Contractor shall simulate the automatic operation of the complete pump station to assure proper operation. After assurance of proper operation, the Contractor shall demonstrate actual (real time) automatic operation to the Engineer's satisfaction.

J. Note that failure to test the equipment completely is not an allowance for an extension.

1.8 ELECTRICAL POWER SYSTEMS STUDIES

A. The electrical power system study shall include the following:

1. Short circuit analysis, protective device evaluation study, protective device coordination study, and arc flash study on entire power distribution system.
2. Portions of electrical distribution system from normal and alternate sources of power throughout distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions and maximum incident energy shall be covered in study.
3. Contractor shall engage services of independent engineering firm for purpose of performing electric power systems studies as specified.

B. Studies include following:

1. Utility Company incoming service lines.
2. Main switchboard.
3. Power transformers.
4. Motor control centers.
5. Pumps
6. Power and lighting distribution panels.
7. Cable, wire, and conduit systems.

C. Short Circuit Study

1. Provide complete report with printout data sheets using digital computer type programs as part of study.
2. Include utilities' short circuit contribution, resistance and reactance components of branch impedances, X/R ratios, base quantities selected, and other source impedances.
3. Calculate short circuit momentary duty values and interrupting duty values based on assumed 3-ph bolted short circuit at switch gear base medium voltage controller, switchboard, low voltage MCC, panelboard, pertinent branch circuit panel, and other significant locations through system. Include short circuit tabulation of symmetrical fault currents and X/R ratios. List with respective X/R ratio each fault location, total duty on bus, and individual contribution from each connected branch.

C. Equipment Device Evaluation Study

1. Provide protective device evaluation study to determine adequacy of circuit breakers, molded case switches, automatic transfer switch, reduced voltage controllers, controllers, surge arresters, busways, and fuses by tabulating and comparing short circuit ratings of these devices with calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards. Notify ENGINEER of problem areas or inadequacies in equipment due to short circuit currents and provide suggested alternate equipment.

D. Equipment Device Coordination Study

1. Provide protective device coordination study with necessary calculations and logic decisions required to select or check selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. Objective of study to obtain optimum protective and coordination performance from these devices.
2. Include as part of coordination study, medium and low voltage classes of equipment from utility's incoming line protective device down to and including largest rated device in 480 v MCCs and panelboards. Include phase and ground overcurrent protection as well as settings of other adjustable protective devices.
3. Draw time-current characteristics of specified protective devices in color on log-log paper or computer printout. Include with plots complete titles, representative one-line diagram and legends, associated Power Company's relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. Indicate types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing in-rush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits, and significant symmetrical and asymmetrical fault currents. Provide coordination plots for phase and ground protective devices on system basis. Provide sufficient number of separate curves to indicate coordination achieved.
4. Provide separate selection and settings of protective devices in tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment, and recommended settings. Tabulate recommended power fuse selection for medium voltage fuses where applied in system. Notify ENGINEER of discrepancies, problem areas or inadequacies and provide suggested alternate equipment ratings and/or settings.

E. Arc Flash Study

1. Provide Incident Energy Study – An incident energy study shall be done in accordance with the IEEE 1584, ”IEEE Guide for Performing Arc Flash Hazard Calculations” as referenced in NFPA 70E, “Standard for Electrical Safety in the Workplace”, in order to quantify the hazard for selection of personal protective equipment (PPE).

2. Adjust system design to optimize the results of the study as it relates to safety and reliable electrical system operation (e.g. overcurrent device settings, current limiting devices). This includes mitigation, where possible, of incident energy levels that exceed 40 calories/cm2. Provide suggested alternate equipment and settings to minimize incident energy levels.
3. Provide incident energy level (calories/cm2) for each equipment location and recommended PPE.
4. Based on the results of the incident energy study provide and install a warning label (orange <40 cal/cm2) or danger label (red > 40 cal/cm2) for each piece of equipment. The label must be readable in both indoor and outdoor environments and contain the following information:

    a. Arc hazard boundary (feet and inches).
    b. Working distance (feet and inches).
    c. Arc flash incident energy at the working distance (calories/cm2).
    d. PPE category and description including the glove rating.
    e. Voltage rating of the equipment.
    f. Limited approach distance (feet and inches).
    g. Restricted approach distance (feet and inches).
    h. Prohibited approach distance (feet and inches).
    i. Equipment/bus name.
    j. Date prepared.

5. Provide one day of arc flash safety training, travel time excluded and at jobsite or classroom designated by OWNER, that contains the requirements referenced in OSHA 1910.269, OSHA 1910 Subpart S and NFPA 70E. Training shall include but not be limited to the following:

    1. Proper use of the system analysis data.
    2. Interpretation of hazard labels.
    3. Selection and utilization of personal protective equipment.
    4. Safe work practices and procedures.

F. Upgrade Equipment

1. The contractor shall correct, rectify or upgrade equipment and or any deficiencies that surface due to the power system studies at no additional cost to the Owner.

1.8 DATA TO BE FILED WITH THE OWNER

A. Submit shop drawings and product data under provisions of Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES. Certain data, as specified herein, shall be furnished to the Owner when installation and testing are complete, before final acceptance.

G. The data shall be compiled in 8-1/2 x 11 inch format in high-quality heavyweight, hard cover binders with piano-style metal hinges or in an alternate format approved by the Engineer. Large drawings and other materials which would be opened or removed for reading shall be provided with heavy clear plastic pouches within the binders.

The number of binders shall be as required to hold all required material without over-filling. Various sections, as appropriate shall have suitable dividers. All volumes shall be labeled.

C. Four sets of all required material shall be provided.

D. As a minimum, the data files shall include:

1. A table of contents.
2. Approved, final shop drawings and product data for all equipment and materials incorporated in the work under this Division.
3. Manufacturer's maintenance manuals for all equipment furnished under this Division for which maintenance is recommended by the manufacturer.
4. A tabulation of cable insulation tests.
5. A tabulation of motor nameplate data.
6. A tabulation of required voltage tests.
7. A tabulation of required motor no load & full load current test data.
8. A tabulation of relay and control device set points.
9. A tabulation of alarm set points.
10. A Study Report providing summary of results of power systems study under paragraph 3.8 of this Section including:

    a. Description, purpose, basis, and scope of study and single line diagram of power system.
    b. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties and commentary regarding same.
    c. Protective device time versus current color coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
    d. Fault current calculations including definition of terms and guide for interpretation of computer printout.
    e. Tabulation of appropriate tap settings for relay units.
    f. Arc flash calculations and tabulation of incident energy level (calories/cm2) for each equipment location and recommended personal protective equipment (PPE).

11. Complete testing report for the testing of electrical systems under paragraph 3.9 of this Section utilizing NETA printed forms. Submit report no later than 30 days after testing is complete. Submit proof of testing agency qualification.

E. All data shall be neat and clearly legible. The table of contents and tabulations of set points and other recorded test data shall be typed. Sloppy, illegible, inaccurate, or incomplete data will not be accepted.

1.9 RECORD DRAWINGS

A. Alterations and additions to the contract documents which are made during the execution of the work shall be neatly and plainly marked in red on a set of Record Drawings kept at the contractor's field office for the project.

These drawings shall be updated as the work progresses and shall be available for inspection by the Engineer at all times during the course of the work.

B. When the work is complete, and before final acceptance, a set of CAD generated Record Drawings and contract specifications shall be submitted to the Engineer for review and acceptance. Changes made to the contract documents shall be highlighted or identified. The set shall include the marked field set and a set of reproducible drawings. A set of reproducible drawings will be supplied to the Contractor for use in preparing the Record Drawings. The drawings shall each be stamped "RECORD DRAWING", and shall be marked with the contractor's stamp, the date, and the signature of the contractor's supervising engineer or electrician.

C. The Record Drawings must be submitted and must be acceptable to the Engineer prior to final acceptance. There will be no deviation from this requirement.

1.10 GUARANTEES

A. Guarantees shall be provided for equipment, materials and work provided under this Division as specified in Division 1.

1.11 CLASSIFICATION OF ELECTRICAL ENCLOSURES AND INSTALLATIONS IN PROJECT LOCATIONS

A. Unless otherwise specified in the individual Specification Section or shown on Plans, type of electrical enclosures and installations shall be in accordance with the following:

B. NEMA 7(CLASS I, Division 2, GROUP D): All spaces in the pump station including Pump Room, Intermediate Level, Wet Well, Dry Well and Stairwell, except otherwise indicated.

NEMA 1: Electrical Room.

NEMA 4X: Outdoor area and other unclassified area.

NEMA 12: Indoor area not defined.

1.12 BASIS OF PAYMENT

A. Unless otherwise noted the work shall be paid for at the Contract lump sum price for PUMP STATION ELECTRICAL WORK, which shall be payment in full for the work described herein unless otherwise noted.

B. The work for Temporary Electric Service specified under Subsection 3.4 shall be paid under the pay item TEMPORARY ELECTRIC SERVICE CONNECTION.

C. The work for Permanent Electric Service specified under Subsection 3.5 shall be paid under the pay item ELECTRIC UTILITY SERVICE CONNECTION.

Revised 06/06/12

PART 2 - PRODUCTS

2.1 SERVICE PEDESTAL & METERING CABINET PADS

A. Construction Requirements:

1. Concrete shall reach 4,000 psi at 28 days.
2. Reinforcing bars shall be number 4, ASTM A615 Grade 60. All reinforcing bars are to be epoxy coated. Epoxy coated bars shall conform to the requirement of AASHTO M284. Pad rebar are to be placed at 12 inch intervals, center to center, and be tied at points of crossing.
3. Joint tape shall be 1” x 1” Butyl Sealant as approved by the City of Naperville.
4. The manufacturer shall certify in writing that the pad meets or exceeds the City of Naperville standards. For field pours, 48 hour advance notice shall be provided to the Naperville DPU-E (420-6185) of the proposed concrete pours, so that an inspector may determine that City Standards have been met.

2.2 MATERIALS AND EQUIPMENT

A. Quality

All materials, equipment and appurtenances shall be new, shall be suitable for the application and shall be the product of established, reputable manufacturers.

B. Standards

The construction, sizes, ratings and capacities of items shall be in conformance with the requirements of the NEC and with NEMA standards, as applicable.

C. UL Label

Unless otherwise indicated, materials and equipment shall bear the UL label whenever such labeling is available for the type of material or equipment being furnished.

D. Service Equipment
Equipment which is used as electric service equipment shall bear a UL listing: "SUITABLE FOR USE AS SERVICE EQUIPMENT".

E. Other Requirements
Refer to Division 1 for other requirements relating to materials and equipment.

PART 3 EXECUTION

3.1 GENERAL

A. Provide other trades with advance information on locations and sizes of concrete pads, frames, boxes, sleeves and openings needed for the Work. Also provide information and shop drawings necessary to permit trades affected to install their Work properly and without delay.

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B. Prior to submittal of shop drawings coordinate electrical equipment, particularly motor control equipment and control panels, with all applicable equipment and systems furnished under other Divisions of the Specifications. Acknowledge in submittal drawings any designated instrument tag numbers when tag numbers are assigned in drawings or specifications. Acknowledge that coordination of all applicable equipment has been performed.

C. The electrical system design, including, but not limited to, the type, size and quantity of equipment and components, layout, installation and connections as shown on Plans and/or as indicated in the Specifications, is based on electrical, electro-mechanical and/or electronic equipment supplied by selected manufacturers. If equipment furnished by the Contractor requires a different electrical system than that specified hereinafter or shown on Plans, the Contractor shall make all necessary modifications to the electrical system design, subject to the Owner's approval, to provide a complete electrical system ready for successful operation. The costs of making the modifications to the electrical system shall be entirely borne by the Contractor without extra cost to the Owner. If equipment furnished by the Contractor necessitates changes to electric, gas and/or telephone utilities' service equipment, or to the Work specified under other Sections of the Specifications, then the cost for making the changes shall also be entirely borne by the Contractor without extra cost to the Owner.

D. Locate all equipment such that they are readily accessible for operation, maintenance, repair and replacement. Ready accessibility to removable parts of equipment and to wiring shall be provided without moving other equipment which is to be installed or which is in place. In general, such equipment is not to be blocked or concealed except where specifically permitted. Do not route conduits across or through access or maintenance space of other equipment. Where equipment is permitted to be concealed, provide approved access door. Where equipment is concealed in fire-resistance rated walls or partitions provide access doors having same fire-resistance rating as well as partitions in which door is placed.

E. Where electrical equipment is to be installed in limited space, provide additional drawings (scale - minimum 1/4 in. = 1 ft.) as necessary to show physical and dimensional relationship between electrical equipment and adjacent equipment furnished under other Divisions of the Specifications. Acknowledge locations of adjacent structural or mechanical systems, including ductwork, piping, or equipment accesses. Acknowledge clearances established by all codes and regulations are met or exceeded.

F. The installation shall be such that its components will function together as workable systems. It shall be complete, with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The Work shall be executed in conformity with the best practices and so as to contribute to efficiency of operation, minimum maintenance, accessibility and appearance.

G. Location of electrical equipment shown on Plans is approximate and is subject to minor changes as directed by and at no extra cost to the Owner.

H. Perform equipment tests as per manufacturer's instructions except where otherwise specified.

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3.2 PROTECTION OF WORK

A. All electrical work, including equipment, fixtures and appurtenances shall be protected from damage until final acceptance. Fixtures and equipment shall be covered to protect against dirt, moisture, paint and the like. The work shall be protected from mechanical injury by appropriate covering or shielding.

B. Prior to final acceptance, protective measures shall be removed and equipment and items shall be cleaned as required to deliver the installation to the State in clean, undamaged condition.

3.3 CLEAN-UP AND SAFETY

A. The work site shall be maintained in a clean condition, free of hazards, all in conformance with the requirements of Article 107 of the Standard Specifications. Special care shall be taken to assure that electrical systems are not left in an exposed or otherwise hazardous condition. All electrical boxes, cabinets, pole handholes, etc., which contain wiring, either energized or non-energized, shall be closed or shall have their covers in place and shall be locked when possible, during off-work hours.

3.4 TEMPORARY ELECTRIC SERVICE

A. Work under this Section shall include all equipment, wiring and appurtenances required for the complete, operational temporary electric service.

B. All electric utility's charges for disconnecting the existing electric service and providing new service to the existing pump station shall be paid to the utility by the Contractor. The Contractor will be reimbursed the exact amount of these charges, plus any allowable administrative costs as permitted in Standard Specificication Article 109.05 under a separate pay item,

TEMPORARY ELECTRIC SERVICE CONNECTION.

For bidding purposes, this item shall be estimated at $50,000.

C. The Drawings and Specifications indicate the general nature of work required for electric service. The Contractor shall verify the service requirements, shall ascertain the installation requirements and the items of equipment, wiring, appurtenances being furnished by the utility and shall provide all other material and work required for a complete installation.

3.5 PERMANENT ELECTRIC SERVICE

A. Work under this Section shall include all equipment, wiring and appurtenances required for the complete, operational permanent electric service.

H. All electric utility's charges for providing two new services to the new pump station shall be paid to the utility by the Contractor. The Contractor will be reimbursed the exact amount of these charges, plus any allowable administrative costs as permitted in Standard Specificication Article 109.05 under a separate pay item,

ELECTRIC UTILITY SERVICE CONNECTION.

For bidding purposes, this item shall be estimated at $255,000.

C. The Drawings and Specifications indicate the general nature of work required for electric service. The Contractor shall verify the service requirements, shall ascertain the installation requirements and the items of equipment, wiring, appurtenances being furnished by the utility and shall provide all other material and work required for a complete installation.

D. Power metering cabinets shall consist of utility provided transformers, and meter socket in a NEMA 4X enclosure. Coordinate the transformer rating with the electric utility.

E. All electric service work must conform to the requirements of the electric utility

F. The Contractor shall obtain approval of the electric utility for the electric service and metering prior to installation. Copies of approved documents and drawings shall be submitted to the Engineer for the record prior to installation.

3.6 PEDESTAL & METERING CABINET PAD INSTALLATION

A. The pedestal pad & metering cabinet pad shall be installed on a 12 inch compacted crushed rock base.

B. Secondary conduits shall enter from the bottom of the pad. Exact location of the conduit stubs may vary: coordinate the exact location with the Naperville Department of Public Utilities – Electric (DPU-E) prior to construction.

C. Protection posts in the form of 8 inch concrete filled steel pipes are required in areas of vehicular traffic. Posts shall be 4 feet below grade with 4 feet extended above grade. Each post shall be installed in an 18 inch diameter hole filled with concrete and set 1 foot off the exposed corners.

3.7 ELECTRIC SERVICE COORDINATION

A. Existing Pump Station shall remain operational until new Pump Station is operational. ComEd is to provide a temporary service to the existing pump station prior to removing the existing service. Contractor is responsible for coordinating with ComEd service disruptions such that one service is in constant operation. Contractor shall initiate cancelation of existing service, and once the new pump station is commissioned ensure that the process is completed including terminating billing and invoices for energy charges. The following constraints shall be followed:

1. The temporary ComEd transformers, poles, and service extension shall be installed prior to disconnection of the existing ComEd equipment.
2. Conduit and conductors from new Naperville transformers to the 480V switchgear shall be installed. Coordinate with Naperville for transformer terminations.

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3. At this time, the new service will be connected to the new Pump Stations. Existing Pump Station is now powered from the new temporary ComEd service and new Pump Station is powered from new Naperville service.
4. Contractor shall perform necessary testing of equipment at new Pump Station to verify all equipment is operational prior to the disconnection of existing ComEd equipment.
5. Temporary service feeding existing Pump Station shall be disconnected. ComEd equipment that feeds existing Pump Station shall then be removed. Service disconnection to existing Pump Station shall only occur after new Pump Station is constructed and operational, and inflow and outflow sewers are complete.

C. The Drawings and Specifications indicate the general nature of the work required for telephone service. The Contractor shall verify the service requirements, shall ascertain the installation requirements and the items of equipment, wiring and appurtenances being furnished by the utility and shall provide all other material and work required for a complete installation.

D. All telephone service work must conform to the requirements of the telephone utility.

E. The Contractor shall obtain approval of the telephone utility for the modification of the telephone wiring. Copies of approved Documents and drawings shall be submitted to the Engineer for the record prior to installation.

3.8 FINAL ACCEPTANCE INSPECTION

A. When the work is complete, tested and fully operational, and only after the Record Documents have been reviewed and accepted by the Engineer, the Contractor shall schedule a Final Acceptance Inspection with the Engineer. The Contractor is cautioned to test for the proper operation of all equipment prior to the final acceptance inspection and to make any corrections necessary to establish proper operation. THE FINAL ACCEPTANCE INSPECTION SHALL NOT BE HELD WHILE FINAL CONNECTIONS AND CHECKS ARE BEING MADE.

B. The Final Acceptance Inspection shall be made for the complete work at the facility as a whole and shall be as further described in Division 1.

3.9 MAINTENANCE

A. During the course of the construction work and until final acceptance, the Contractor shall be responsible for maintenance and operational integrity of the facility as specified in Division 1.

3.10 ELECTRICAL POWER SYSTEMS STUDIES

A. Section includes:

1. Short circuit analysis, protective device evaluation study, protective device coordination study, and arc flash study on entire power distribution system.

2. Portions of electrical distribution system from normal and alternate sources of power throughout distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions and maximum incident energy shall be covered in study.
3. Contractor shall engage services of independent engineering firm for purpose of performing electric power systems studies as specified.
4. The contractor is responsible to provide adequately rated electrical equipment at no additional cost to the owner if based on the power system study the equipment is found to be underrated.

B. Studies

1. Studies shall include following:

    a. Utility Company incoming service lines.
    b. Main switching station.
    c. Power transformers.
    d. Low voltage switchgear.
    e. Motor control centers.
    f. Power and lighting distribution panels.
    g. Cable, wire, and conduit systems.

C. Short Circuit Study

1. Provide complete report with printout data sheets using digital computer type programs as part of study.
2. Include utilities' short circuit contribution, resistance and reactance components of branch impedances, X/R ratios, base quantities selected, and other source impedances.
3. Calculate short circuit momentary duty values and interrupting duty values based on assumed 3-ph bolted short circuit at switch gear base medium voltage controller, switchboard, low voltage MCC, distribution panelboard, pertinent branch circuit panel, and other significant locations through system. Include short circuit tabulation of symmetrical fault currents and X/R ratios. List with respective X/R ratio each fault location, total duty on bus, and individual contribution from each connected branch.

D. Equipment Device Evaluation Study.

1. Provide protective device evaluation study to determine adequacy of circuit breakers, molded case switches, automatic transfer switches, knife switches, controllers, surge arresters, busways, and fuses by tabulating and comparing short circuit ratings of these devices with calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards. Notify ENGINEER of problem areas or inadequacies in equipment due to short circuit currents and provide suggested alternate equipment.

E. Equipment Device Coordination Study.

1. Provide protective device coordination study with necessary calculations and logic decisions required to select or check selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. Objective of study is to obtain optimum protective and coordination performance from these devices.
2. Include as part of coordination study, medium and low voltage classes of equipment from utility's incoming line protective device down to and including largest rated device in 480 v MCCs and panelboards. Include phase and ground overcurrent protection as well as settings of other adjustable protective devices.
3. Draw time-current characteristics of specified protective devices in color on log-log paper or computer printout. Include with plots complete titles, representative one-line diagram and legends, associated Power Company's relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. Indicate types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing in-rush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits, and significant symmetrical and asymmetrical fault currents. Provide coordination plots for phase and ground protective devices on system basis. Provide sufficient number of separate curves to indicate coordination achieved.
4. Provide separate selection and settings of protective devices in tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment, and recommended settings. Tabulate recommended power fuse selection for medium voltage fuses where applied in system. Notify ENGINEER of discrepancies, problem areas or inadequacies and provide suggested alternate equipment ratings and/or settings.

F. Arc Flash Study

1. Provide Incident Energy Study – An incident energy study shall be done in accordance with the IEEE 1584, ”IEEE Guide for Performing Arc Flash Hazard Calculations” as referenced in NFPA 70E, “Standard for Electrical Safety in the Workplace”, in order to quantify the hazard for selection of personal protective equipment (PPE).
2. Adjust system design to optimize the results of the study as it relates to safety and reliable electrical system operation (e.g. overcurrent device settings, current limiting devices). This includes mitigation, where possible, of incident energy levels that exceed 40 calories/cm2. Provide suggested alternate equipment and settings to minimize incident energy levels.
3. Provide incident energy level (calories/cm2) for each equipment location and recommended PPE.
4. Based on the results of the incident energy study provide and install a warning label (orange <40 cal/cm2) or danger label (red > 40 cal/cm2) for each piece of equipment. The label must be readable in both indoor and outdoor environments and contain the following information:

a. Arc hazard boundary (feet and inches).
b. Working distance (feet and inches).
c. Arc flash incident energy at the working distance (calories/cm2).
d. PPE category and description including the glove rating.
e. Voltage rating of the equipment.
f. Limited approach distance (feet and inches).
g. Restricted approach distance (feet and inches).
h. Prohibited approach distance (feet and inches).
i. Equipment/bus name.
j. Date prepared.

5. Provide one day of arc flash safety training, travel time excluded and at jobsite or classroom designated by OWNER, that contains the requirements referenced in OSHA 1910.269, OSHA 1910 Subpart S and NFPA 70E. Training shall include but not be limited to the following:

   a. Proper use of the system analysis data.
   b. Interpretation of hazard labels.
   c. Selection and utilization of personal protective equipment.
   d. Safe work practices and procedures.

6. Protective Device Testing, Calibration, and Adjustment
7. Comply with Section 3.12 TESTING ELECTRICAL SYSTEMS.

3.11 TESTING ELECTRICAL SYSTEMS

A. Summary

1. Prior to energizing equipment, retain services of recognized independent testing laboratory for purpose of performing inspections and tests as herein specified.
2. Ensure electrical equipment supplied by Contractor and Owner is operational within industry and manufacturer’s tolerances and installed in accordance with Specifications.
3. Device Ratings and Settings: Verify ratings and settings of overload relays, motor circuit protectors, and overcurrent devices. Make final adjustments of devices in accordance with paragraph 3.8.

B. General

1. Test Work and equipment installed to ensure proper and safe operation in accordance with intent of Drawings and Specifications.

   a. Check interlocking and automatic control sequences and test operation of safety and protective devices.
   b. Correct defects found by Work of this Section.
   c. Cooperate with Power Company, supplier, and manufacturer representatives in order to achieve proper intended operation of equipment.

2. Test, adjust, and record operating voltages at each system level before energizing branch circuits.

    a. Transformer taps shall be adjusted to obtain as near as possible nominal system voltage.
    b. Where transformer is under utility jurisdiction, obtain services of utility to correct voltage.
    c. Replace devices and equipment damaged due to failure to comply with this requirement.

3. Balance load among feeder conductors at each panelboard, switchboard or substation and reconnect loads as necessary to obtain reasonable load balance on each phase. Electrical unbalance shall not exceed 20%.

C. Switchgear/Motor Controller Assembly.

1. Visual and Mechanical Inspections:

    a. Inspect for physical damage.
    b. Verify equipment supplied and connected in accordance with Specifications.
    c. Inspect for proper alignment, anchorage, and grounding.
    d. Check tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instructions for proper ft-lb levels.
    e. Key interlock system shall be physically tested to ensure proper function.
    f. Doors, panels, and sections shall be inspected for paint, scratches, and fit.
    g. Mechanical operation of relays, switches, and other devices.

2. Electrical Tests:

    a. Insulation Resistance Test: Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for 1 min. Test voltage and minimum acceptable values in accordance with Paragraph 3.9.C-3.b.

3. Test Values:

    a. Bolt torque levels shall be in accordance with manufacturer's instructions.
    b. Insulation resistance test shall be performed in accordance with following:

Insulation Resistance Test Voltage	
Voltage Rating	**Test Voltage**
150 – 600 v	1,000 v
601 – 5,000 v	2,500 v
5,001 v and above	5,000 v

    c. Values of insulation resistance less than rated kv +1 in Megohms shall be investigated and corrected.

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D. Motor Controllers

1. Visual and Mechanical Inspections: Include following inspections and related work:

   a. Motor Control Device Ratings and Settings: Verify ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective device ratings and settings where differences found. Use accepted revised ratings or settings to make final system adjustments.
   b. Inspect for defects and physical damage and nameplate compliance with Drawings.
   c. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's written instructions.
   d. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturers recommended torque values.
   e. Clean devices using manufacturer’s approved methods and materials.
   f. Verify proper fuse types and ratings in fusible devices.

2. Electrical Tests:

   a. Perform following in accordance with manufacturer’s written instructions.

      1) Insulation resistance test of motor control devices conducting parts to extent permitted by manufacturer's written instructions. Insulation resistance less than 100 megaohms is not acceptable.
      2) Use primary current injection to check performance characteristics of motor circuit protectors and for overload relays of controllers for motors 15 hp and larger. Trip characteristics not within manufacturer's published time-current tolerances are not acceptable.
      3) Make adjustments for final settings of adjustable trip devices.
      4) Test auxiliary protective features such as loss of phase, phase unbalance, and undervoltage to verify operation.
      5) Check for improper voltages at terminals in controllers having external control wiring when controller disconnect opened. Voltages over 30v are unacceptable.

   b. Correct deficiencies and retest motor control devices. Verify system tests that specified requirements are met.

E. Instrument Transformers

1. Visual and Mechanical Inspection:

   a. Inspect for physical damage and compliance with Drawings.
   b. Check mechanical clearances and proper operations of disconnecting and grounding devices associated with potential transformers.
   c. Verify proper operation of grounding or shorting devices.

2. Electrical tests:

    a. Confirm transformer polarity electrically.
    b. Verify connection at secondary CT leads by driving low current through leads and checking for this current at applicable devices.
    c. Confirm transformer ratio.
    d. Measure insulation resistance of transformer secondary and leads with 500v megaohm meter.
    e. Measure transformer primary insulation with applicable overpotential tests.
    f. Verify connection of secondary PT leads by applying low voltage to leads and checking for this voltage at applicable devices.

F. Metering and Instrumentation

1. Visual and Mechanical Inspection:

    a. Examine devices for broken parts, indication of shipping damage, and wire connection tightness.
    b. Verify meter connections in accordance with single line meter and relay diagram.

2. Electrical Tests:

    a. Calibrate meters at midscale. Calibration instruments shall have precision no more than 50% of instrument being testing.
    b. Calibrate watthour meters to 1/2%.
    c. Verify instrument multipliers.

G. Grounding System

1. Testing:

    a. Subject completed grounding system to megger test at each Location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
    b. Measure ground resistance not less than 2 full days after last trace of precipitation, and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    c. Perform tests by 2 point method according to Section 9.03 of IEEE 81.

2. Maximum grounding resistance values are as follows:

    a. Equipment Rated 500 kVA and less: 10 ohms.
    b. Equipment Rated 500 to 1000 kVA: 5 ohms.
    c. Equipment Rated More than 1000 kVA: 3 ohms.
    d. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.
    e. Manhole Grounds: 10 ohms.

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3. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify ENGINEER promptly and include recommendations to reduce ground resistance and to accomplish recommended work.
4. Report: Prepare certified test reports, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

H. Ground Fault Systems

1. Visual and Mechanical Inspections:

   a. Inspect for physical damage and compliance with Drawings and Specifications.
   b. Inspect neutral main bonding connection to ensure following.

      1) Zero sequence system grounded upstream of sensor.
      2) Ground strap systems grounded through sensing device.
      3) Ground connection made ahead of neutral disconnect link.

   c. Inspect control power transformer to ensure adequate capacity for system.
   d. Manually operate monitor panels (if present) for the following:

      1) Trip test.
      2) No trip test.
      3) Non-automatic reset.

   e. Record proper operation and test sequence.
   f. Inspect zero sequence systems for symmetrical alignment of core balance transformers about current carrying conductors.
   g. Verify ground fault device circuit nameplate identification by actuation observation.
   h. Pickup and time delay settings shall be set in accordance with settings developed through coordination study and as approved by ENGINEER.

2. Electrical Tests:

   a. Test in accordance with manufacturer's instructions.
   b. Measure system neutral insulation resistance to ensure no shunt ground paths exist, neutral-ground disconnect link removed, neutral insulation resistance measured, and link replaced.
   c. Relay pickup current shall be determined by primary injection at sensor and circuit interrupting device operated.
   d. Relay timing shall be tested by injecting 150% and 300% of pickup current into sensor. Total trip time shall be electrically monitored.
   e. System operation shall be tested at 55% rated voltage.
   f. Zone interlock system shall be tested by simultaneous sensor current injective and monitoring blocking function.

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3. Test Parameters:

    a. For the power wires and cables the Contractor must Megger test them at 1000 volts. The minimum acceptable reading must be 250 Megohms. The Megger test must not be done until any and all splicing is completed.
    b. Relay pickup current shall be within 10% of device dial or fixed setting, and in no case greater than 1,200 amps.
    c. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves, but in no case longer than 1 sec.

3.12 ELECTRICAL IDENTIFICATION

A. Installation

1. Install As indicated where used for color coding.
2. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
3. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.
4. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
5. Self Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
6. Install painted identification as follows:

    a. Clean surfaces of dust, loose material, and oily films before painting.
    b. Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.
    c. Apply one intermediate and one finish coat of silicone alkyd enamel.
    d. Apply primer and finish materials according to manufacturer's instructions.

7. Apply warning, caution, and instruction signs and stencils as follows:

    a. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
    b. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8 in. (9 mm) high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.

8. Install Nameplate as follows:

a. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 1/2 in. (13 mm) high lettering on 1-1/2 in. (38 mm) high label; where 2 lines of text are required, use lettering 2 in. (51 mm) high. Use black lettering on white background. Apply labels for each unit of following categories of equipment.

1) Access doors and panels for concealed electrical items.
2) Electrical switchgear.
3) Motor control centers.
4) Push button stations.
5) Power transfer equipment.
6) Transformers.
7) Power generating units.
8) Telephone switching equipment.
9) Fire alarm master station or control panel.
10) Security monitoring or control panel.

b. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3.13 EXCAVATION AND BACKFILL

A. Excavation and backfill for work under this Division shall be provided under this Division in conformance with Division 2.

3.14 CONCRETE

A. Concrete for equipment pads, conduit encasement, handholes, manholes and other work under this Division shall be provided under this Division in conformance with Division 3.

3.15 CUTTING AND PATCHING

A. All cutting and patching of building materials required for work under this Division shall be provided under this Division.

B. No structural members shall be removed, cut or otherwise modified without approval of the Engineer and any such work shall be done in a manner as directed by the Engineer.

I. Cutting and patching shall be performed in a neat and workmanlike manner, consistent with the best practices of the appropriate trade. All patching shall be done in a manner consistent with the building material being patched.

D. Holes made in concrete shall be made using a suitable core drill. The use of a star drill or air hammer will not be permitted.

E. In new construction, sleeves, chases, inserts and the like required for work under this Division shall be provided under this Division and the furnishing and placement of these items shall be fully coordinated with the other trades involved so as not to delay the new construction.

END OF SECTION 26 05 11

DIVISION 26 - ELECTRICAL

SECTION 26 24 13 SWITCHBOARD

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, complete installation, and connection of switchboard.

B. The power system feeding Switchboard shall be 480/277 volts, 60 Hertz, 3 phase, 4-wire, solidly grounded wye.

C. The Switchboard shall have a short circuit rating of 35,000 amperes RMS symmetrical.

D. The switchboard shall be an automatic transfer switch throw-over system as indicated on the drawings.

E. Switchboard shall be a deadfront type.

1.2 RELATED WORK

A. Section 01 01 01, Summary of Work

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that is common to more than one section of Division 26.

C. Section 26 05 21, CONDUCTORS AND CABLES: Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

E. Section 26 24 19, MOTOR CONTROL CENTER: Requirements for connection and control of motors and miscellaneous equipment.

F. Section 26 36 23, AUTOMATIC TRANSFER SWITCH: Requirements for switching from one source to a secondary source.

G. Section 40 94 23, SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA): For control and operation of all security systems.

H. Section 03 30 00, CAST IN PLACE CONCRETE: Requirements for concrete and reinforcing bars for the construction of foundations and pads.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. Low-voltage switchboard shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. Tests shall be conducted as per UL and ANSI Standards. Factory tests shall be certified.

B. Thoroughly test the switchboard at the factory with the circuit breakers in the connected position in their cubicles. The factory tests shall be in accordance with C37.20 and ANSI C37.51 and shall include the following tests:

1. Verify that circuit breaker sizes and types correspond to drawings and coordination study.
2. Verify tightness of bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
3. Confirm correct operation and sequencing of electrical and mechanical interlock systems by attempting closure on locked-open devices, and attempting to open locked-closed devices, and making key exchange with devices operated in off-normal positions.
4. Exercise all active components.
5. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, by applying 1550 VAC for a duration of 1 min. and in accordance with manufacturer's published data.
6. Perform insulation-resistance tests on control wiring with respect to ground. Applied voltage shall be 500VDC for 300-volt rated cable, and 1000VDC for 600-volt rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300-volt rated cable and 100 megohms for 600-volt rated cable.
7. Verify correct function of control transfer relays located in the switchboard with multiple control power sources.
8. Perform phasing checks on dual-source switchboards to insure correct bus phasing from each source.
9. Inspect indicating devices for correct operation.

1.5 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 01 01 01 – Summary of Work, Part 1.6 Submittals (this includes samples, shop drawings, submittal schedules, and product data).

B. Catalog Data: Submit catalog data and information as required to demonstrate that materials conform to the specification requirements. Data shall include features, characteristics, ratings, and settings of all adjustable components.

C. Shop Drawings:

1. Clearly present sufficient information to determine compliance with drawings and specifications.
2. Include electrical ratings, enclosure type, dimensions, weights, mounting details, front view, side view, equipment and device arrangement, running overcurrent protection, branch circuit overcurrent protection, wiring diagrams, materials, connection diagrams for the switchboard, and nameplate schedule.
3. For starters: a list of overload sizes for each motor and circuit breakers sizes.

D. Manuals: Two weeks prior to the final inspection, submit four copies of the following to the Engineer:

1. Complete maintenance, operating and testing manuals, including wiring diagrams, technical data sheets, including load current, overload relay and settings of adjustable relays, and information for ordering replacement parts:

    a. Include complete "As Installed" diagrams that indicate all pieces of equipment and their interconnecting wiring.
    b. Include complete diagrams of the internal wiring for each piece of equipment, including "As Installed" revisions of the diagrams.
    c. The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation, and testing.
    d. Instructions for testing and adjusting overcurrent protective devices.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. National Electrical Manufacturers Association (NEMA):

C. National Fire Protection Association (NFPA):
70-05 ..... National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):
UL 891 ..... Dead-Front Switchboards

E. Institute of Engineering and Electronic Engineers (IEEE):
C57.13..... Instrument Transformers

1.7 WARRANTY

A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of final acceptance. The warranty shall include all parts and labor.

1.8 BASIS OF PAYMENT

A. The work shall be paid at the contract lump sum price for
PUMP STATION ELECTRICAL WORK
which shall be payment in full for the work described herein.

PART 2 - PRODUCTS

2.1 LOW VOLTAGE SWITCHBOARD

A. The Contractor shall furnish and install, where indicated on the Drawings, a deadfront type low voltage metal-enclosed switchboard assembly as specified herein and as shown on the contract drawings.

B. The switchboard shall be a GE Type Spectra, low voltage metal-enclosed switchboard, utilizing low voltage insulated case circuit breakers, a short circuit rating of 35,000 amperes RMS symmetrical and as herein specified or approved substitute.

2.2 COMPONENTS

A. Refer to Contract Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; interrupting and withstand ratings of devices, buses, and components; and other required details.

B. Standard Features

1. Switchboards shall be a fully self-supporting structures with 90 inch tall vertical sections (excluding lifting eyes and pull boxes) bolted together to form required arrangement.
2. Switchboard frame shall be die formed, 12 gauge steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plates (code gauge steel), bus bars and installed devices during shipment and installation.
3. All sections may be rolled, moved or lifted into position. Switchboard shall be capable of being bolted directly to the floor without the use of floor sills.
4. All switchboard sections shall have removable top plate(s) to install conduit.
5. Front-Access switchboard shall be front and rear aligned.
6. Switchboard shall be UL listed.
7. All covers shall be fastened by hex head bolts.
8. Provide hinged doors over metering compartments and individually mounted device compartments. All doors shall have concealed hinges and be fastened by hex head bolts.
9. Switchboard protective devices shall be furnished as listed on drawings and specified herein, including interconnections, instrumentation and control wiring. Switchboard and devices shall be rated for the voltage and frequency listed on the drawings.
10. Switchboard current ratings, including all devices, shall be based on a maximum ambient temperature of 40 degree C per UL Standard 891. With no derating required, temperature rise of switchboards and devices shall not exceed 65 degrees C in a 40 degree C ambient environment.
11. Switchboard Service Entrance sections shall comply with UL Service Entrance requirements including a UL service entrance label, incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.

C. Incoming Section

1. Two incoming sections shall contain utility current transformers and main circuit breakers.
2. Furnish switchboard arranged for bottom entry of incoming cable. Provide crimp compression type lugs in the quantity and size required per the contract drawings. All lugs shall be tin-plated copper and UL listed for use with copper cable. Lugs shall be rated for 75 degree C. Cable.
3. Furnish switchboard where indicated on the drawings with a transition for close - coupled connection to a MCC.

D. Bus Bars

1. Bus bars shall be silver-plated copper. The bus bars shall have sufficient cross sectional area to meet UL 891 temperature rise requirements. Phase and neutral bus ampacity shall be as shown on the plans. The neutral bus shall have the same ampacity as the phase bus.
2. Bus bars shall be mounted on high impact, non-tracking insulated supports. Joints in the vertical bus are not permitted.
3. Bus bars shall be braced to withstand mechanical forces exerted during short circuit conditions as indicated in drawings, but in no case less than 100KA RMS SYM.
4. Bus joints shall be bolted with high tensile steel Grade 5 bolts. Belleville type washers shall be provided with aluminum bus.
5. Ground Bus shall be sized to meet UL 891. Ground bus shall extend full length of switchboard. Ground bus shall be copper
6. A-B-C bus arrangement (left to right, top to bottom, front to rear) shall be used throughout to assure convenient and safe testing and maintenance. Where special circuitry precludes this arrangement, bus bars shall be labeled.
7. All feeder device line and load connection straps shall be rated to carry current rating of device frame (not trip rating).
8. The main incoming bus bars shall be rated for the main protection device frame size or main incoming conductors, if there is no main device.
9. Main horizontal bus bars shall be fully rated and arranged for future extensions.

E. Enclosure

1. Switchboard shall be NEMA 12, deadfront construction or as indicated on drawings.

F. Micro Processor Based Metering Units

1. Provide a UL listed and digital multifunction power monitor. The monitor case shall be fully enclosed and shielded
2. The monitor shall accept a voltage monitoring range of up to 600 volts, phase to phase.

    a. The Monitor shall withstand 200% rated current continuously. It shall withstand 10X rated current for at least 3 seconds. Isolation shall be no less than 2500V AC.
    b. Surge withstand shall conform to IEEE C37.90.1, 62.41 and IEEE 1000-4
    c. Shall have a standard ANSI C39.1 case mount.
3. The Monitor shall provide true RMS measurements of total pump station load in amps, voltage, maximum demand load in KW, phase to neutral and phase to phase; current, per phase and neutral; real power, reactive power, apparent power, power factor and frequency. Data shall be transmitted to remote locations in District 1 and at contractore's maintenance facility via SCADA.

    a. The Monitor must be capable of providing readings for both instantaneous and average readings.
    b. The Monitor must also be capable of providing all single phase real, apparent, reactive power and power factor values.

c. The Monitor shall record and store total bi-directional energy. It shall include separate registers for positive and negative energy.
d. The Monitor shall record and store total bi-directional accumulated energy and total accumulated apparent energy.
e. The Monitor shall monitor max/min average demand values for all current and power readings. The demand interval shall be user programmable. Maximum and minimum values shall be stored with a date/time stamp.

4. The Monitor shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power functions, and shall meet IEC687 (0.2%)
5. The monitor shall include a three line, integrated, light-emitting diode (LED) display.

   a. The Monitor must be capable of displaying one leg of volts, amps and total power simultaneously.
   b. The display shall provide user access to all phase voltages (phase to neutral and phase to phase), currents (phase and neutral), watts, VARs, VA, power factor, frequency and kwh
   c. The display must provide user access to max/min values for all displayed quantities.
   d. The display shall have a % load bar display for ease of full load viewing

6. The monitor shall be microprocessor based and shall be fully user programmable.
7. The monitor shall be provided with an RS485 digital communications port. The Monitor shall communicate using a MODBUS RTU protocol and shall have a communication baud rate of at least 57k.
8. The monitor shall be provided with one KYZ pulse outputs
9. The Monitor shall have three serial communication ports; 1 RS232C and 2 RS485. Ports must be capable of communicating simultaneously to different devices.
10. The Monitor shall communicate using a MODBUS RTU or DNP open protocol and support communications baud rates of up to 19.2K
11. The Monitor shall calculate the harmonic signature, %THD and K-Factor for all voltage and current inputs with valid data for harmonic spectrum capability to the 32nd harmonic.
12. The Monitor must be capable of capturing a graphic image of the waveform for each of the 6 channels of Voltage and Current and make it available in a RAM buffer for retrieval through the digital communication port.

G. Metering Transformers

1. All instrument transformers shall be UL listed and classified as indicated in drawings.
2. Current Transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].
3. Potential transformers shall be provided where indicated on drawings with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].

I. Main Devices

1. Main device shall be individually mounted, insulated case circuit breaker. Provide device as specified in appropriate article below.
2. Where indicated provide the following with the main device:

    a. Insulated case circuit breakers shall be individually mounted.
    b. Mains shall be electrically operated, stationary mounted. Breakers shall be constructed of a high dielectric strength, glass reinforced insulating case. The interrupting mechanism shall be arc chutes. Steel vent grids shall be used to suppress arcs and cool vented gases. Interphase barriers shall to isolate completely each pole.
    c. Breakers shall contain a true two-step stored energy operating mechanism which shall provide quick make, quick break operation with a maximum five cycle closing time. Breakers shall be trip free at all times. Common tripping of all poles shall be standard.
    d. Insulated Case circuit breakers shall be rated to carry 100 percent of their frame ampacity continuously.
    e. A charging handle, close push-button, open push-button, and Off/On/Charge indicator shall be located on the breaker escutcheon and shall be visible with the breaker compartment door closed.
    f. Where drawout breakers are indicated on the drawings, the drawout design shall permit the breaker to be withdrawn from an engaged position, to a test position, and to a disengaged position.

J. Digital Electronic Trip Unit for Insulated Case Circuit Breakers

1. Each insulated case PowerBreak II breaker shall be equipped with a digital electronic trip unit. The trip unit shall provide protection from overloads, short circuits and ground faults. The protective trip unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation. Furnish GE Entelliguard TU digital electronic trip units as specified below.
2. As a minimum, the trip unit shall have the following protective functions unless otherwise indicated on the drawings:

    a. adjustable current setting or long time pickup;
    b. adjustable long time delay (22 bands);
    c. switchable, adjustable short time pickup and delay (11 bands) with 3 I2t selectable slopes;
    d. adjustable instantaneous pickup;
    e. adjustable ground fault pickup and delay.
    f. Reduced Energy Let-Through (RELT) Instantaneous trip. This feature shall provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard.
    g. Zone Selective Interlocking for Short Time, Ground Fault and Instantaneous protection.
    h. High contrast liquid crystal display (LCD) unit shall display settings, trip targets, and the specified metering displays.

i. Multi-button keypad to provide local setup and readout of all trip settings on the LCD.
j. UL Listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug.
k. An integral test jack for testing via a portable test set and connection to a battery source.
l. A mechanism for sealing the rating plug and the trip unit.
m. Noise immunity shall meet the requirements of IEEE C37.90.2.
n. Display trip targets for long time, short time, and ground fault, if included.
o. The trip unit shall keep a log of the last ten events including overcurrent trips, protective relay trips. The log shall store rms currents, phase, type of trip, trip counter, time and date for each event.
p. Instantaneous trip shall utilize filtering which permits fully selective operation with downstream current limiting devices up to the short time rating of the circuit breaker, when the instantaneous pickup is set above the current limiting threshold.
q. The trip unit shall include Modbus RTU communication capability. The trip unit, through dedicated secondary terminals on the breaker, shall provide a communication port for communication with and access to a remote computer. All metering, set points, protective trip counts, and other event signaling shall be retrievable by the remote computer.

4. The trip unit shall include the following metering functions, which shall be displayed on the LCD (if the manufacturers trip unit cannot incorporate the specified functions, separate device(s) with equal function shall be provided for each breaker):

a. Current, RMS, each phase;
b. Voltage, RMS (V), line-to-line or line-to-neutral.
c. Energy (kWh, MWH, GWH), each phase and total, user resettable.
d. Peak Power Demand (KW, MW), user resettable.
e. Real power (KW, MW), each phase and total.
f. Reactive power (KVAR, MVAR), each phase and total.
g. Apparent power (KVA, MVA), each phase and total
h. Frequency (Hz).
i. Power factor.
j. Waveform capture capability. Upon triggering, a total of eight cycles of voltage (each phase) and current (each phase) shall be recorded. The eight cycles shall include four pre-trigger and four post-trigger cycles. The waveform capture shall be configurable to trigger by manually over communications (when specified), by a overcurrent trip, by a protective relay trip (when specified), or by a current alarm. Waveform data shall be available in "Comtrade" file format via serial communications or at a front port at the trip unit.

5. The trip unit shall include all of the following protective functions. It shall be possible to disable, by user programming, any combination of unwanted protective functions.

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Except for reverse power, relay settings shall be in 1 percent steps over indicated range. Each function shall have a time delay, adjustable in 1-second increments (1 to 15 seconds) and shall be able to be switched OFF. If the manufacturer's trip unit cannot incorporate the specified functions, separate device(s) with equal function shall be provided for each breaker.

a. Undervoltage, adj. pickup, 50 to 90 percent; 1% increment adj. delay, 1 to 15 seconds.
b. Overvoltage, adj. pickup, 110 to 150 percent; 1% increment adj. delay, 1 to 15 seconds.
c. Voltage unbalance, adj. pickup, 10 to 50 percent; adj. delay, 1 to 15 seconds.
d. Current unbalance, adj. pickup, 10 to 50 percent; 1% increment adj. delay, 1 to 15 seconds.
e. Reverse power, selectable direction, adj. pickup, 10 KW to 990 KW; 10kW increment adj. delay, 1 to 15 seconds.

K. Automatic Throw-over System:

1. The switchboard manufacturer shall provide an automatic transfer switch as specified in Section 26 36 23 and as indicated on the drawings.

L. Surge Protective Devices (SPD)

1. Surge protective devices type 2 shall have UL 1449 3rd edition suppression ratings for each mode of protection, as follows:

a. 480/277 volt, 3 phase "WYE" – 800 volts.
b. 480 volt 3 phase "Delta" – 1500 volts.

2. Provide protection in all modes. Ten modes for "WYE" systems, L-L, L-N, L-G and N-G, and six modes for "Delta" systems, L-L and L-G.

3. The Catastrophic Protection System shall provide temporary over voltage and voltage swell protection to the following:

a. TOV - should be capable of surviving and continue to protect critical loads against multiple TOV events (described as 200% nominal voltage by 8 mS.

b. Swell- should be capable of protection against swells up to 180% nominal for 0.7 ohms load >18,000 cycles.

4. MOV's tested per ANSI/IEEE C62.33-1982.

5. Minimum Single Pulse Surge Current Capacity per ANSI/IEEE C62041-1991's standard 8 X 20 microsecond current waveform, shall not be less than as follows:

a. 300,000 amps, L-N

b. 300,000 amps, L-G min. amps per phase 600,000 (L-N plus L-G

c. 300,000 amps, N-G

d. 300,000 amps, L-L

6. Minimum continuous operating voltage of any component shall not be less than 115% of nominal operating voltage.

7. All surge current devices shall incorporate low impedance plated busbars. No small gauge round wire, printed circuit boards, silicon avalanche diodes or plug-in connections are acceptable.

8. Each MOV and capacitor shall be fused so that the failure of any component does not affect the operation or protection of the entire unit.

9. Provide in metal enclosure NEMA rated suitable for the installed location.

10. Accessories

a. Monitoring. One set of status monitoring lights that will provide visual indication of voltage present to the SPD. The lights shall also indicate the failure of MOV.
b. An audible alarm with battery backup, indicating lights showing loss of power and a surge counter shows the number of surges. Two sets of Form C contacts for remote monitoring.

2.3. FINISH

A. The Motor Control Center steel parts shall be cleaned and sprayed in controlled cleaning solutions by a 7-stage spray washer. The operation shall produce an iron phosphate coating of a minimum of 150 milligrams per square foot to meet MIL Specification TT-C-490. The primed metal parts shall be electrostatically coated with powder paint consisting of 670-011 ANSI-61 Acrylic Paint (Light Gray) with a gloss of 60 plus or minus 5 and thickness of 2.5 mils. The paint finish shall withstand a minimum of 1000 hours salt spray test.

2.4 ACCESSORIES

1. Fuses

a. Manufacturer: Ferraz Shawmut (or equal).
b. Interrupting Rating of all fuses shall be [200,000] RMS amperes.

2. Furnish adhesive plastic strip mimic bus for switchboards.

3. Furnish nameplates for each device as indicated in drawings. Nameplates for Power System equipment shall be white with black engraved lettering. Lettering shall be a minimum of 1/2 inch high. Nameplates shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of power branch as applicable. Secure nameplates with screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify location of 480V Switchboard

B. Verify that electrical power is available and of correct characteristics.

3.2 PREPARATION

A. Install concrete bases after dimensions of equipment are confirmed by equipment manufacturer.

3.3 INSTALLATION

A. The installer shall provide all labor and perform all work to install and make operational all equipment necessary to assure a safe and reliable operation.

B. Installation shall be in accordance with NEC, written instructions of the manufacturer, and as shown on the drawings.

C. Install switchboard on concrete pad as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Bolt the switchboard to the concrete pad.

D. Make connection to Motor Control Center as shown on the drawing.

E. Provide the services of qualified technical representative(s) of the manufacturer during installation, field testing and startup of the switchboard.

3.4 ACCEPTANCE CHECKS AND TESTS

Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:

1. Visual and Mechanical Inspection

    a. Compare equipment nameplate data with specifications and approved shop drawings.
    b. Inspect physical, electrical, and mechanical condition.
    c. Verify appropriate anchorage and required area clearances.
    d. Verify that fuse and circuit breaker sizes and types correspond to approved shop drawings.
    e. Use calibrated torque-wrench method to verify the tightness of accessible bolted electrical connections, or perform a thermographic survey after energization.
    f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
    g. Clean switchboard.
    h. Inspect insulators for evidence of physical damage or contaminated surfaces.
    i. Exercise all active components.
    j. Verify the correct operation of all sensing devices, alarms, and indicating devices.
    k. Inspect control power transformers.

2. Electrical Tests

   a. Perform insulation-resistance tests on each bus section.
   b. Perform overpotential tests as required, disconnect solid-state components or control devices if they cannot tolerate the applied voltage.
   c. Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.
   d. CT/PT polarity and ratio tests.
   e. Primary injection test for breakers verifying settings.
   f. Functional operation of all devices.
   g. Perform ground resistance test per SECTION 26 05 26 – GROUNDING & BONDING, paragraph 3.7.

3. Test Values:

   a. Bolt torque levels shall be in accordance with manufacturer's instructions.
   b. Insulation resistance test shall be performed in accordance with following:

Insulation Resistance Test Voltage	
Voltage Rating	**Test Voltage**
150 – 600 v	1,000 v
601 – 5,000 v	2,500 v
5,001 v and above	5,000 v

   c. Values of insulation resistance less than rated kv +1 in Megohms shall be investigated and corrected.

3.5 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

B. Equipment identification nameplate of engraved plastic laminate with black letters on white background shall be installed on the outside front doors.

3.6 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the switchboard is in good operating condition and properly performing the intended function.

B. The contractor shall correct or rectify any deficiencies noticed during the field test at no additional cost.

3.7 TRAINING

A. The services of a qualified representative of the manufacturer shall be provided to instruct on proper installation of the equipment, inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment, place the equipment in trouble-free operation, and instruct operating personnel in its operation and maintenance.

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This service shall include all equipment provided in this Section for the Switchboard, Include:

a. 1 manday for Installation Services for Switchboard.
b. 1 manday for Instructional Services for Switchboard.

A. The start-up services for the Switchboard shall be coordinated with IDOT and IDOT shall be notified at least one week in advance:

END OF SECTION 26 24 13

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DIVISION 26 - ELECTRICAL

SECTION 26 24 19 MOTOR CONTROL CENTER

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, complete installation, and connection of the Motor Control Center to the Switchboard.

B. The Motor Control Center shall be rated for 480/277 volt, three phase,4 wire, 60 Hertz having a short circuit rating of 35,000 amperes RMS symmetrical.

C. The Motor Control Center shall include Reduced Voltage Soft Start controllers (RVSS) for the 4 pumps.

1.2 RELATED WORK

A. Section 01 01 01 – Summary of Work

B Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that is common to more than one section of Division 26.

C. Section 26 05 21, CONDUCTORS AND CABLES: Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

E. Section 26 24 13, SWITCHBOARD: Requirements for providing power to MCC and miscellaneous equipment.

F. Section 40 94 23, SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA): For control and operation of all security systems.

G. Section 03 30 00, CAST IN PLACE CONCRETE: Requirements for concrete and reinforcing bars for the construction of foundations and pads.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. The Motor Control Center shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. Tests shall be conducted as per UL and ANSI Standards. Factory tests shall be certified.

B. Thoroughly test the Motor Control Center at the factory with the starters and circuit breakers in the connected position in their cubicles. The factory tests shall be in accordance with C37.20 and ANSI C37.51 and shall include the following tests:

1. Verify that starters and circuit breaker sizes and types correspond to drawings and coordination study.
2. Verify tightness of bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
3. Confirm correct operation and sequencing of electrical and mechanical interlock systems by attempting closure on locked-open devices, and attempting to open locked-closed devices, and making key exchange with devices operated in off-normal positions.
4. Exercise all active components.
5. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, by applying 1550 VAC for a duration of 1 min. and in accordance with manufacturer's published data.
6. Perform insulation-resistance tests on control wiring with respect to ground. Applied voltage shall be 500VDC for 300-volt rated cable, and 1000VDC for 600-volt rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300-volt rated cable and 100 megohms for 600-volt rated cable.
7. Verify correct function of control relays located in the Motor Control Center with multiple control power sources.
8. Perform phasing checks on Motor Control Center to insure correct bus phasing.
9. Inspect indicating devices for correct operation.

1.5 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 01 01 01 – Summary of Work, Part 1.6 Submittals (this includes samples, shop drawings, submittal schedules, and product data).

B. Submit RVSS package to the Engineer for approval prior to factory assembly of the RVSS. The submittal package shall consist of the following:

1. Elementary diagrams showing factory power and control wiring along with field wiring connections for line and load power connections and control wiring connections.
2. Outline diagrams showing the overall enclosure and mounting dimensions with front and side views and weights as a minimum. The outline drawings shall also include conduit entry/exit locations along with intended conduit sizes.
3. Voltage, horsepower, current rating, and product features from standard catalog sheets.

C. Catalog Data: Submit catalog data and information as required to demonstrate that materials conform to the specification requirements. Data shall include features, characteristics, ratings, and settings of all adjustable components.

D. Shop Drawings:

1. Clearly present sufficient information to determine compliance with drawings and specifications.

2. Include electrical ratings, enclosure type, dimensions, weights, mounting details, front view, side view, equipment and device arrangement, running overcurrent protection, branch circuit overcurrent protection, wiring diagrams, materials, connection diagrams for each motor control center, and nameplate schedule.
3. For starters: a list of overload sizes for each motor and circuit breakers sizes.

E. Manuals: Two weeks prior to the final inspection, submit four copies of the following to the Engineer:

1. Complete maintenance, operating and testing manuals, including wiring diagrams, technical data sheets, including load current, overload relay and settings of adjustable relays, and information for ordering replacement parts:

   a. Include complete "As Installed" diagrams that indicate all pieces of equipment and their interconnecting wiring.
   b. Include complete diagrams of the internal wiring for each piece of equipment, including "As Installed" revisions of the diagrams.
   c. The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation, and testing.
   d. Instructions for testing and adjusting overcurrent protective devices.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. National Electrical Manufacturers Association (NEMA):
ANSI/NEMA 250 ..... Enclosures for Electrical Equipment (1000 Volts Maximum)
ANSI/NFPA 70. ..... National Electrical Code
SG-3 ..... Low Voltage Power Circuit Breakers.
ICS 1-05 ..... Industrial Control and Systems: General Requirements
ICS 2-05 ..... Industrial Control and Systems: Controllers, Contactors, and Overhead Relays, Rated 600 volts
ICS 6-06 ..... Industrial Control and Systems: Enclosures
FU 1-02 ..... Low-Voltage Cartridge Fuses
250-03 ..... Enclosures for Electrical Equipment (1000 Volts Maximum)

C. National Fire Protection Association (NFPA):
70-05 ..... National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):
UL 508..... Industrial Control Equipment (only for devices included in specification)
977 ..... Safety Fused Power Circuit Devices
1053 ..... Ground Fault Sensing and Relaying Equipment
845-05 ..... Motor Control Centers

E. Institute of Engineering and Electronic Engineers (IEEE):
C37.13..... Low Voltage AC Power Circuit Breakers Used in Enclosures

C37.20.1.....Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
C57.13.....Instrument Transformers
C62.41.....Surge Voltage in Low Voltage AC Power Circuits

1.7 WARRANTY

A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of final acceptance. The warranty shall include all parts and labor.

1.8 DELIVERY, STORAGE AND HANDLING

A. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.

B. Ship up to three motor control sections in individual shipping splits for ease of handling. Each shipping split shall be mounted on shipping skids and wrapped for protection.

C. Contractor shall inspect and report concealed damage to carrier within 48 hours.

D. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.

E. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish. Lift only by installed lifting eyes.

1.9 BASIS OF PAYMENT

A. The work shall be paid at the contract lump sum price for
PUMP STATION ELECTRICAL WORK
which shall be payment in full for the work described herein.

PART 2 - PRODUCTS

2.1 LOW VOLTAGE MOTOR CONTROL CENTER

A. The Contractor shall furnish and install, where indicated on the Drawings, a deadfront type, low voltage metal-enclosed Motor Control Center assembly as specified herein and as shown on the contract drawings.

B. The motor control center shall be a GE Evolution E9000, or approved substitute, low voltage motor control center, utilizing reduced voltage starters, low voltage combination starters and power circuit breakers, with a short circuit rating of 35,000 amperes RMS symmetrical or higher, and as herein specified.

2.2 COMPONENTS

A. Refer to Contract Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; interrupting and withstand ratings of devices, buses, and components; and other required details.

B. Structure

1. Enclosures shall be NEMA Type 12. Enclosures shall be suitable for front mounting.
2. Wiring: NEMA ICS 3, Class I, Type B.
3. Motor control center shall consist of the required number of vertical sections of heavy gauge sheet steel bolted together to form a rigid self- supporting assembly. A removable lifting angle shall be mounted to the motor control center at the top. Removable bottom channel sills shall be mounted front and rear of the vertical sections and shall extend the width of the lineup.
4. Vertical sections shall be nominally 90-inch high and depth to match the switchboard. Section widths shall be 24-inches or 30-inches wide when required.
5. The SCADA and Control panel enclosures shall be NEMA Type 12 floor mounted, front accessible only, metal enclosed type, arranged for cable and/or conduit entry from the top, bottom or sides, as required. Panel design shall allow easy access to all internal wiring and appurtenances. Ventilation fan, air filter, thermostatically controlled space heater, light kit and 120V receptacle shall be provided. The panel shall have a full piano hinge door(s) and a 3-point latch with a locking handle. The handle shall have a cylinder type lock keyed to match IDOT's system.
6. Vertical sections shall be nominally 90-inch high and depth to match the motor control center. Section widths shall be 36-inches wide.
7. The enclosure shall be finished inside and out. Exterior color shall match that for the motor control center, and the interior color shall be white or as otherwise approved by the Engineer.

C. Wireways

1. Each vertical section shall contain a minimum 12-inch high top horizontal wireway and a 6“bottom wireway. When loads exit the bottom a 12” bottom wireway shall be provided. A removable hinged door shall cover the horizontal wireway.
2. A separate vertical wiring trough shall be furnished in each vertical section adjacent to plug-in unit. The wire trough shall permit the installation of field wiring and shall isolate this wiring from the adjacent unit. No terminal blocks shall be located in the vertical wireway.
3. Cable tie supports shall be furnished in the vertical wireway to hold cable and wiring in place. A removable hinged door shall cover the vertical wiring trough.
4. A separate low-level signal raceway shall be provided within the vertical wiring trough.

D. Incoming Power

1. Incoming power to the motor control center shall be bus bars extended from the building switchboard as shown on the drawing.

    a. Incoming bus shall enter the side of the motor control center and shall have a current rating as shown on the drawing.

2. If required, the motor control center shall be provided with an incoming transition section for close coupling with the switchboard.

E. Bus System

1. Power shall be distributed by means of a continuous horizontal bus with a current rating of 600 amperes.
2. The main bus shall be tin-plated .0003 micro inch thick copper.
3. The main bus shall be braced for 35,000 amperes RMS symmetrical.
4. The main bus shall be isolated by barriers from wire troughs, starters, and other areas.
5. There shall be double bolt connections on main bus joints and splice connections. Main bus splicing between shipping splits shall be accomplished from the front with no structural disassembly.
6. The main bus shall be fully rated and arranged for future extension.
7. The vertical bus in each section shall be rated 300 amperes and shall be tin-plated.
8. The vertical bus shall have a flame-retardant white polyester-glass insulation/isolation system. This system shall insulate the vertical bus front and rear. In addition, the barrier shall isolate each phase bus. Openings in the vertical bus insulation/isolation system shall permit the entry of unit stabs. Unused openings shall have plugs or covers to prevent the entry of foreign objects.
9. The vertical bus shall be braced the same as the main horizontal bus.
10. A non-insulated copper ground bus shall extend the full width of the motor control center with a minimum size of 2” x ¼”. The ground bus shall be rated same capacity as main phase bus. The ground bus shall be drilled and lugs furnished as specified.
11. A neutral bus shall be furnished full-width of line up. The neutral bus shall be same capacity as main horizontal phase bus. Lugs of the proper ampacity shall be furnished.

F. Units

1. Combination motor controller and feeder units shall employ molded case circuit breakers for branch circuit protection. Circuit breaker disconnects for combination motor starters shall be thermal-magnetic.
2. All combination starter and feeder units of plug-in construction shall utilize a positive guidance system to insure positive connection of the unit stabs to the section vertical bus. Insertion and removal of each unit shall not require the use of special tools.
3. Unit shelves shall be of a lift out design, so that the shelf may be removed without the use of special tools.
4. Connection from the power stabs to the unit disconnect shall be a direct connection.

5. Each circuit breaker starter unit size 1 through size 5 shall be of plug-in construction. Each feeder breaker rated 600A or less shall be plug-in construction.
6. Each unit compartment shall be equipped with a flange-formed pan type door. The door shall be mounted on the vertical section with removable hinge pins.
7. Each unit shall be equipped with an operating handle. The handle shall be connected to the disconnect operator using a direct drive and requiring no adjustments of linkage.
8. The handle shall be mechanically interlocked with the door preventing it from opening with the disconnect switch closed. The interlock shall also prevent the disconnect switch being closed with the door open. The interlock shall be capable of being defeated allowing the door to be opened with disconnect closed or disconnect closed with the door open.
9. The unit handle shall have provision for up to three padlocks in the off position. On circuit breaker units the handle shall have a "tripped" position in addition to OFF/ ON.
10. Each unit shall be capable of being padlocked in a partially withdrawn position. In this position, the unit power stabs are disengaged from the vertical bus and no power can enter the unit.
11. Combination starter units specified with Type B or C wiring shall be supplied with split-type control terminal blocks. The terminal blocks shall be front mounted and shall allow the removal of the unit without disconnecting any of the control wiring. Combination starter units up to size 5 shall be plug-in construction and shall be capable of being removed without disconnecting any control leads from their terminal blocks.
12. Overload relays shall be:

    a. Solid-state, ambient insensitive, self powered, including adjustable FLA, phase unbalance, phase loss protection, selectable overload class 10, with 2% accuracy and repeatability, built-in thermal memory to prevent hot motor starts, isolated 1 NO and 1 NC auxiliary contacts.

13. Control power for starter units shall be from:

    a. Individual control power transformers furnished in each starter unit. One secondary lead shall be furnished with a fuse and the other lead shall be grounded. Control power primary fuses are required. The transformer shall be large enough to operate all indicating lights and control devices.

14. Starter units shall be provided with the following auxiliary devices:

    a. auxiliary starter interlocks, 3 N/O, 3 N/C].
    b. control / timing relays as shown on the drawings.
    c. door mounted pilot devices shall be 30mm heavy duty:

        1) Start-stop pushbutton
        2) H-O-A selector switch
        3) Indicating lights quantity and color as shown on the drawing. Indicating lights shall be reduced voltage transformer push to test led type.
        4) Ammeter
        5) Ammeter selector switch

G. Reduced Voltage Soft Starter (RVSS)

1. Refer to Contract Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; interrupting and withstand ratings of devices, buses, and components; and other required details. Furnish GE ASTAT XT or approved substitute.
2. The RVSS shall be capable of operating a NEMA design B induction motor with a full load current equal to or less than the continuous output current rating of the soft starter.
3. The RVSS shall be microprocessor controlled and shall consist of a power section, logic board, and field wiring interface terminal board for ease of access to control and power wiring as well as maintenance requirements. The RVSS shall consist of the following general components:

    a. Three sets of back-to-back phased controlled power semiconductors rated 1400 PIV to 500V, 1600 PIV to 600V and 1800 PIV to 690V.
    b. Integral thermal sensor to trip and disengage the soft starter on heat sink over temperature.
    c. Programmable keypad and alphanumerical LCD display that indicates present mode of operation. The LCD keypad shall display programming and diagnostic data in full text.
    d. LED indicators to show the following: On, Start, Run, Soft Stop, Stop, Save/Slow Speed, Dual Set/Reverse, & Fault.
    e. Modbus RTU communications port.

4. The RVSS input power section shall be designed to operate at 460 Vac three phase input voltages.
5. The RVSS output power section shall be designed for three phase NEMA design B induction motor with amperage ratings from 8A through 820A depending on actual configuration.
6. RVSS shall include control power that is 120 Vac via a control power transformer.
7. All RVSS shall meet UL508A.
8. The RVSS shall include a Mag-Break motor circuit protector with a through-the-door handle interlocked to the enclosure door to provide a local and lockable means of removing all input power from the RVSS.
9. Branch circuit protection fuses shall be provided to protect the RVSS. Fuses shall be sized to provide proper branch circuit protection and be coordinated with other power circuit components.
10. The RVSS shall include door mounted operator devices and a through the door keypad to facilitate programming, control functions and diagnostics.

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11. The RVSS shall include a line isolation contactor to remove three phase power from the starter and motor during stop and fault conditions.
12. An AC3 rated Bypass Starter with Class 20 motor overload relay will be included and controlled by the ASTAT XT to allow cooler and more efficient operation during run conditions. This will also allow the RVSS panel to run the motor using a full voltage, non-reversing starter in the event the RVSS trips.

H. RVSS PROTECTIVE AND DIAGNOSTIC FEATURES

1. In the event of a fault, the soft starter will have tripped. Faults must be reset to restart operation once their cause has been rectified. The soft starter shall offer the following Faults list:

   a. External Fault (by a digital input).
   b. Frequency out of Range
   c. Heat Sink Over Temperature
   d. Long Start Time
   e. Overcurrent / Jam
   f. Overload
   g. Overvoltage
   h. Phase Loss
   i. Phase Sequence
   j. Shorted SCR
   k. Slow Speed Time
   l. Thermistor Trip
   m. Too Many Starts
   n. Undercurrent
   o. Undervoltage
   p. Wrong Motor Connection
   q. Wrong Parameters
   r. Wrong Wiring Connection
   s. RVSS panels with an AC3 rated bypass shall contain an adjustable Class 20 ambient compensated overload relay. The overload relay shall provide; single-phase protection, visible trip indication, selectable manual/automatic reset, and trip test.

I. Molded Case Circuit Breakers

1. Furnish GE Spectra RMS™ Molded Case Circuit Breakers.
2. Feeder circuit breakers to 600A shall be provided in a plug-in for connection to the MCC vertical bus.

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3. Circuit breaker frames shall be constructed of a high-strength, molded, glass-reinforced polyester case and cover. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action, independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
4. Breaker plug-in units shall be provided with an external operating handle which shall have ON and OFF position clearly marked on the outside of the breaker enclosure.
5. Breakers shall include factory installed mechanical lugs. Lugs shall be UL listed and rated 75 or 60/75 degrees C as appropriate. Breakers shall be standard, or 80 percent rated.
6. Breakers shall use digital true RMS sensing trip units and a rating plug to determine the breaker trip rating.
7. Breaker digital electronic trip units shall be as described in Article 2.02H.

J. Circuit Breaker Trips for Molded Case Breakers

1. Feeder molded case circuit breakers shall be supplied with digital electronic trips. Furnish GE microEntelliGuard digital electronic trip units or approved substitute that complies with all of the following.
2. The protective trip unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation.
3. Long time and short time protective functions shall have true RMS sensing technology for harmonic rich currents including up to the 19th harmonic.
4. High contrast liquid crystal display (LCD) unit shall display settings, trip targets, and the specified metering displays.
5. Multi-button keypad to provide local setup and readout of all trip settings on the LCD.
6. UL Listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug. Rating plugs shall be available in sizes from 40% to 100% of the breaker sensor rating
7. An integral test jack for testing via a portable test set and connection to a battery source.
8. Noise immunity shall meet the requirements of IEEE C37.90.
9. Display trip targets for long time, short time, and ground fault, if included.
10. Visual illuminated indication of the trip unit (normal, pickup, trip, error).
11. The trip unit shall be provided with a 10 event trip history log. Each trip event shall be recorded with type, phase and magnitude of fault that caused the trip
12. As a minimum, the trip unit shall have the following protective functions:

    a. Current setting or long time pickup, adjustable from 50% to 100% of the rating plug value.
    b. Adjustable long time delay with typical inverse time characteristics (minimum of 10 bands). In addition, a set of straight line fuse shaped long time delay bands shall be provided to facilitate selectivity with downstream fuses (minimum 7 bands).
    c. Instantaneous pickup, adjustable from 2.0 to 10 times the rating plug in 0.5 increments

d. Short time pickup and delay. Short time pickup shall be adjustable from 1.5 to 9 times the long time pickup setting in 0.5 increments with an OFF option. Provide minimum of 12 short time delay bands with three selectable I2t bands.
e. Adjustable ground fault pickup and delay. Ground fault pickup shall be adjustable from 0.4 to 1.0 times the breaker sensor rating in 0.05 increments. Provide a minimum of 15 ground fault delay bands with three selectable I2t bands

13. The trip unit shall display rms current, each phase, on the LCD.
14. The following monitored values shall also be displayed on the trip unit LCD:

    a. Voltage, rms, line - to - line, or line - to - neutral;
    b. Energy, KWH, total;
    c. Demand KWH, over an adjustable time period of 5 to 60 minutes;
    d. Peak demand, KW, user resettable;
    e. Real power, KW, line - to - line, line - to - neutral;
    f. Total (apparent) power, KVA, line - to - line, line - to - neutral.
    g. Reactive Power, KVAR, line - to - line, line - to - neutral.
    h. Power Factor (%)
    i. Frequency (Hz)]

15. Trip shall be provided with serial communications using Modbus RTU protocol. Manufacturer's literature shall provide full register map.
16. Trip unit shall provide waveform capture capability for fault events. Capture data shall include 4 cycles before and 4 cycles after the event. Data shall be provided in a Comtrade file format for use by power management system.
17. If a manufacturer's trip unit can not incorporate the above specified metering functions, separate device(s) with equal function shall be provided for each breaker

K. Motor Management Relays

1. Motor management shall be provided using a relay with complete protection, metering, and monitoring functions. The relay may be applied on induction motors from 200V to 7.2KV @ 60 Hz from 1 to 800 FLA
2. The protection functions shall include selectable overcurrent Class 10, 15, 20, & 30, adjustable current unbalance, Zero Sequence ground fault if specified on drawings, fixed over/under-voltage, adjustable Stall & Jam, selectable Load & Power Loss, auxiliary sense failure, stop motor and record event upon failure of an auxiliary device to change state upon command.
3. Monitoring and metering functions shall include:

    a. Phase current, each phase and ground; average current; % current unbalance; voltage; power factor, three-phase power, elapsed motor hours.
    b. Non-volatile memory that can store up to 10 trip events.

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4. Control functions shall include:

    a. Four output contacts with NEMA C150 pilot duty ratings. Two NO contacts shall be used to control motor contactors, one form-C contact shall be used to annunciate ground fault status as shown on drawings, and one form-C contact shall be used for programmable fault status indications.
    b. Six digital inputs for the following: Run 1, Run 2, Stop, Trip, Operation Mode, Reset.
    c. Power Loss auto restart. Upon power loss, the relay will record a power loss fault as well as latest motor condition and parameter settings. The relay shall have the ability to restart after a preset delay. The relay shall have an adjustable delay setting of 0.15 to 30 seconds, set at 10 seconds.

5. The Motor Protective relay shall include the following user interfaces:

    a. Front mounted LED's indicators shall indicate module status, network status, overcurrent pickup, ground fault pickup and current unbalance pickup.
    b. Dip-switch configuration for overload trip class (10, 15, 20, 30), DeviceNet MAC ID, and Baud Rate. Software shall not be required for configuring these values.
    c. DeviceNet communications using a standard 5-pin sealed micro style (female) connector.
    d. An RS232 port, using an RJ11, on relay shall be provided for PC or Display device to access the settings and following data:

        1) Phase Currents
        2) Average Phase Current
        3) Line Voltage
        4) KW
        5) Power Factor
        6) Elapse Time
        7) Trip record of last 10 events
        8) Address (MAC ID)
        9) Trip Class
        10) Baud rate

    e. Programming and Display Unit (PDU)

        1) PDU shall have capability to configure the relay, display faults and all monitored parameters.
        2) PDU shall have a 4-line by 16 character LCD display and control keys.
        3) LED indicators on the PDU shall indicate control power availability and fault status.

    f. EnerVista compatible Windows® based PC software which enables setpoint programming, file storage, on-line help, and real time display of status and measured data.

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L. Miscellaneous Units:

1. The following units shall be included in the motor control center as indicated on the drawings:

   a. Lighting and Power transformers
   b. Lighting panelboards, type AQ or AL for 120/208V applications.
   c. PLC'S

2. Furnish the following devices where indicated on Drawings.

   a. Push-Button Stations and Selector Switches: NEMA 12, heavy-duty type.
   b. Stop and Lockout Push-Button Station: Momentary-break push-button station with factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
   c. Control Relays: Auxiliary and adjustable time-delay relays.
   d. Elapsed Time Meters: Heavy duty with digital total running time readout in hours.

M. Enclosure shall be provided with adequate space for the installation of the moisture/temperature monitoring relay(s) provided by the pump manufacturer. Interface requirements shall be coordinated with the pump manufacturer.

2.3 FINISH

A. The Motor Control Center steel parts shall be cleaned and sprayed in controlled cleaning solutions by a 7-stage spray washer. The operation shall produce an iron phosphate coating of a minimum of 150 milligrams per square foot to meet MIL Specification TT-C-490. The primed metal parts shall be electrostatically coated with powder paint consisting of 670-011 ANSI-61 Acrylic Paint (Light Gray) with a gloss of 60 plus or minus 5 and thickness of 2.5 mils. The paint finish shall withstand a minimum of 1000 hours salt spray test.

2.4 ACCESSORIES

1. Fuses

   a. Manufacturer: Ferraz Shawmut (or equal).
   b. Interrupting Rating of all fuses shall be [200,000] RMS amperes.

2. Furnish adhesive plastic strip mimic bus for switchboards.

2. Furnish nameplates for each device as indicated in drawings. Nameplates for Power System equipment shall be white with black engraved lettering. Lettering shall be a minimum of 1/2 inch high. Nameplates shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of power branch as applicable. Secure nameplates with screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify location of 480V Motor Control Center

B. Verify that electrical power is available and of correct characteristics

3.2 PREPARATION

A. Install concrete bases after dimensions of equipment are confirmed by equipment manufacturer.

3.3 INSTALLATION

A. The installer shall provide all labor and perform all work to install and make operational all equipment necessary to assure a safe and reliable operation.

B. Installation shall be in accordance with NEC, written instructions of the manufacturer, and as shown on the drawings.

C. Install motor control center on concrete pad as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Bolt the motor control center to the concrete pad.

D. Make connection to the switchboard as shown on the drawing.

E. Provide the services of qualified technical representative(s) of the manufacturer during installation, field testing and startup of the motor control center.

3.4 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:

1. Visual and Mechanical Inspection

    a. Compare equipment nameplate data with specifications and approved shop drawings.
    b. Inspect physical, electrical, and mechanical condition.
    c. Verify appropriate anchorage and required area clearances.
    d. Verify that fuse and circuit breaker sizes and types correspond to approved shop drawings.
    e. Use calibrated torque-wrench method to verify the tightness of accessible bolted electrical connections, or perform a thermographic survey after energization.
    f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
    g. Clean motor control center.
    h. Inspect insulators for evidence of physical damage or contaminated surfaces.
    i. Exercise all active components.
    j. Verify the correct operation of all sensing devices, alarms, and indicating devices.
    k. Inspect control power transformers.
    l. Check main bus connections, electrode conductor and equipment ground.

3. Electrical Tests

a. Perform insulation-resistance tests on each bus section as shown paragraph 3.4, 3, b.
b. Perform overpotential tests as required, disconnect solid-state components or control devices if they cannot tolerate the applied voltage.
c. Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.
d. Perform ground resistance test per SECTION 26 05 26 – GROUNDING & BONDING, paragraph 3.7.
e. CT/PT polarity and ratio tests.
f. Primary injection test for breakers verifying settings.
g. Functional operation of all devices.
h. Ground resistance test.
i. Test of protective relays and verify trips and alarms.

3. Test Values:

a. Bolt torque levels shall be in accordance with manufacturer's instructions.
b. Insulation resistance test shall be performed in accordance with following:

Insulation Resistance Test Voltage	
Voltage Rating	**Test Voltage**
150 – 600 v	1,000 v
601 – 5,000 v	2,500 v
5,001 v and above	5,000 v

c. Values of insulation resistance less than rated kv +1 in Megohms shall be investigated and corrected.

3.5 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

B. Equipment identification nameplate of engraved plastic laminate with black letters on white background shall be installed on the outside front doors.

3.6 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the motor control center is in good operating condition and properly performing the intended function.

B. The contractor shall correct or rectify any deficiencies noticed during the field test at no additional cost.

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3.7 TRAINING

A. The services of a qualified representative of the manufacturer shall be provided to instruct on proper installation of the equipment, inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment, place the equipment in trouble-free operation, and instruct operating personnel in its operation and maintenance. This service shall include all equipment provided in this Section for the Motor Control Center, Include:

a. 1 manday for Installation Services for Motor Control Center.
b. 1 manday for Instructional Services for Motor Control Center.

I. The start-up services for the Motor Control Center shall be coordinated with IDOT and IDOT shall be notified at least one week in advance:

END OF SECTION 26 24 19

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DIVISION 40

SECTION 40 94 23 – SCADA SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The requirements of the Special Provisions and Division 1, General Requirements, shall apply to all SCADA SYSTEM described herein.

B. The SCADA (Supervisory Control and Data Acquisition) system shall be provided to function as the "Master Control Station" for the Pump Station facility.

C. The SCADA will be a PLC based system with an operator interface mounted on SCADA Panel SP47 for control, monitoring and system configuration. The following equipment and instrumentation, as a minimum, will be monitored/controlled via hardwired connections:

   a. Main Switchboard

   b. Motor Control Center

   c. Automatic Transfer Switch

   d. Pump Motor Controllers and Protection Devices

   e. Level Sensing Systems

   f. Pavement Float Switches

   g. Slide Gates

   h. Recirculation Pipe Valve

   i. Combustible Gas Detection System

   j. Fire Detection and Alarm System

   k. Intrusion Detection System

D. The operator interface shall consist of a graphical interface which provides a view of the pumping station. Several “screens” shall be designed in order to display the features of the facility.

E. The SCADA system shall consist of, but not be limited to; programmable controllers, data communication equipment, displays as noted, process instrumentation and control devices, uninterruptible power systems (UPS), and other devices as required and/or as indicated on Plans.

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F. All materials, equipment, labor, programming, configuration and installation services, and incidentals required to achieve a fully integrated and operational system shall be furnished and installed complete by a qualified Contractor with a minimum of 10-years experience. The Contractor shall design and coordinate the instrumentation and control system for proper operation with related equipment and materials.

G. Auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with equipment provided under this Contract shall be included whether shown on the Plans or not.

H. The Contractor shall provide all programming and configuration of equipment and software including development of graphic displays and reports. Displays and Report development shall be coordinated with existing IDOT standards.

I. The Contractor shall install the control system and shall perform all on-site testing, start-up, and training of IDOT's staff.

J. All necessary coordination required for interfacing the proposed pump station facility with the proposed SCADA system shall be provided by the Contractor.

1.2 RELATED SECTION

A. Section 01 01 01 – Summary of Work

B. Section 26 24 13 – Switchboard

C. Section 26 24 19 – Motor Control Centers

D. Section 26 36 23 – Automatic Transfer Switches

E. Section 28 16 11 – Intrusion Detection System

F. Section 28 31 00 – Fire Detection and Alarm

G. Section 28 35 10 – Combustible Gas Detection System

H. Section 40 94 24 – HMI Improvements

I. Section 43 20 10 – Valves and Appurtenance

J. Section 43 20 20 – Hydraulic Gates

K. Section 43 20 10 – Valves and Appurtenance

L. Section 43 21 39 – Submersible Pumps

M. Section 43 21 43 – Sump Pumps

1.3 REFERENCES

A. ISA Standards and Recommended Practices for Instrumentation and Control.

1.4 SUBMITTALS

A. Submit product data, shop drawings, project documentation, O & M Data and record documents in accordance with the provisions of Specification Section 01 01 01 Part 1.6 - SUBMITTALS and the following specific information.

B. Product Data

a. Bill of Material: List all the materials and equipment to be furnished. Tag number, manufacturer's complete catalog number, service, location, and cross-reference numbers of instruction sheet, specification data sheet and wiring diagram shall be included under each item.

b. Specification Data and Drawings: Furnish instrument specification data sheet as per ISA standard instrument specification form, if applicable, wiring and/or connection diagram, outline dimensions, installation diagram and manufacturer's catalog for each instrument. A common set of drawings with setting and/or scale individually listed may be furnished for instruments with identical specification except setting and/or scale.

c. Panel Drawings: Furnish panel drawings for each instrument/control panel. List bill of materials, show panel or cabinet structure, outline dimension, general arrangement, devices, cutouts and mounting details of instruments and control devices, terminal blocks, wire ways and piping.

C. System Diagrams

a. Instrument Loop Diagram: Show all analog and digital loops for all instrument sensors, secondary instruments, I/O functions, alarms, control and displays using ISA standard symbols per ISA Standard S5.4.

b. SCADA System Block Diagram: Show system hardware configuration and identify model numbers of each system component.

c. Schematic diagrams, point-to-point internal wiring diagrams, point-to-point field wiring diagrams, and other necessary diagrams and installation requirements for the SCADA system and other components and systems that are interfaced to these systems.

d. Interconnecting Wiring and/or Piping Diagrams: Show schematically the wiring and piping runs for each instrumentation and control system. The diagram shall show and identify, with location noted, all instruments, piping and appurtenances furnished under this section and related electrical equipment furnished under other Sections. All terminal blocks and pipe taps shall be identified.

D. Software Documentation

a. Submit system software, application software, I/O point data base listing, programming ladder diagrams, graphic pages and report forms in prints. Software, application programs, ladder diagrams and control logics shall also be submitted in 740MB CD-R.

E. Instruction Manuals

a. Submit instruction manuals covering installation, operation, calibration, maintenance, diagnostic and repair for all hardware and software.

F. Record Documents

a. Accurately record actual calibration setting and scales of instruments.

1.5 WORK FOR HIRE

A. Any and all configuration, programming, setup or other software functions (SOFTWARE) performed on all intelligent devices provided as part of this Project is to be considered "Work for Hire" under the 1976 Copyright Act as amended (title 17 of the United States Code). The SOFTWARE shall be owned by IDOT and shall be turned over to IDOT fully documented as the work is completed.

B. IDOT intends only to obtain the SOFTWARE for its own use.

C. IDOT will not prevent the SOFTWARE supplier from reuse of the SOFTWARE concepts and ideas for other projects. Any reuse of the SOFTWARE concepts and ideas generated under this Project is solely the responsibility of the SOFTWARE supplier. The SOFTWARE supplier shall defend, indemnify and hold harmless IDOT from all claims, damages and expenses (including reasonable litigation costs), arising out of any use, misuse or misapplication of SOFTWARE concepts and ideas.

1.6 OPERATIONAL AND PERFORMANCE REQUIREMENTS

A. General

a. The SCADA System will be designed for full automatic control and monitoring of the pump station. The individual pumps in the station will be called to start and stop due to the water level in the wet well. Under normal conditions the water level will be measured via a primary and secondary bubbler type level measuring systems. The station will also be equipped with a direct action float switch level system as a backup to the primary and secondary bubbler systems. Finally, the control system will also allow for manual operation.

b. The Low Flow Pump will be the first pump to start and the last one to stop. The Main Flow Pumps (MFP-1, MFP-2 and MFP-3) will operate in a 3-pump alternator sequence with one of the pumps designated as a standby. The operator shall select which pump shall be designated as standby via a selector switch mounted on Control Panel CP47.

The lead and lag pump alternation shall occur when all pumps are off in a pumping cycle. System operation shall be the same no matter which level control system is functioning.

c. The SCADA system will interface with the District's supervisory control system via a fiber optic Ethernet connection and a hardwired leased line telephone will be provided for backup. The fiber optic cable connection shall be provided by others in the future. The SCADA system shall be designed to allow for control of Pump Station 47 from remote location in the future.

B. Manual Pump Operation

a. The Pump Station includes (4) pumps. Each of the (4) pump motors are equipped with a starter with a Manual/Off/Auto selector switch. When the switch is in the Manual mode, the respective pump will immediately start, assuming no fault conditions. When in Auto mode, the respective pump shall be started and stopped based on Sequence of Operation detailed below.

C. Automatic Pump Operation Via Bubbler Type Leveling System

a. The pump operation shall be automatically staged based on the water level in the wet well. The level in the wet well shall be monitored via (2) independent level sensing systems. The main level sensing system shall consist of primary and secondary redundant bubbler systems. The level transducers shall monitor the wet well liquid level and generate electronic analog process control signals proportional to the head of liquid. The signals shall be monitored by a Programmable Logic Controller (PLC-SP47-03) installed in SCADA Panel (SP47). The PLC establishes the "ON-OFF" set points for the (4) pumps based on wet well conditions. Pump operating sequence and pump availability is also established via the PLC.

b. On a rise in wet well liquid level, the Low Flow Pump motor will start. With the low flow pump running and a further rise in liquid level, the lead pump setpoint causes the lead motor to start and the low flow pump to stop. With the lead pump running and a further rise in liquid level, the lag pump setpoint causes the lag motor to start. As the wet well liquid level falls, the pumps stop in succession in response to commands by the PLC.

c. The following tables summarize the sequence of pump operation for rising and falling wet well conditions.

Rising Wet Well Condition	
Wet Well Level Elevation	Pump Operation Sequence
676.00 feet	Low Flow Pump Start
678.00 Feet	Lead Main Flow Pump Start / Low Flow Pump Stop
680.00 feet	Lag Main Flow Pump Start
682.30 feet	High Water Alarm

Falling Wet Well Condition	
Wet Well Level Elevation	Pump Operation Sequence
678.00 Feet	Lag Main flow Stop
676.00 Feet	Lead Main Flow Pump Stop / Low Flow Pump Start
674.00 Feet	Main Flow Pump Failure To Stop Alarm
672.00 Feet	Low Flow Pump Stop
671.50 Feet	Low Water Alarm

d. The next main flow pump (including the pump designated as standby) in sequence will automatically start in the event the lead or lag main flow pump fails to start for whatever reason when automatically required by the control system. The failed pump is removed from automatic service and is by-passed by the controller until manually reset.

D. Automatic Pump Operation Via Float Switch Leveling System

a. The backup level sensing system shall be a series of (7) floats. The system will only be active if the primary and secondary bubbler type leveling system, as described above, fails or if the operator selects float operation via a selector switch mounted on Control Panel CP47. The floats shall be mounted at specific levels in the wet well. Refer to the FLOAT CONTROL SYSTEM Section of this Specification and Plans for additional details.

b. The pump operation shall be automatically staged based on the water level in the wet well. The control of pump operation shall be identical shall be identical to that described above for the bubbler system. The PLC shall not be used for pump control and staging when the Float Switch Level System is operating. Rather relay logic as detailed on the Plans shall be used.

E. Integrated Protective Controls

a. The control system shall include the following protective features to protect the motor. These features shall be active in manual and automatic modes of operation no matter which type of leveling sensing system is active.

i. Low Level Cutout shall inhibit pump operation upon occurrence of a predetermined low liquid level in the wet well. The Annunciator Panel shall identify this condition via a pilot light. Restoration of pump operation is automatic upon rise in wet well liquid level to the predetermined set point.

ii. Dedicated Pump Overtemperature Relay monitors thermal switches in the respective pump motor windings and locks-out pump operation upon occurrence of a high motor temperature. A door mounted pilot light indicating “OVERTEMP” is energized while the motor is locked-out. The affected pump motor remains locked-out until the associated “RESET” pushbutton is depressed following correction of the problem. A door mounted selector switch shall provide the operator with the option of bypassing the lock-out feature. Refer the motor wiring diagrams for additional details.

iii. Dedicated Pump Seal Probe Relay monitors moisture probes in the oil seal chamber of the pumps. The presence of moisture activates the associated probe relay, which locks-out the associated pump and energizes a door-mounted pilot light (“SEAL FAILURE”). The affected pump motor remains locked-out until the associated “RESET” pushbutton is depressed following correction of the problem. A door mounted selector switch shall provide the operator with the option of bypassing the lock-out feature. Refer the motor wiring diagrams for additional details.

iv. Refer to the motor wiring diagrams for additional motor protective details.

1.7 GUARANTEES AND WARRANTEES

A. Guarantees and warrantees shall be provided in accordance with the provisions of Specification Section 01 01 01 Part 1.7 – GUARANTEES AND WARRANTEES and the following specific information.

B. Contractor shall provide a one year warranty from dated of final acceptance, including parts and labor.

C. All hardware and software furnished under this contract including but not limited to the microprocessors, accessory peripherals, discrete devices, analog instruments and control devices shall be unconditionally guaranteed.

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1.8 BASIS OF PAYMENT

A. Payment for the work specified under this Section and as required shall be included in the Contract lump sum price for the Item, PUMP STATION SCADA EQUIPMENT.

1.9 DELIVERY, STORAGE AND PROTECTION

A. Deliver, store, protect and handle products to site under provisions of Division 1.

1.10 SCADA PANEL SYSTEM I/O TABLE

A. Refer Attachment 1 for the I/O Table associated with Programmable Logic Controller PLC-SP47-03, which is located in the SCADA Panel (SP47).

1.11 MASTER PLC I/O POINTS VIA ETHERNET

A. Motor Control Center MCC-P47

a. The following data points shall be transmitted from the MCC digital customer metering package to PLC-SP47-03 located in SP47 via an Ethernet connection:

i. Electric Service No. 1 Phase A, B & C Voltage (0 to 480VAC)
ii. Electric Service No. 1 Phase A, B & C Amperage (0 to 600 Amps)
iii. Electric Service No. 1 KW
iv. Electric Service No. 1 Max Demand
v. Electric Service No. 1 Power Factor
vi. Electric Service No. 2 Phase A, B & C Voltage (0 to 480VAC)
vii. Electric Service No. 2 Phase A, B & C Amperage (0 to 600 Amps)
viii. Electric Service No. 2 KW
ix. Electric Service No. 2 Max Demand
x. Electric Service No. 2 Power Factor

1.12 PLC I/O POINTS VIA CONTROLNET

A. There are two redundant PLCs, PLC-SP47-01 & PLC-SP47-02, located in SCADA Panel SP47. There is a third PLC, PLC-SP47-03, which is also located in SP47. PLC-SP47-03 contains a redundant controller and power supply. The three PLCs are connected via a redundant ControlNet network configuration. The system requirements call for the following I/O points to be alarmed on the Annunciator Panel located on Control Panel CP47.

a. SCADA Panel PLC Trouble – Alarmed when trouble is sensed for PLC-SP47-01, PLC-SP47-02 or PLC-SP47-03
b. SCADA Panel PLC Failure– Alarmed when PLC-SP47-01, PLC-SP47-02 or PLC-SP47-03 fails.
c. The three PLCs shall monitor the status of the other PLCs. A PLC “Trouble Alarm” shall be triggered for any general fault that is sensed. A PLC “Failure” shall be triggered if it is sensed that a PLC has failed.

B. All I/O data that is monitored or controlled at the Pump Station shall be available for transmission to District 1 Headquarters and the Electrical Maintenance Facility. The data shall be used for the development of Human Machine Interface (HMI) Screens. Refer to Specification Section 40 94 24 – HMI Improvements for additional details.

1.13 SYSTEM DESCRIPTION

A. The following points are not intended to be a comprehensive list of the system's features, only summarize the major functions of the system. The SCADA system specified herein shall perform the following generalized functions:

a. Perform real-time process control, including proportional integral derivative control action, sequencing, process calculations, etc.
b. Collection and store accurate, reliable operating information for present and future uses.
c. Assist plant operating personnel by noting and communicating, off-normal operating conditions and equipment failures.
d. Accumulate and store equipment running times for use in preventative maintenance.
e. Provide color graphic displays and summary reports for use by the plant operating and supervisory personnel.
f. Provide trending for all analog values.
g. Provide control system diagnostics.

B. The system is based on the SCADA system block diagram shown on Plans. The system shall include:

a. Programmable logic controllers (PLCs) with local input/output (I/O)
b. Graphical Interface Panel (GIP)
c. Network Communications
d. Telephone communications
e. Other capabilities as specified herein and shown on the SCADA system block diagram.

C. All process control functions including PID, calculations, sequencing, set points, timing, etc., shall be done in the PLCs.

D. The system shall allow the operator to monitor the status of pumps, valves, etc. (i.e., on-off, open-close, set point value, etc.) when viewing the GIP Screens.

PART 2: PRODUCTS

2.1 SCADA PANEL SP47 (LOCATED IN ELECTRICAL ROOM)

A. The SCADA Panel shall house redundant PLCs, which shall be programmed for monitoring Pump Station operations. The PLCs shall be connected to the PLC located in Control Panel. The PLCs shall interface with an Ethernet switch and telephone modem for communication with District 1 Headquarters and Electrical Maintenance Facility. Refer to the Plans for additional details.

2.2 CONTROL PANEL CP47 (LOCATED IN ELECTRICAL ROOM)

A. The Control Panel shall house discrete relay logic that shall control the starting and stopping of the low flow pump and three main flows to prevent highway flooding. The discrete logic shall be for responsible for control and monitoring functions performed at the Pump Station. The discrete logic shall be interfaced to the PLC-SP47-03 housed in the SCADA Panel. Refer to the Plans for additional details.

2.3 PROGRAMMABLE LOGIC CONTROLLERS

A. An Allan-Bradley programmable logic controller (PLC) system shall be furnished and programmed to operate all functions herein specified. All analog and discrete inputs and outputs shall be provided as necessary. The logic program shall be of universal type architecture and shall not be of a proprietary language. In addition, the programmable controller shall be capable of being monitored from remote facilities via leased telephone lines and an Ethernet Network communication system. The programmable controller equipment supplier shall be responsible for coordinating and providing a complete and properly functioning software package for the control and operation of the equipment as specified herein.

B. The Contractor shall furnish the station operational program. A CD ROM copy and printout of the PLC control program shall be furnished to IDOT at the time of start-up. Disk and printed copy of the operating program shall be maintained on the file with the Contractor.

C. SCADA Panel PLCs PLC-SP47-01 & PLC-SP47-02: The system shall consist of two (2) redundant ControlLogix processors, two (2) ControlLogix System Redundancy Modules, two (2) Control Net communication interfaces, two (2) Ethernet modules, two (2) redundant hot-swappable power supplies, (1) Graphic Interface Panel(GIP), necessary cable assembly, and necessary specialty modules to form a complete system. The PLC shall be Allen-Bradley ControlLogix Redundant System with sufficient memory and I/O capacity to handle monitor and control functions of the system plus 25% spare memory. The PLC shall be mounted in the Electrical Room SCADA Panel SP47 and shall be programmed for monitoring and control functions.

D. SCADA Panel PLC-SP47-03: The system shall consist of a PLC consisting of (2) ControlLogix processors, two (2) Control Net communication interfaces, one(1) Ethernet modules, two (2) redundant hot-swappable power supplies, various analog and digital I/O modules, Communication gateways, necessary cable assembly, and necessary specialty modules to form a complete system. The PLC shall be an Allen-Bradley ControlLogix System with sufficient memory and I/O capacity to handle monitor and control functions of the system plus 25% spare memory and 10% spare I/O. The PLC shall be mounted in the Electrical Room SCADA Panel and shall be programmed for monitoring and control functions. The main processor module shall be capable of accepting additional I/O plug-in modules for expansion.

2.4 PLC PROGRAM DEVELOPMENT SOFTWARE SYSTEM

A. The Contractor shall provide as part of the System a software package to allow off-line or on-line ladder logic program development, annotation and monitoring on an IBM or compatible personnel computer operating under the computer operating system specified herein.

B. The software shall be utilized for development of the ladder logic programs and transfer to the PLC. Provide all PLC configuration required to implement the control strategies specified in this Section and as shown on the Plans.

C. The software package shall be completely menu driven and shall be distributed on standard CD's.

D. All required hardware (including cables, cable adapters, etc.) to allow the PLC's connection to a Standard RS-232-C or USB personal computer port shall be furnished.

E. The software package shall include a software license agreement allowing IDOT the rights to utilize the software as required for any current or future modification, documentation, or development of the PLC's furnished for this project.

F. The software shall provide as a minimum the following functions.

   a. Annotation of all ladder elements with at least 3 lines of 6 characters each.

   b. Annotation of all ladder rungs with at least 240 characters.

   c. Provide visual "power flow" monitoring of circuit elements (when connected to the PLC).

   d. Provide annotated ladder diagram printout for documentation purposes.

   e. On-line help facility.

f. Download or upload ladder program from the PLC to the PC.

g. Provide a ladder element and I/O cross reference table.

h. Provide all monitoring, forcing, programming error detection, searching, configuration, etc., functions as required to allow an operator/programmer to completely program a PLC.

G. Programming software shall be Allen-Bradley RSLogix 5000 for Windows NT. Software shall be suitable for simultaneous operation with the computer based control system software specified herein. Provide means for development software operation without affecting on-line operation of the computer control system.

2.5 PLC PROGRAM SOFTWARE DEVELOPMENT PHASE

A. The Contractor shall provide all PLC programming and configuration of equipment and software to ensure a fully functional system per the Plans and Specifications. Software development shall be coordinated with existing IDOT standards

B. IDOT has standardized common elements of their PLC programming in an effort to have common program elements at all their pump stations. Specific details regarding these programming standards are not provided as part of the specification. As part of the PLC Program Software Development Phase, the detailed requirements for the PLC Programming shall be provided. Refer to Part 3 of this Specification for details regarding the PLC Program Software Development Phase. The Contractor is responsible for providing and developing all software to meet this Specification and to ensure a functional system that meets IDOT's operational requirements.

2.6 GRAPHICAL INTERFACE PANEL (GIP)

A. Provide a graphical interface panel incorporated into the PLC system as shown on the Plans. Graphical interface panel shall be configured to allow operator access to status and control of local processes being monitored by the PLC. Provide all software, hardware, cables, and appurtenances for a fully configured system.

B. Provide industrial grade sealed panel suitable for panel mounting with keypad. Keypad shall include a minimum of 15 user definable panel buttons and 5 user definable control buttons. Provide 15 inch, 1024 x 768 pixel, 18-bit color graphics, active-matrix TFT display.

C. Provide PLC communications interface drivers to allow direct access of the graphical interface panel to the PLC and network. During configuration, the Contractor shall assign specific addressing and input/output access to allow monitoring of the specific local process. Provide a minimum of two configurable serial local ports. Provide a minimum of two configurable serial communication ports.

D. Provide Windows based configuration software with the graphical interface panels. Configuration software shall utilize fill-in-the-blank style structure and support a minimum of 30 control display pages per panel. Control pages shall be stored in non-volatile EEPROM memory. Configuration shall be performed using the POWS device specified herein.

E. Provide screen templates for screen configuration including discrete indicator, analog numeric readout, message text display, graphical analog bar, register table, alarm windows, and control button. Panel software shall allow mixing of custom graphics and templates on any page configuration. Provide variable sizing of templates with no limitation on the number of elements on any alarm page.

F. Provide custom graphic capability for a schematic, graphical representation of the process. Resolution of graphics shall be to the screen pixel level. Custom graphics shall have the ability to be animated including proportional and status color based strategies. Provide a library of pre-developed symbols based on ISA graphical standards.

G. Provide alarm monitoring capabilities with audio output. Alarm buffer shall store a minimum of 100 alarms for scrolling, review, and acknowledgment by the operator using an alarm summary page. Provide alarm acknowledge and audio output silence logic. Alarm audio output shall be adjustable up to 2 watts maximum.

H. Provide capacity for a minimum of 500 text messages.

I. Provide all configuration, transfer and graphics software as required.

J. Unit shall operate from 24V DC power source. Operating temperature range shall be 0-50ºC with 20-80% humidity range, non-condensing. Provide a single Form C alarm fault contact rated a minimum of 1A at 120 VAC. Contact shall be wired into a discrete input of the PLC serving the GIP.

K. Graphical interface panel shall be Allen-Bradley PanelView Plus 1500.

2.7 GIP SOFTWARE CONFIGURATION

A. General: The GIP graphical presentation shall present graphic logic for the PanelView monitor. Specific details of the graphical presentation at the GIP are not necessarily shown on the Plans or described in the Control Descriptions. As part of the GIP Graphical Screen Development Phase, the detailed requirements for the GIP screens shall be defined. Refer to Part 3 of this Specification for details regarding the GIP Graphical Screen Development Phase. The Contractor is responsible for providing and developing all software and graphical interfaces to meet this Specification and to ensure a functional system that meets IDOT's operational requirements.

B. The GIP shall provide the following screens as a minimum. This is a general listing. Additional "drilldown" screens may be required in order to present the graphical details in manner that is conducive to viewing by the operator. The final list of required screens shall be developed during the GIP Graphical Screen Development Phase.

a. Main menu and navigation screens for the GIP screens presented in a general to specific hierarchy.

b. GIP Help screen(s) that summarize operator interface formats, use of function keys, navigational standards, etc.

c. System alarm screen that presents a list of critical system wide alarms. Operator acknowledgment of all system alarms shall be possible at the GIP panel or the Alarm Acknowledge pushbutton located on the Control Panel CP47. Refer to the Plans for additional details.

d. Local alarm screen that presents a list of local process alarms. Operator acknowledgment of all system alarms shall be possible at the GIP panel or the Alarm Acknowledge pushbutton located on the Control Panel CP47.

e. System status screens that summarize the present operational status of the major pump station equipment such as pumps, sluice gates, motorized valves, meters, floats, transducers, etc.

f. Electrical Distribution system one-line showing the status of the (2) Electrical Services, ATS, (2) main circuit breakers, circuit breakers feeding (4) pump motors mounted in the MCC, etc.

g. Customer Metering Screen detailing information gathered via the MCC digital metering equipment and ammeter information for the individual motors.

h. Building Status Screen that provides details on the status of room temperatures, Trash Rack Differential Level, Combustible Gas Alarm Panel, Intrusion Alarm Panel, Fire Alarm Panel, Pavement Flooded Status, Sump Pump Panel, UPS status, PLC Status, etc.

i. GIP Interface Screens shall match to the greatest extent possible IDOT's standard formats used at other pump station installations. Details regarding IDOT's standard formats shall be provided during the GIP Graphical Screen Development Phase.

2.8 ETHERNET DATA SWITCHES

A. Manufacturers:

a. Allen Bradley Stratix 6000 Fixed Managed Switch.

b. Or equal.

B. Features:
   a. Modular Ethernet expandable switch. Locate equipment in enclosure to allow addition of one additional "expansion module" in the future, including sufficient length of DIN rail.

   b. Store and forward switch in compliance with IEEE 802.3.2 priority classes in accordance with IEEE 802.1D, TCP/IP protocol.

   c. As a minimum the switch shall have the following port configuration:

      i. (8) 10/100 Base T Mbps Auto Sensing Copper ports with RJ45 connection.

      ii. (1) 1000 Mbps fiber port

   d. Ambient temperature (operation) - 0ºC to 55 ºC.

   e. Humidity: 10% to 95% non-condensing.

2.9 UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

A. Uninterruptible Power Supplies (UPS) System shall be provided for the SCADA and instrumentation systems as shown on the Plans and specified herein. The UPS shall sustain operation during short-term power failures, and shall provide power for an orderly shutdown to prevent the loss of data during power failure and shall provide isolation between the control system and the plant power system.

B. The UPS shall be a single phase, true on-line, solid unit with microprocessor controlled static inverter, hot pluggable batteries, battery charger, LED display and keypad.

C. Under normal operating conditions, the critical load shall be continuously supplied by the UPS inverter. The battery charger shall maintain a float-charge on the battery. When AC line power fails, or goes out of tolerance, the inverter shall obtain power from the batteries and supply AC power to the loads without interruption.

D. The UPS system shall be sized to sustain 1.5 times the connected full load for a minimum period of 30 minutes in an operating environment of 32ºF to 104ºF. Final UPS sizing is the responsibility of the Contractor.

E. The UPS system shall be lightning and surge tested per ANSI/IEEE C62.41 and shall be capable of reducing an input spike to less than 3 volts on the output for a 2000 to 1 spike attenuation. The UPS system shall have 120 dB common mode and 60 dB Transverse mode noise attenuation.

F. The UPS system shall provide a true separately derived power source as defined in the NEC article 250.30 with output neutral bonded to ground. There shall be no direct connection between input and output and less than 23 pf of effective input to output capacitance.

G. The system input voltage shall be 120 VAC, 60 Hz, single phase. Provide external break before make disconnect switch to allow transition to like power for testing or removal of the UPS.

H. The UPS system output shall be regulated to 120VAC ± 3%, single phase three wire, 60 HZ ± 0.5 HZ over the full dynamic range from no load to full load and low line VAC to high line VAC and low battery voltage to high battery voltage.

I. The UPS system shall provide computer grade sine wave power with 5 percent or less total harmonic distortion.

J. The UPS system capacity shall be rated in volt amperes (VA) while loaded with typical computer grade switch mode power supplies having a power factor of 0.6 to 0.7 and crest factor of 2.7 to 3.5.

K. The UPS system shall have an efficiency of at least 92% when operated from AC line.

L. The UPS system shall have built-in self-diagnostic monitoring capable of monitoring as a minimum AC volts in/out, AC current in/out, battery voltage, VA load, watts, power factor percent of full load, time of day, system hours, inverter hours and projected run time available. Unit shall have relay contacts that close to indicate that the UPS is running on battery power, the UPS battery capacity is running low and the UPS has failed or overloaded.

M. The UPS system shall have a dual track redundant configuration that utilizes either line or inverter output for power and shall be designed to meet or exceed a MTBF of 100,000 hours.

N. The system input voltage shall be 120 VAC, 60 Hz, single phase. Provide external break before make disconnect switch to allow transition to like power for testing or removal of the UPS.

O. Provide hardwired input and output connections or as a minimum provide L5-30P input connection and (4) 5-20R output connections on a 3KVA unit. If larger unit is required, Contractor is responsible for determining input and output configuration to meet application needs.

P. The UPS shall be designed with internal batteries and with the capabilities of adding external batteries to meet power ride-thru requirements. The batteries shall be sealed, no maintenance type rated to provide minimum continuous operation of connected equipment as specified herein.

Q. The Contractor shall provide sizing data on the UPS listing all loads and calculations required for sizing the UPS system. As a minimum a 3 KVA unit shall be provided.

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R. A maintenance bypass switch shall be provided which shall allow for manual transfer of connected load to utility power permitting scheduled maintenance or UPS replacement without discontinuing power to the control panels. The electrical rating and capacity of the bypass switch shall match that of the UPS. Refer to the Plans for additional details regarding the wiring configuration between the UPS and Control Panels.

S. The UPS system shall be as manufactured by Liebert, Oneac, MGE or approved Engineer's equal with output relay card, and extra battery module, if required.

T. The maintenance bypass switch shall be the Liebert MicroPOD or approved Engineer's equal.

2.10 DIRECT ACTING FLOAT SWITCHES

A. Manufacturers:

a. The float switches shall be Model 9G-EF floats as manufactured by Siemens Water Technologies, Control Systems Products

b. Engineer approved equal.

B. Features:

a. Provide required mounting accessories as detailed on the Plans. The floats shall sense water levels as shown on the Plans. The float shall contain a switch which closes or opens its contacts when floating in a horizontal position. Float switch shall not contain Mercury. Float switches shall be suitable for Class 1 Division 2 locations. Provide intrinsically safe barriers as required.

b. Float switch body shall be constructed of Teflon-coated, 20 gauge, 316 stainless steel housing measuring not less than 51/2" (14 cm) in diameter. A long life, high reliability, potted SPST magnetic reed switch rated for not less than 100 VA at up to 250 Volts shall be mounted inside the float and connected to a multi-stranded, 2 conductor plus ground, 16 gauge, CPE jacketed cable. The cord shall have fine strand conductors (not more than 34 gauge) made especially for heavy flexing service. The cable connection point shall be potted in epoxy providing a strong bond to the float and reed switch forming a water/moisture tight connection. A flexible Neoprene sleeve, not less than 1/8" (3.2 mm) thick, shall be provided over the CPE jacketed cable extending not less than 5" (12.7 cm) from the top of the mounting bracket extending down through the cable mounting bracket hinge point to the top of the float switch body, providing cable stress point relief and extended operational life. Heavier gauge cable shall be provided as required to account for voltage drop considerations.

c. A 316 stainless steel flanged cable mounting clamp assembly shall be supplied allowing pipe or cable mounting as specified below. The float cable-mounting bracket shall be flared on both sides providing hinge point stress relief to both sides of the cable.

d. The float switch assembly shall provide a minimum of two pounds of buoyancy in solutions with a specific gravity of 1.0 (water) and shall have an operating temperature rating of-31 to 194 degrees F (-35 to +90 degrees C).

e. Each float shall be provided with sufficient length of cable to allow a direct connection to the junction box or control panel without field splicing as detailed on the Plans.

2.11 IL 59 PAVEMENT FLOODED ALARM SYSTEM

A. A single direct acting float switch shall be mounted in a control cabinet and mounted on retaining Wall W045 for detecting water on IL 59. Refer to the Civil Plans for location of the control cabinet and additional details.

B. Refer to the DIRECT ACTING FLOAT SWITCHED section of this Specification for float switch requirements.

C. The float switch shall be interfaced with Control Panel CP47 located in the Pump Station Electrical Room.

D. The SCADA system will monitor the status of the float switch and provide an alarm when flood conditions are detected.

2.12 WET WELL FLOAT CONTROL SYSTEM

A. The float control system shall include floats, interconnecting integral cable of a length required, and control logic for the functions indicated.

B. Refer to the DIRECT ACTING FLOAT SWITCHES section of this Specification for float switch requirements.

C. The system shall be intrinsically safe for installation in the wet well.

D. The system shall be complete with control logic to provide the contacts for controls and alarm functions indicated.

E. The system shall be complete with all required mounting hardware and accessories.

F. The float system shall be complete with mounting arrangement with a stilling well of adequate size to forestall the attachment of large sections of ice to the floats during cold weather which could then disturb the system mounting. The mounting arrangement shall permit easy removal of the floats and easy realignment when replaced. Submit details for approval by the Engineer prior to installation.

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2.13 WET WELL BUBBLER TYPE LEVEL SENSING SYSTEM

A. Two (2) independent Bubbler Control Panels (BPC47-001 & BPC47-002) shall be provided. Each bubbler level sensing system shall be a self-contained, continuous flow type with a fully integrated pressure sensor capable of monitoring the variations of water level in the Wet Well by sensing back pressure on air sent through a bubbler tube. The bubbler type level sensing system shall be installed in the Electrical Room and mounted as indicated on the Plans. Each bubbler level sensing system shall meet the following criteria:

1. Input voltage into the system shall be 120 VAC, 60 Hz, 1 Phase.

2. A 4-20mA scalable isolated analog output signal proportional to the Wet Well water level shall be provided for integration into the SCADA system.

3. A normally open fault contact indicating a general fault condition with the bubbler system shall be provided for integration into the SCADA system.

4. Each system provided shall have all components contained within a single NEMA 4 enclosure.

5. Pressure range shall be suitable for measurement of the full range of Wet Well operating and alarm levels as indicated in the Project Documents. Pressure accuracy shall be at minimum +/- 1.0% of full scale over temperature range.

6. A RS-232 interface shall be provided for system communications support.

7. Each system shall contain one (1) oil less compressor unit to maintain pressure in an internal tank; with a microprocessor that determines how much pressure is needed in the tank, based on the current head pressure, to produce a constant bubble rate. Bubble rate shall be user selectable from 30 to 120 bubblers per minute.

8. Provide a 0-150 psig pressure gauge to indicate tank pressure.

9. The system shall have a purge feature that is designed to remove any sediment that may collect in or around the outlet of the orifice line. The purge process shall not interfere with level measurement in order to prevent erroneous readings and improper pump calls. The air purge process shall be initiated by the following methods:

    a. Manual push-button operation.

    b. A detection of reduced air flow.

c. A timed purge cycle.

d. Immediately after the system is powered up after loss of power.

10. The system shall have a replaceable air filter/desiccator to limit moisture into the compressor intake air.

11. Orifice lines shall be polyethylene type sized per the manufacturer's requirements.

12. Bubbler type level sensing systems shall be provided by WaterLOG (YSI Incorporated), Digital Control Company, or approved equal.

2.14 TRASH RACK DIFFERENTIAL LEVEL SENSING SYSTEM

A. Two (2) hydrostatic level sensors (LIT-007A and LIT-007B) shall be used to measure water level. Refer to the HYDROSTATIC TYPE LEVELS SENSING SYSTEM Section of this Specification for details regarding the level sensors. LIT-007A shall be mounted upstream of the Trash Rack and LIT-007B shall be mounted downstream of the Trash Rack. Refer to the Plans for additional details regarding the location and mounting requirements for the sensors. A 4-20mA signal proportional to water level shall be produced by each transmitter and those signals shall be fed to Programmable Logic Controller PLC-SP47-03 located in the SCAD Panel. The PLC shall calculate the differential level between the two signals. The PLC shall provide a 4-20mA output proportional to the differential level which shall be fed to a meter mounted on the Control Panel. The PLC shall be programmed to take into account the level offset in the difference in the mounting height of the transducers. The PLC shall provide an alarm when the differential level becomes to great indicating that the trash rack has become clogged. The differential level for this alarm shall be programmable by the operator via the GIP panel mounted on the Control Panel.

2.15 HYDROSTATIC TYPE LEVEL SENSING SYSTEM

A. The hydrostatic type level transmitter shall include an upper and a lower assembly. The lower assembly shall include housing and gauge pressure diaphragm type transducer as specified herein.

B. The hydrostatic type level transmitter upper assembly shall be installed in the Electrical Room and shall house the system signal conditioning and transient protective electronics and connections terminal block. A desiccant type or expansion bag type breathing system shall be installed. A labyrinth seal vent shall be provided on the side to allow atmospheric pressure access to the breathing system. The Upper assembly shall be housed in a NEMA 4 enclosure. A meter assembly shall be provided on the front of the panel for system readout and programming. A 4-20 mA scalable isolated analog output signal proportional to Wet Well water level shall be provided for integration into the SCADA system. The input voltage to the assembly shall be 120 VAC, 60 Hz, 1 Phase.

C. The Connecting Cable between Lower and Upper Assemblies shall consist of ½" O.D., B.F. Goodrich Estane polyurethane jacket, a 3-conductor shielded AWG #16 cable and an integral breather tube which shall form the sealed breathing system between the expansion bag and the Lower Assembly.

D. The liquid level transmitter shall be a 4-20 mADC, 2-wire, 15-40 VDC loop powered type with its output signal directly proportional to the measured level excursion over a factory-calibrated range of zero to 15 ft. of water. The transducer shall be of the solid state head-pressure sensing type, suitable for continuous submergence and operation.

E. The transducer housing shall be fabricated of type 316 stainless steel with a bottom diaphragm 2-5/8" diameter of heavy-duty, limp, foul-free, molded Teflon bonded to a synthetic rubber back/seal. A hydraulic fill liquid behind the diaphragm shall transmit the sensed pressure to a solid STATE variable capacitance transducer element to convert the sensed pressure to a corresponding electrical value. The sensed media shall exert its pressure against the diaphragm which flexes minutely so as to vary the proximity between an internal ceramic diaphragm and a ceramic substrate to vary the capacitance of an electrical field created between two surfaces. A stable, hybrid, operational amplifier assembly shall be incorporated in the transducer to excite and demodulate the sensing mechanism. The transducer shall incorporate laser-trimmed, temperature compensation and high quality components and construction to provide a precise, reliable, stable output signal directly proportional to the sensed pressure over a factory calibrated range.

F. The transducer element shall incorporate high over-pressure protection and be designed to withstand intermittent overpressures five times the full scale range being sensed. Metallic diaphragms and sensing principles employing LVDT's, resistive or pneumatic elements are not considered equal.

G. The transmitter shall include easily accessible zero and span adjustments in the upper assembly. +20% zero and 3 to 100% span adjustment shall be provided, using potentiometer and dip switches. Zero and span adjustments shall be non-interactive for ease of calibration.

H. The internal pressure of the lower transducer assembly shall be relieved to atmospheric pressure through a heavy duty urethane jacketed hose/cable assembly and a slack PVC bellows mounted in the Upper Assembly. The sealed breather system shall compensate for variations in barometric pressure and expansion and contraction of air due to temperature changes and altitude as well as prevent fouling from moisture and other corrosive elements.

I. The level transmitter shall be intrinsically safe or an intrinsically safe barrier shall be provided for mounting in the control panel.

J. The level transmitter shall be mounted as indicated on Plans.

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K. The level transmitter shall be manufactured by Ametek, Druck, Endress Hauser, or approved equal.

2.16 ULTRASONIC CLAMP-ON TYPE FLOW METER

A. The Recirculation Pipe Flow Meter (FT-010), Main Flow Pump No. 1 Flow Meter (FT-001), Main Flow Pump No. 2 (FT-002), Flow Meter, Main Flow Pump No. 3 Flow Meter (FT-003), and the Low Flow Pump Flow Meter (FT-004) must be a clamp-on design precluding the requirement of penetrating into the pipe. The flow meter shall be completely microprocessor based utilizing a compression mode propagation measurement technique. The meters shall be of the size and mounted as indicated on the Plans.

B. The meter shall have remote mounted transducers that permit separation of up to 300 meters using a coaxial or twin axial cable. The transducers shall be rated NEMA 6 (IP 67). Contractor shall be responsible for determining the proper cable length required to connect the transducer mounted on the recirculation pipe and the flow meter mounted on Control Panel CP47 located in the Electrical room. Refer to the Plans for additional details regarding the location of equipment.

C. The flow meter electronics shall be housed in a NEMA Type 4 (IP65) enclosure and powered by 95-264VAC, 50-60Hz. The front panel shall consist of a two line backlit LCD display. The flow meter shall be suitable for panel mounting and shall have the following features as a minimum:

    a. Integral Front Panel Keypad for Programming

    b. Flow Rate Display

    c. Flow Totalizer Display

    d. 4-20 mA Output

    e. 0 to 1,000Hz Rate Pulse and Dual Alarm Outputs

    f. USB Programming Port

    g. RS485 Modbus Network Connection

    h. Remote Totalizer Reset Capability

D. The flor meter electronic assembly shall be intrinsically safe or an intrinsically safe barrier shall be provided.

E. The flow meter shall have an accuracy of ±1% for flows from 4 to 40fps flow range. Repeatability shall be 0.5% of reading and a flow sensitivity of 0.001 fps.

F. The furnished flow meter shall be Spirax Sarco UTM10 or Engineer's Approved equal.

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2.17 PUMP METER CONTROL PANEL

A. The Pump Meter Control Panel (PMCP47)shall be located in the Electrical Room as indicated on the Plans. Provide a NEMA 12 Enclosure. The Individual Main and Low Flow Pump Meters shall be mounted in a the enclosure.

B. Each meter shall be equipped with a 4-20mA output proportional to flow rate. The analog signal shall be wired to the PLC mounted in SCADA Panel. The PLC shall total the individual meter flow rates and produce a 4-20mA signal proportional to the total station flow rate. The signal shall be wired to the Plant Total Flow Meter mounted on CP47. The PLC shall also calculate the station's totalized flow.

C. The following equipment shall be included. This represents the minimum equipment required. Additional equipment may be required base on system operating requirements:

   i. Main Flow Pump No. 1 Flow Meter (FT-001),

   j. Main Flow Pump No. 2 (FT-002),

   k. Flow Meter, Main Flow Pump No. 3 Flow Meter (FT-003)

   l. Low Flow Pump Flow Meter (FT-004)

   m. Intrinsically safe barriers

   n. Equipment Ground Bus

   o. Instrumentation Ground Bus.

   p. Control terminal to support all required I/O plus additional spares.

   q. Power supplies and any other ancillary equipment required to insure proper system.

2.18 MOTOR OPERATED SLIDE GATES

A. Sequence of Operation

   a. The Operator has the flexibility to operate the slide gate either locally at the gate itself or remotely at the motor control center via the Local/Off/Remote selector switch located on the unit. In both Local and Remote operation, the Operator can "Open", "Close" or "Stop" the movement of the gate. Pilot lights are provided both locally and remotely for indicating that the gate is filly open, fully closed or in an intermediate position.

B. Refer to Specification Section 43 20 20, HYDRAULIC GATES, for additional details.

2.19 MOTOR OPERATED VALVES

A. Sequence of Operation

a. The Operator has the flexibility to operate the valve either locally at the valve itself or remotely at Control Panel CP47 via the Local/Off/Remote selector switch located on the unit. In both Local and Remote operation, the Operator can “Open”, “Close” or “Stop” the movement of the valve. Pilot lights are provided both locally and remotely for indicating that the gate is filly open or fully closed.

B. Refer to Specification Section 43 20 10, VALVES AND APPURTENANCES, for additional details.

2.20 AUTOMATIC TRANSFER SWITCH INTERFACE

A. Refer to Specification Section 26 36 23, AUTOMATIC TRANSFER SWITCHES, for additional details.

2.21 FIRE DETECTION AND ALARM INTERFACE

A. Refer to Specification Section 28 35 00, FIRE DETECTION AND ALARM, for additional details.

2.22 COMBUSTIBLE GAS DETECTION SYSTEM INTERFACE

A. Refer to Specification Section 28 35 10, COMBUSTIBLE GAS DETECTION SYSTEM, for additional details.

2.23 SUMP PUMP SYSTEM INTERFACE

A. Refer to Specification Section 43 21 43, SUMP PUMPS, for additional details.

2.24 TELEPHONE MODEMS

A. Provide 56K US Robotics Model 5686

2.25 INTRUSION DETECTION SYSTEM INTERFACE

A. Refer to Specification Section 28 16 11, INTRUSION DETECTION SYSTEM, for additional details.

2.26 PILOT DEVICES AND CONTROL STATION COMPONENTS

A. Manufacturers:

a. Allen Bradley 800T.

b. Square D Class 9001, Type K.

c. Cutler-Hammer 10250T.

B. Construction:

a. Heavy duty.

b. Watertight.

c. Oil-tight.

d. Flush panel mounting

e. Size to mount in 30.5-mm diameter.

f. Match NEMA rating of associated Control Station (see below)

C. Pushbuttons:

a. Flush head unless specified elsewhere.

b. Contact Blocks:

i. Double break silver contacts.

ii. Ac Ratings: 7,200 va make, 720 via break.

iii. Single pole, double throw or double pole, single throw.

iv. Up to six tandem blocks.

c. Momentary contact unless specified elsewhere.

d. Non-illuminated.

e. Legend plates, as required, for type of operation or as specified elsewhere.

D. Pushbuttons – Emergency Stop (ESTOP)

a. Jumbo red mushroom head.

b. Contact Blocks:

i. Double break silver contacts.

ii. Ac Ratings: 7,200 va make, 720 via break.

iii. Single pole, single throw.

iv. Up to six tandem blocks as specified.

c. Push/pull.

d. Maintained contact.

e. Non-illuminated.

f. Legend plates:

i. Extra large.

ii. Red.

iii. “ESTOP”.

E. Selector Switches:

a. Maintained position unless specified elsewhere.

b. Contact Blocks:

i. Double break silver contacts.

ii. Ac Ratings: 7,200 va make, 720 va break.

iii. Contact configuration as specified.

iv. Up to six tandem blocks.

c. Operators:

i. Number of positions as specified elsewhere.

ii. Standard knob type unless specified elsewhere.

d. Legend plates as required for type of operation or specified elsewhere.

F. Pilot Lights:

a. Transformer type.

b. Bayonet, 6 to 8 v bulb.

c. Colored lens as specified elsewhere.

d. Interchangeable lenses.

e. Transformer rated for 120 v, 60 Hz.

f. Push to test.

g. Legend plates as specified elsewhere.

G. Control Stations:

a. Describes enclosures used to house field pilot devices.

b. NEMA ratings:

i. NEMA 7 in Class 1, Division 1 or 2 Hazardous (Classified) Locations.

ii. NEMA 4X 316 stainless steel in indoor wet/corrosive locations or outdoors.

iii. NEMA 12 in other areas.

c. Nameplates:

i. Engraved laminated plastic.

ii. Letters 3/165 in. high.

iii. Black letters on white background.

iv. Identify per equipment controlled, using names found on Plans.

2.27 PROCESS INDICATORS, ELECTRONIC

A. Manufacturers:

a. Precision Digital.

b. Red Lion, IMP.

c. Moore Industries.

B. Features:

a. 4-20mA dc Input.

b. ½ digit LED indicator.

c. Loop powered.

C. Enclosures:

a. Panel mounted as indicated on Plans.

b. For below grade or outdoor installations: NEMA 4X: Impact-resistant polycarbonate body, clear gasketed polycarbonate cover ½" conduit hole in bottom of case.

c. For Explosion Proof installations: NEMA 7 XP: FM approved cast aluminum body, screw-type cast aluminum cover with view port. Two ¾" conduit holes.

d. Provide 2" pipe mounting kit as detailed.

D. Model: PD675-N, NEMA 4X; PD677-N, NEMA 7 XP.

2.28 TEMPERATURE SWITCHES – BUILDING STATUS

A. Manufacturers:

a. Honeywell.

B. Features:

a. Integral temperature indicator.

b. Suitable for wall or ceiling mount.

c. Adjustable high and low temperature setpoints.

d. Dry contacts suitable for connection to PLC Reed Relay input.

2.29 TEMPERATURE SENSORS/TRANSMITTERS

A. Manufacturers:

a. Minco

b. Siemens

c. Honeywell

d. Engineer's approved equal

B. Features:

a. Temperature Sensor/transmitter shall be suitable for temperature ranges between -20 to 125 Degree F.

b. Transmitter shall have 4-20 mA output proportional to ambient temperature and shall be integrated into the SCADA system.

c. Temperature Sensor/transmitter for Electrical Room shall be wall mounted and housed in a NEMA 1 Enclosure.

d. Temperature Sensor/transmitter for Electrical Room shall be wall mounted and housed in an Explosion Proof Enclosure.

e. Units shall be UL Listed.

2.30 CONTROL RELAYS

A. Manufacturers:

a. Potter and Brumfield

b. Struthers Dunn.

B. Operating Data:

a. Pickup Time: 13 ms maximum.

b. Dropout Time: 10 ms maximum.

c. Operating Temperature: - 45ºF to 150ºF.

C. AC Coil:

a. 120 or 2409 vac.

b. Continuous rated.

c. VA inrush maximum.

d. VA sealed, maximum.

e. 50 to 60 Hz.

f. Light to indicate energization
.

g. Minimum Dropout Voltage: 10% of coil rated voltage.

D. DC Coil:

a. 24 or 120 Vdc.

b. Continuous rated.

c. Light to indicate energization.

d. Minimum Coil Resistance:

e. 24 Vdc: 450 Ω.

f. 120 Vdc: 9,000 Ω.

E. Contacts:

a. Gold flashed fine silver, gold diffused for 1 amp or less resistive load.

b. Silver cadmium oxide.

c. form C.

d. 120 vac.

e. 10 amp make, 1.5 amp break (inductive).

f. Rated at 10 million operations.

g. 11 pin, square socket.

h. DIN rail mountable.

i. Enclosed and protected by polycarbonate cover

j. Provide relay-retaining clips.

2.31 TIMERS

A. Interval/Duration Timer (Rear of Panel):

a. Manufacturers:

i. Potter and Brumfield, CN series.

ii. Eagle Signal DM 100 series.

iii. Or equal.

b. Mounting: Plug-in with dust tight cover.

c. Type: Integrated circuit.

d. Range: 0.5 sec to 99 min. Field selectable.

e. Contacts: 2 DPDT contacts rated 10 amp. 120 vac.

f. Power: 120 vac, 60 Hz.

B. Interval/Duration Timer (Front of Panel):

a. Manufacturers:

i. Eagle Signal, CX300 series.

ii. Or equal.

b. Type: Microprocessor.

c. Timing Range: Five ranges from 200 sec to 200-hr field selectable.

d. Contacts: 10 amp, 120 vac.

e. Controls: Membrane switches for operator input.

2.32 TERMINAL BLOCKS

A. Manufacturers:

a. Phoenix Contact.

b. Weidmuller.

c. Or equal.

B. 300 v rating for 120 v circuits and below, 600 v rating for 480 v circuits.

C. Clamping screw type.

D. Isolating end caps for each terminal.

E. Identification on both terminals.

F. Clip-mounted on DIN rail.

G. Accept AWG 12 to 22.

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H. Feed-Through Terminals:

a. 20 Amp rating.

I. Switched Terminals:

a. Knife disconnect with test sockets.

b. 10 Amp rating.

J. Fused Terminals:

a. Hinged fuse removal/disconnect.

b. 10 Amp rating.

c. Include blown fuse indication.

2.33 ELECTRONIC CURRENT ISOLATOR

A. Manufacturers:

a. Phoenix Contact Model MCR Series.

b. Approved Engineer's equal.

B. Features

a. Solid state instrument to electrically isolate one instrument loop from another instrument loop. Converter to accept 4-20mA dc input signal and provide equal but isolated and power-boosted output.

b. Mounting: DIN Rail.

c. Temperature compensated, calibration-free.

d. Signals: Input: 4-20mA dc into 50 ohms. Output: 4-20mA dc into output for up to 500 ohms.

e. Isolation: Common mode up to 700 vac between input and output.

f. Accuracy: 0.5% of span.

g. Provide power supply specific to isolator.

2.34 INTRINSICALLY SAFE BARRIERS AND RELAYS

A. Manufacturers:

a. Gems Safe-Pak or Engineer's approved equal

B. Provide intrinsically single channel safe barriers, dual channel safe barriers and relays as indicated on the Plans and as required to meet NEC requirements for explosion proof applications. All wiring between those rooms identified as Hazardous Locations and Non-Hazardous locations shall be provided with intrinsically safe barrier or relay as the installation calls for.

C. Provide relays with 4NO/4NO auxiliary contacts or as indicated on the Plans. Provide additional contacts as required to meet installation requirements.

2.35 CONTROL PANEL FABRICATION

A. General

a. Refer to Plans for additional details.

b. The panels shall match the general construction of the motor control center and shall be of the same height.

c. The panels shall conform to all application standards of NEMA and ANSI and shall consist of formed steel panels containing equipment and devices as indicated.

d. The panels shall be equipped with space heater(s) as specified for motor control centers.

B. Enclosure

a. The SCADA and Control panels shall be NEMA 12 floor mounted, front accessible only, metal enclosed type, arranged for cable and/or conduit entry from the top, bottom or sides, as required. Panel design shall allow easy access to all internal wiring and appurtenances. Ventilation fan, air filter, thermostatically controlled space heater, light kit and 120V receptacle shall be provided.

b. The enclosure shall be of a height and depth to match the motor control center and of a width sufficient for the equipment to be housed.

c. The panel shall have a full piano hinge door and a 3-point latch with a locking handle. The handle shall have a cylinder type lock keyed to match the IDOT's system. The doors shall have a hinged gasketed door.

d. The enclosure shall be finished inside and out. Exterior color shall match that for the motor control center, and the interior color shall be white or as otherwise approved by the Engineer.

C. Devices and Appurtenances

a. Unless otherwise indicated, pushbuttons, selector switches, indicating lights, relays, and other devices shall be provided as part of the control panel and shall be as specified for motor control centers. Devices similar by those in he motor control center panel shall be of the same manufacturer.

b. Where indicated, certain devices shall be furnished under other Sections of the Specifications for installation under this Section. The control panel manufacturer shall coordinate the arrangement and wiring of these devices for a complete finish assembly. Such devices shall be factory installed by the panel manufacturer.

c. Nameplates shall be white with black lettering and consistent on all panels and devices. Relays and all other devices located inside the panel shall be identified with nameplates.

D. Wiring

a. Wiring shall be brought to terminal strips near the bottom of enclosures and 10 percent spare terminals shall be provided in each. The identification of terminals shall conform to the schematic diagrams and shall consist of adhesive labels as manufactured by Brady, Thomas, or equal.

2.36 CONTROL DEVICES AND WIRING

A. Control devices, local instrument cables and wiring required on the equipment shall be furnished and installed at the factory.

B. All small wiring for control or accessory equipment shall be installed in code approved wireways.

C. Wiring Conventions

a. All wiring shall be of the following minimum.

i. Power wiring to power PLC power supply shall be #12 AWG MTW. PLC chassis shall be connected to the enclosure ground bus with #8 AWG MTW.

ii. Control panel doors shall be connected to the enclosure ground bus with #8 AWG MTW

iii. Single conductor I/O control wiring that is connected to 120VAC control circuits shall be No. 12 AWG MTW, minimum. Single conductor I/O control wiring that is not connected to 120VAC circuits shall be No. 14 AWG MTW, minimum.

The conductor shall be stranded copper for fixed wiring and extra flexible copper for wiring to components that are mounted to a movable surface, i.e. doors or hinged panels. The extra flexible conductors shall have 600 volts, 90 Degree C, polyvinyl chloride insulation with flameproof braid covering, Type TBS or cross-linked polyethylene, Type SIS. The conductor type for fixed mounted components shall be type THHN/THWN, 600 volt, 90 Degree C.

D. Cabling

a. For indoor, Non-Plenum applications analog I/O shall be wired with Belden 8760 or equivalent, single twisted pair, shielded cable. For outdoor and Plenum applications analog I/O shall be wired with Belden 88760 or equivalent, single twisted pair, shielded cable. The drain-wire from each cable shall be connected an isolated ground bus. All shields shall be covered with clear Teflon tubing. The black conductor shall carry the positive signal (+) and the clear conductor shall carry the negative signal (-)

b. Remote I/O (R I/O) communications circuits shall be wired with Belden 9463 or equivalent, twin-axial, shielded cable. Communications wiring shall cross AC conductors at a 90-degree angle. Where communication wiring must run parallel to AC conductors, a minimum of 2” separation must be maintained.

c. All wires and cables that enter or leave the control panel must terminate at a terminal.

2.37 ALARM ANNUNCIATOR PANEL

A. The Alarm Annunciator Panel shall be mounted on Control Panel CP47.

B. Unless otherwise indicated, alarm annuciators shall be of the plug-in relay type and shall be configured of single-alarm modules in an arrangement as indicated on the Plans or as otherwise directed by the Engineer.

C. Each module shall be engraved as indicated on the Plans or as otherwise directed by the Engineer.

D. The relay annunicator modules shall be individually removable from the front of the unit. Input and output terminals shall be accessible from the rear of the unit.

E. Relays shall be hermetically sealed and shall be securely held in place by retaining clips or other means approved by the Engineer. Relays shall have silver/silver alloy contacts rated not less than 2 amperes at 120 volts. Each alarm module shall produce at least one isolated double throw auxiliary contact for remote connection.

F. The annunciator shall operate in a “Sequence A” flashing mode as follows:

a. The control logic selectable to incorporate lock-in or non-lock-in alarm activation. Lock-in selection shall maintain alarm status until the alarm has been acknowledged by depressing the acknowledge pushbutton at the annunciator. Non-lock-in selection shall permit alarm status to return to the normal off condition as soon as the alarm input is cleared.

b. The following chart details the Nameplate status for each given condition.

Condition	**Nameplate Status**
Normal	Off
Alarm	Flashing
Acknowledge	Steady On
Normal (clear)	Off
Lamp Test	Steady On

G. Each alarm window shall be illuminated with not less than two long-life lamps which shall be easily accessible for replacement.

H. Each annunicator shall be complete with an integral flasher unit. Alarm logic, such as for the flasher, shall be solid state. The flasher shall not occupy a designated alarm module, i.e., if twelve alarm positions are shown, all shall be useable for alarms.

I. Unless otherwise indicated, annuciators shall have provisions for an audible alarm and silence upon alarm “acknowledge” condition for possible future addition of an audible alarm.

J. Each unit shall be complete with “ACKNOWLEDGE” and “LAMP TEST” pushbutton functions, with heavy duty oil-tight pushbuttons mounted adjacent to the alarm windows as shown on the Plans.

K. Each unit shall be complete with a flush mounted alarm horn mounted adjacent to the alarm windows as shown on the Plans.

L. Each annunciator shall be equipped with a power monitor relay to monitor the power supply to the unit, complete with a DPDT contact rated not less than 2 amperes at 120 volts for remote connection.

M. Unless otherwise indicated, annunciators shall operate from 20 volt, 60 Hz supply.

N. Unless otherwise indicated, annunciators shall be flush panel mounted.

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O. Blank alarm module units shall be fully equipped for alarms, complete with relays and logic.

P. After power failure all alarm output contacts shall remain in the original positions just before the power failure.

Q. For uniformity among stations, alarm annunciator shall be Ronan Model X3-1000, Panalarm Series 10, DeLine Model 11, or approved equal.

3.1 INSPECTION

A. Verify that field conditions are acceptable and are ready to receive work.

3.2 INSTALLATION

A. The modification, demolition and installation of the SCADA equipment shall be scheduled to minimize interruption of automatic operation and monitoring of the pumping system. The contractor shall submit a detailed schedule for IDOT's approval

B. The Contractor shall install the equipment in strict accordance with the approved Shop Drawings and the equipment manufacturer's recommendations

C. Unload, unpack and transport equipment to prevent damage or loss.

D. Protect from dust and other harmful materials

E. The Contractor shall adjust the location of equipment to accommodate the work in accordance with field conditions encountered.

F. The equipment shall be installed with workspace clearances required by the Code.

G. The equipment shall be installed to permit maintenance and replacement of parts, and shall be clear of all openings with swinging or moving doors, partitions or access panels.

H. Mounting Bases for Floor Mounted Control Panel

1. The Contractor shall install each floor mounted control panel on a concrete housekeeping pad of sufficient with an apron as indicated on the Plans. Control Panel CP47 and SCADA Panel SP47 shall be mounted flush with the MCC mounted in the Electrical Room. Housekeeping pad shall be consistent for all equipment mounted adjacent to one another. The equipment shall be of such construction that when it is installed on the concrete pad there are no openings between the top of the pad and the bottom of the equipment.

2. Each foundation shall be level, stable, and compacted to 95 percent Standard Proctor.
3. Entryways or conduit locations shall be in accordance with manufacturer's approved Shop Drawings.

I. Wall Mounted Control Panels

1. Each wall mounted control panel shall be supported and mounted away from the wall with "C" shaped channel. The minimum separation between the equipment and the wall shall be 1 inch.

2. Each control panel shall be mounted with the top a maximum of 6' - 6" above the finished floor

J. Install in accordance with manufacturer's instructions.

K. Replace damaged components as directed by Engineer.

L. Provide all required cables, cords, and connective devices for interface with other control system components.

M. Field signal wiring and cables under this SECTION shall be installed in conduit.

3.3 INSTALLATION OF INTRINSICALLY SAFE BARRIERS AND RELAYS

A. Field wiring of intrinsically safe circuits is to be segregated from non-intrinsically safe wiring by use of suitable barriers, separate wireways or trays. Wire insulation to be .010" minimum.

B. Intrinsically safe and non-intrinsically safe connection points should be located sufficiently apart to prevent any possibility of bypassing or miswiring during installation or servicing of equipment.

C. The enclosure shall contain a cautionary statement as follows: "CAUTION: ANY SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY".

D. The device mounting bracket must be grounded to insure intrinsic safety. Resistance between bracket and ground electrode should be below one ohm. refer to Article 250 of the National Electrical Code for methods and practices.

E. Non-intrinsically safe wiring cannot be run in conduit or open raceways together with intrinsically safe wiring.

3.4 PLC PROGRAM SOFTWARE AND GIP GRAPHICAL SCREEN DEVELOPMENT PHASE

A. PLC software programming and GIP graphical screen development meetings must be conducted with the IDOT to ensure all operational and maintenance requirements are met. The following meetings are required:

1. Meeting No. 1 – Design Review

a. Meeting No. 1 is to be conducted at an IDOT location. A minimum of (1) 8-hour day must be allotted for this meeting.
b. The meeting is to include, but not limited to the following:

i. IDOT's presentation of standardized PLC software programming elements

ii. An overview presentation of the manufacturer's GIP graphical screens

iii. Detailed overview of SCADA and control requirements

iv. Detailed overview of operational requirements

v. Detailed overview of proposed facility requirements

c. IDOT will provide CAD drawings of the project for use in GIP Screen development.

d. IDOT will provide electronic copy of programming software of standardized elements for the Contractor to use as a base in his software development.

e. The meeting must produce the following documents to aid the GIP screen software development:

i. A detailed list of GIP screens that are to be developed

ii. A written description of each that is to be developed

iii. A general color scheme for graphics

iv. Meeting minutes

2. Meeting No. 2 – 35% Design Completion

a. Meeting No. 2 is to be conducted at an IDOT location. A minimum of one (1) eight-hour day must be allotted for this meeting.

b. Contractor must review all requirements discussed with IDOT during Meeting No. 1.

c. The Contractor must present the preliminary PLC software programming. IDOT will provide comments regarding the presented material for incorporation into the PLC programming design. The requirements for Contractor's 90% Design Completion are to be established

d. The Contractor must present the preliminary GIP screen graphics. IDOT will provide comments regarding the presented material for incorporation into the GIP design. The requirements for Contractor's 90% Design Completion are to be established.

3. Meeting No. 3 – 90% Design Completion
   a. Meeting No. 3 is to be conducted at an IDOT location. A minimum of 4 hours must be allotted for this meeting.

b. Contractor must incorporate all required changes requested by IDOT during Meeting No. 2.

c. The level of completion must meet the 90% design requirements established at Meeting No. 2.

d. The Contractor must present a demonstration of the actual software operation to IDOT. A minimum of eight copies of the CD containing the software programming as presented in the meeting must be provided to IDOT. IDOT will review the information and provide written comments to the Contractor.

e. The Contractor must present a demonstration of the actual operation of GIP graphics to IDOT. A minimum of eight copies of the CD containing the GIP graphical screens as presented in the meeting must be provided to IDOT. IDOT will review the information and provide written comments to the Contractor.

4. Meeting No. 4

a. Meeting 4 is to be conducted during Factory Acceptance Testing as detailed below.

b. Contractor must incorporate all required changes requested by the IDOT during Meeting No. 3.

c. The final executable version of the PLC software program must be presented. Upon review by IDOT, minor changes must be allowed during the Factory Acceptance Testing.

d. The final executable version of the GIP screen graphics must be presented. Upon review by IDOT, minor changes must be allowed during the Factory Acceptance Testing.

e. Contractor must provide detailed minutes of meeting to all individuals whom attended the meetings.

3.5 FACTORY ACCEPTANCE TESTING (FAT)

B. The assembled control equipment, wiring and connections shall be tested in the factory. A full functional test shall be applied to each control panel. The manufacturer shall demonstrate to IDOT that each panel and/or group of panels properly function as designed and accepted.

C. The Contractor shall be able to simulate the SCADA system within his facility. Shop testing shall include, but not necessarily be limited to, the following:

1. Manually fill-in required additions to database
2. Manual forcing of outputs

3. Operation of the control programs

4. Recall of simulated data points on the displays and printers

5. Recall of all reports with partial fill-in data and manual fill-in data at time of testing

6. Routing testing of logger, alarm printer and LCD displays based upon manual input data

7. Change of alarm and limit setpoints, etc., and observation of results

8. Any additional testing which may be found to be necessary at the time the above is observed.

9. During the Factory Acceptance Test, minor software adjustments must be finalized and incorporated into the final system.

10. All necessary contact and analog inputs must be provided to permit satisfactory testing of the above.

D. The Contractor must provide to IDOT a Factory Acceptance Test Plan and schedule forty-five (45) days before the scheduled Factory Acceptance Test. IDOT will review the Factory Acceptance Test Plan and schedule for content and reserves the right to make changes. The Contractor must provide the Director a copy of the final Factory Acceptance Test Plan and schedule ten (10) working days before the Factory Acceptance Test. The Contractor will be expected to do all necessary pretrial testing and debugging to ascertain that the system is in running order.

E. At a minimum, the Factory Acceptance Test must allow for two (2) days of testing and review, but may require additional time depending on the results of the testing.

F. IDOT reserves the right to be present for the Factory Acceptance Testing. The Contractor must include the costs of setting up and performing the test including the cost for transportation and lodging for up to two (2) of IDOT's representatives.

G. During shop testing, the Contractor shall generate hard copy prints of all reports and graphics, indexes and point I.D.'s on both printer and LCD monitor for submittal, review and correction. A certified letter that the listed shop tests have been performed shall be submitted. IDOT reserves the right to be present when shop tests are run.

3.6 FIELD QUALITY CONTROL

A. Field Service:
   1. The control panel equipment manufacturer(s) shall provide a qualified factory trained service engineer to provide technical direction for the installation and final adjustments of the equipment. As a minimum, the following shall be performed:

a. Inspect wiring, components, connections, and equipment installation.

b. Assist in field testing of equipment.

c. Install and test SCADA software.

d. Install and test SCADA application.

e. Report results in writing

2. The service engineer shall certify that the equipment has been installed in accordance with the equipment manufacturer's recommendations.

3. The service engineer shall be available for a minimum of two, 8-hour working days.

B. Installation and Start-Up:

1. The Contractor shall develop a specific plan for the startup of the new SCADA system and for cutover of control to the new system. No startup or cutover activities shall be performed until the plan has been successfully approved by the Engineer.

2. Coordinate so that all control panels, instrumentation, etc. provided under separate specifications are installed, integrated re ready for field testing.

3. The Contractor shall correct or rectify any deficiencies that are noted during field testing at no additional cost to IDOT.

3.7 SITE ACCEPTANCE TESTING

A. A Site Acceptance Test of the functions, software, and performance shall be conducted after all system elements have been installed and a complete checkout of all I/O points has been completed. The system site tests shall be performed to verify complete operation of the system, requiring a repeat of much of the comprehensive Factory Acceptance Test but with the equipment installed at the permanent sites, and shall include additional tests required to verify field installed equipment, which was not available during the FAT. The SCADA System Provider shall:

1. Verify all the facility installations

2. Demonstrate each functional requirement identified by the specification. This demonstration shall repeat the tests used during FAT, but using real rather than simulated conditions

3. Demonstrate all equipment control functions, including the operation of automatic control strategies. Actuation of field devices shall be closely coordinated with facility operations
4. Verify system performance parameters and system responses under field operational conditions.

5. Verify accuracy of documentation, especially operator's manuals, software documentation, and general system operating instructions

B. The SCADA System Provider shall provide the appropriate technical representatives for the execution of the Site Acceptance Test. The SCADA System Provider's test support personnel shall be qualified to resolve and correct problems encountered with the system during the tests. In addition to test support personnel, the SCADA System Provider shall provide all test instruments and equipment necessary to troubleshoot any of the SCADA System Provider's proposed system problems encountered. The Engineer reserves the right to increase the requirements for test support personnel if support by the SCADA System Provider is inadequate.

C. Final Acceptance Testing

1. Satisfactory operation of the work by IDOT shall be interpreted to mean that the work is sufficiently advanced to form a reliable system for system operation; the I/O control loops, software, control programs and peripheral equipment are operating properly; the necessary debugging programs have been performed; data output is reliable and control loops are operational. Equipment which was found to be ineffective or inoperable has been returned or replaced, and checking and calibrating of systems has been completed.

2. Final acceptance test will be run for 40 days within which cumulative major component down time, consisting of the computer systems and the PLC's, does not exceed 8 hours. Repeat test if 8 hour limit is exceeded.

3. Written acceptance by IDOT shall be the starting date of the guarantee period.

3.8 TRAINING

A. Operational Training

1. Operator training shall be provided at IDOT's facility concurrently with system installation on a prearranged formalized basis and shall include the necessary training aids in conjunction with actual work on the equipment supplied. Work shall include complete review of all operating and training manuals and physical application.

2. Training shall include operation of the SCADA system, set up the changes of control logic and set points, initiation of diagnostic routine, set up and revisions of graphic and report format, system shutdown and restart, etc. It shall also include care, maintenance and tuning of the monitor and screens.

3. Upon completion of this program, the operators shall be capable of operating the processor equipment, peripherals and I/O equipment to monitor and control the process, system shutdown and restart, diagnose system failure and to initiate routine switch over procedures and component replacement.
4. This training shall consist of a minimum of two (2) 3 day (8 hours per day) classes for 2 persons in each class. Training manuals shall be provided.

B. Programming Training

1. The Contractor shall make arrangement for two persons from IDOT District 1 to attend software manufacturers' regular programming classes held by the manufacturers or their representatives. The class shall not be less than 1 week for SCADA GIP software and 1 week for PLC programming (Allen-Bradley PLC). The training course fee shall be paid for by the Contractor. The manufacturer shall have regular training facilities within 40 miles of the Pumping Station.

C. Maintenance Training

1. The Contractor shall provide two 1-day on-site maintenance training classes for 2 persons in each class. The maintenance training may be combined with the OPERATOR TRAINING.

END OF SECTION 40 94 23

Revised 06/06/12

DIVISION 40

SECTION 40 94 24 – HMI IMPROVEMENTS

PART 1 - GENERAL

1.1 SCOPE OF SERVICES

A. The requirements of the Special Provisions and Division 1, General Requirements, shall apply to all SCADA SYSTEM described herein.

B. The proposed Pump Station SCADA System shall be remotely monitored at District 1 Headquarters and the Electrical Maintenance Facility via Ethernet network and telephone communications. Each location currently monitors the current pump station, as well as, the other IDOT pump stations. Currently, Allen Bradley RSView is the Human Machine Interface (HMI) software that is installed at the workstations at these locations and is the means in which the operators monitor the pump stations.

C. The work under this section includes the software development, installation, integration and testing of the HMI screens for the proposed pump station at both locations. IDOT's Electrical Maintenance Contractor shall be responsible for performing the work.

D. Contractor is responsible for all necessary coordination with the Electrical Maintenance Contractor required for ensuring the proper functioning of the remote monitoring systems.

1.2 RELATED SECTION

A. Section 40 94 23 – SCADA System

1.4 SUBMITTALS

A. Submit product data, shop drawings, project documentation, system descriptions, Analog and Digitla I/O List, Digital I/O addresses for interfacing to remote locations, O & M Data and record documents in accordance with the provisions of Section 1A and the following specific information.

B. Field test results of all I/O points verifying functionality for remote monitoring. Provide PLC I/O addresses for network monitoring from remote locations.

C. Copies of the following Product Data shall be provided to the EMC so that the makeup of the SCADA system can be understood and all PLC data points can be identified for development of the HMI software.

   a. Bill of Material: List all the materials and equipment to be furnished. Tag number, manufacturer's complete catalog number, service, location, and cross-reference numbers of instruction sheet, specification data sheet and wiring diagram shall be included under each item.

b. Specification Data and Drawings: Furnish instrument specification data sheet as per ISA standard instrument specification form, if applicable, wiring and/or connection diagram, outline dimensions, installation diagram and manufacturer's catalog for each instrument. A common set of drawings with setting and/or scale individually listed may be furnished for instruments with identical specification except setting and/or scale.

D. System Diagrams

a. Instrument Loop Diagram: Show all analog and digital loops for all instrument sensors, secondary instruments, I/O functions, alarms, control and displays using ISA standard symbols per ISA Standard S5.4.

b. SCADA System Block Diagram: Show system hardware configuration and identify model numbers of each system component.

E. Software Documentation

a. Submit system software, application software, graphic pages and report forms in prints. Software, application programs, ladder diagrams and control logics shall also be submitted in 740MB CD-R.

F. Instruction Manuals

a. Submit instruction manuals covering installation, operation, calibration, maintenance, diagnostic and repair for all hardware and software.

G. Record Documents

a. Accurately record actual calibration setting and scales of instruments.

1.5 BASIS OF PAYMENT

A. Payment for the work specified under this Section and as required shall be paid for under Article 109.04 of IDOT’s Standard Specifications for Road and Bridge Construction.

END OF SECTION 40 94 24

Revised 06/06/12

ENGINEER'S FIELD OFFICE TYPE A (SPECIAL)

670.02 Engineer's Field Office Type A. Revise the first paragraph of this Article to read:

Engineer's Field Office Type A (Special). Type A (Special) field offices shall have a ceiling height of not less than 2 m (7 ft.) and a floor space of not less than 4000 sq. ft. with a minimum of three separate offices. The office shall also have a separate storage room capable of being locked for the storage of the nuclear measuring devices. The office shall be provided with sufficient heat, natural and artificial light, and air conditioning. Doors and windows shall be equipped with locks approved by the Engineer.

Revise the first sentence of the second paragraph of this Article to read:

The office shall have an electronic security system that will respond to any breach of exterior doors and windows with an on-site alarm shall be provided.

Revise the second sentence of the third paragraph of this Article to read:

Adequate all-weather parking space shall be available to accommodate a minimum of 25 vehicles.

Add the following to the fourth paragraph of this Article:

A weekly cleaning service for the office shall be provided.

Revise the second sentence of the fifth paragraph of this Article to read:

Provide solid waste disposal, consisting of twenty waste baskets and an outside trash container of sufficient size, to accommodate a weekly provided pick-up service.

Revise subparagraph (a) of this Article to read:

(a) Twenty four (24) desks with minimum working surface (60 in. x 30 in.) each and twenty four (24) non-folding chairs with upholstered seats and backs.

Revise subparagraph (b) of this Article to read:

(b) Two desks with minimum working surface 1.1m x 750mm (42 in. x 30 in) each with height adjustment of 23 in. to 30 in. for computer use.

Revise the first sentence of subparagraph (c) of this Article to read:

(c) Two four-post drafting table with minimum top size of 950 mm x 1.2 m (37 ½ in. x 48 in.) with adjustable height drafting stools.

Added 06/06/12

Revise subparagraph (d) of this Article to read:

(d) Twelve (12) free standing four drawer file cabinets with lock and twelve (12) underwriters' laboratories insulated file devices with 350 degrees one hour rating.

Revise subparagraph (e) of this Article to read:

(e) Ten folding tables (8 foot) and Twenty four (24) folding chairs.

Revise subparagraph (f) of this Article to read:

(f) Two equipment cabinets of minimum inside dimension of 44 in. high x 24 in. wide x 30 in. deep with lock. The walls shall be of steel with a 3/32 in. minimum thickness with concealed hinges and enclosed lock constructed in such a manner as to prevent entry by force. The cabinet assembly shall be permanently attached to a structural element of the field office in a manner to prevent theft of the entire cabinet.

Revise subparagraph (g) of this Article to read:

(g) Two refrigerators with a minimum size of 16 cu. Ft. with a freezer unit.

Revise subparagraph (h) of this Article to read:

(h) Two electric desk type tape printing calculator and two pocket scientific notation calculators with a 1000 hour battery life or with a portable recharger.

Revise subparagraph (i) of this Article to read:

(1) Internet Connection. An internet service connection using telephone DSL, cable broadband, or CDMA wireless technology. Additionally, an 802.11b/N wireless router shall be provided, which will allow connection by the Engineer and up to four Department staff.

(2) Six telephone lines including one line for the fax machine, and two lines for the exclusive use of the Engineer.

Revise subparagraph (j) of this Article to read:

(j) 1 dry process copy machine capable of reproducing prints up to 280 mm x 430 mm (11 in. x 17 in.) from nontransparent master sheets, as black or blue lines on white paper, including maintenance, reproduction paper, activating agent and power source.

Revise subparagraph (k) of this Article to read:

(k) One plain paper fax machine including maintenance and supplies.

Added 06/06/12

Revise subparagraph (l) of this Article to read:

(l) Six telephones, with touch tone, where available, two digital telephone answering machines.

Add the following subparagraphs to this Article:

(s) Four (4) 1.2m x 1.8m (4 ft. x 6 ft.) chalkboard or dry erase board.

(t) One office type conference table with a minimum size of 5 foot x 16 foot (or approved equivalent)

(u) Three plan racks capable of holding multiple sets of full size plans.

(v) A color scanner capable of scanning 11 x 17 plan sheets and producing PDF files for electronic transfer/submittal.

670.07 Basis of Payment. Revise the fourth sentence of the first paragraph of this Article to read:

The building or buildings fully equipped, will be paid for at the contract unit price per calendar month or fraction thereof for ENGINEER'S FIELD OFFICE TYPE A (SPECIAL).

REMOVAL AND DISPOSAL OF REGULATED SUBSTANCES

This work shall be according to Section 669 of the Standard Specifications and the following:

Revise the second and third sentence of the first paragraph of Article 669.08 to read: "The affected area shall be monitored with a photo ionization detector (PID) utilizing a lamp of 10.6 eV or greater or an instrument with a flame ionization detector (FID). Any reading on the PID or FID in excess of background levels indicates the potential presence of contaminated material requiring it to be properly managed as either a non-special waste, non-hazardous special waste, or hazardous waste."

Revise the fourth and fifth sentence of the second paragraph of Article 669.08 to read: "When the analytical results indicate that detected levels are at or below the most stringent maximum allowable concentration (MAC) for chemical constituents in uncontaminated soil established pursuant to the proposed Subpart F of 35 Illinois Administrative Code (IAC) 1100.605, the soil excavated shall be included in the storm sewer or earth excavation, as appropriate, and backfill shall be in accordance to Article 205 and/or 208. When the analytical results indicate that detected levels are above the most stringent MAC for chemical constituents in uncontaminated soil established pursuant to the proposed Subpart F of 35 IAC 1100.605, the soil excavated shall be considered a waste and managed appropriately."

Qualifications. The term environmental firm shall mean an environmental firm with at least five (5) documented leaking underground storage tank (LUST) cleanups or that is pre-qualified in hazardous waste by the Department. Documentation includes but not limited to verifying remediation and special waste operations for sites contaminated with gasoline, diesel, or waste oil in accordance with all Federal, State, or local regulatory requirements and shall be provided to the Engineer for approval.

Added 06/06/12

The environmental firm selected shall not be a former or current consultant or have any ties with any of the properties contained within and/or adjacent to this construction project.

General. This Special Provision will likely require the Contractor to subcontract for the execution of certain activities.

All contaminated materials shall be managed as either "uncontaminated soil" or non-special waste. This work shall include monitoring and potential sampling, analytical testing, and management of a material contaminated by regulated substances. The Environmental Firm shall continuously monitor all soil excavation for worker protection and soil contamination. **Phase I Preliminary Engineering information is available through the District's Environmental Studies Unit.**

A) The Contractor shall manage any excavated soils and sediment **within the construction limits of this project as fill.** Although the soil concentrations may exceed the Maximum Allowable Concentrations (MACs) of Chemical Constituents in Uncontaminated Soils, they can be utilized within the construction limits as fill. All storm sewer excavated soils can be placed back into the excavated trench as backfill unless trench backfill is specified. If the soils cannot be utilized within the construction limits as fill then they must be managed off-site as a non-special waste. The following areas can be managed within the construction limits as fill.

1. Station 3962+00 to Station 3964+40 0 to 100 feet LT (IDOT Pump Station, Site 1496V2-71, 315 IL 59) – non-special waste. Contaminants of concern sampling parameters: PNAs and Lead.

REMOVAL AND DISPOSAL OF REGULATED SUBSTANCES (BDE)
Effective: January 1, 2012

Revise Article 669.01 of the Standard Specifications to read:

"**669.01 Description.** This work shall consist of the transportation and proper disposal of contaminated soil and water. This work shall also consist of the removal, transportation, and proper disposal of underground storage tanks (UST), their content and associated underground piping to the point where the piping is above the ground, including determining the content types and estimated quantities."

Revise the second paragraph of Article 669.16 of the Standard Specifications to read:

"The transportation and disposal of soil and other materials from an excavation determined to be contaminated will be paid for at the contract unit price per cubic yard (cubic meter) for NON-SPECIAL WASTE DISPOSAL, SPECIAL WASTE DISPOSAL, or HAZARDOUS WASTE DISPOSAL."

FIELD SPLICING OF PILES

The cost of any field splices required due to the high-voltage overhead electric lines will not be paid for separately, but shall be included in the cost of "Furnishing Soldier Piles" of the type specified.

Added 06/06/12

ATTACHMENT 1-I/O TABLE FOR PROGRAMMABLE LOGIC CONTROLLER (PLC-SP47-03) LOCATED IN SCADA PANEL (SP47)

FAP 338 (IL Route 59)
Project ACNHF-0338(044)
Section 2011-035-I
DuPage County
Contract 60P41

ATTACHMENT 1

I/O TABLE FOR PROGRAMMABLE LOGIC CONTROLLER (PLC-SP47-03) LOCATED IN SCADA PANEL (SP47)

The Input and Output (I/O) List reflects the minimum requirements and is not limited to the listed items. The I/O List shall accommodate input and output signals that are required or available based on the specific selected vendor and equipment. Additional I/O shall be provided to ensure proper operation. Provide an additional 10% spare I/O of each type.

DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
MFP-1 CALLED FOR			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 CIRCUIT BREAKER TRIPPED			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 FAILURE			1		Control Panel	SCADA Panel	
MFP-1 FLOAT CALL			1		Control Panel	SCADA Panel	
MFP-1 HIGH TEMP			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 HIGH TEMP/MOISTURE PROTECTION IN BYPASS MODE			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 IN AUTO MODE			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 MOISTURE SENSED			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 NOT RUNNING			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 RUNNING			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 RVSS FAIL			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 RVSS OVERLOAD TRIP			1		MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
FLOAT CONTROL ACTIVATED			1		Control Panel	SCADA Panel	
MAIN FLOW PUMP FAILURE			1		Control Panel	SCADA Panel	
MAIN FLOW PUMPS FAIL TO STOP			1		Control Panel	SCADA Panel	
MFP-2 CALLED FOR			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
MFP-2 CIRCUIT BREAKER TRIPPED			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
CONTROL PANEL A/C POWER AVAILABLE			1		Control Panel	SCADA Panel	
MFP-2 FAILURE			1		Control Panel	SCADA Panel	MFP-2 is located in MCC
MFP-2 FLOAT CALL			1		Control Panel	SCADA Panel	MFP-2 is located in MCC
MFP-2 HIGH TEMP			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
MFP-2 HIGH TEMP/MOISTURE PROTECTION IN BYPASS MODE			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
MFP-2 IN AUTO MODE			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
MFP-2 IN MANUAL MODE			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
MFP-2 MOISTURE SENSED			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
MFP-2 NOT RUNNING			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
MFP-2 RUNNING			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC

Added 06/06/12

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DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
MFP-2 RVSS FAIL			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
MFP-2 RVSS OVERLOAD TRIP			1		MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC
SF-1 IN AUTO MODE			1		SF-1 Starter	SCADA Panel	SF-1 is located in MCC
SF-1 IN HAND MODE			1		SF-1 Starter	SCADA Panel	SF-1 is located in MCC
SF-1 MOTOR OIL			1		SF-1 Starter	SCADA Panel	SF-1 is located in MCC
SF-1 RUNNING			1		SF-1 Starter	SCADA Panel	SF-1 is located in MCC
MFP-3 CALLED FOR			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 CIRCUIT BREAKER TRIPPED			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 FAILURE			1		Control Panel	SCADA Panel	
MFP-3 FLOAT CALL			1		Control Panel	SCADA Panel	
MFP-3 HIGH TEMP			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 HIGH TEMP/ MOISTURE PROTECTION IN BYPASS MODE			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 IN AUTO MODE			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 IN MANUAL MODE			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 MOISTURE SENSED			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 NOT RUNNING			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 RUNNING			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 RVSS FAIL			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
MFP-3 RVSS OVERLOAD TRIP			1		MFP-3 Starter	SCADA Panel	MFP-3 is located in MCC
SF-2 IN AUTO MODE			1		SF-2 Starter	SCADA Panel	SF-2 is located in MCC
SF-2 IN HAND MODE			1		SF-2 Starter	SCADA Panel	SF-2 is located in MCC
SF-2 MOTOR OL			1		SF-2 Starter	SCADA Panel	SF-2 is located in MCC
SF-2 RUNNING			1		SF-2 Starter	SCADA Panel	SF-2 is located in MCC
LFP-4 RUNNING			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 NOT RUNNING			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 CIRCUIT BREAKER TRIPPED			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 HIGH TEMP			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 MOISTURE SENSED			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 RVSS FAIL			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC

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DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
LFP-4 IN MANUAL MODE			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 IN AUTO MODE			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 FLOAT CALL			1		Control Panel	SCADA Panel	
LFP-4 CALLED FOR			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 HIGH TEMP/ MOISTURE PROTECTION IN BYPASS MODE			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LFP-4 RVSS OVERLOAD TRIP			1		LFP-4 Starter	SCADA Panel	LFP-4 is located in MCC
LOW FLOW PUMP FAILURE			1		Control Panel	SCADA Panel	
			1				
EF-3 IN HAND MODE			1		EF-3 Starter	SCADA Panel	EF-3 is located in MCC
EF-3 IN AUTO MODE			1		EF-3 Starter	SCADA Panel	EF-3 is located in MCC
EF-3 MOTOR OL			1		EF-3 Starter	SCADA Panel	EF-3 is located in MCC
EF-3 RUNNING			1		EF-3 Starter	SCADA Panel	EF-3 is located in MCC
DISCHARGE CHAMBER HIGH WATER LEVEL - LSH-011			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel
PAVEMENT FLOODED ALARM - LSH-500			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel
SCREENING CHAMBER SLIDE GATE FULLY OPENED - ZSO-006			1		Slide Gate Actuator	SCADA Panel	Field Device
SCREENING CHAMBER SLIDE GATE FULLY CLOSED ZSC-006			1		Slide Gate Actuator	SCADA Panel	Field Device
SCREENING CHAMBER SLIDE GATE INTERMEDIATE POSITION - ZSI-006			1		Slide Gate Actuator	SCADA Panel	Field Device
DISCHARGE CHAMBER SLIDE GATE INTERMEDIATE POSITION - ZSO-012			1		Slide Gate Actuator	SCADA Panel	Field Device
DISCHARGE CHAMBER SLIDE GATE FULLY OPENED - ZSC-012			1		Slide Gate Actuator	SCADA Panel	Field Device
DISCHARGE CHAMBER SLIDE GATE FULLY CLOSED - ZSI-012			1		Slide Gate Actuator	SCADA Panel	Field Device

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DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
COMBUSTIBLE GAS MONITORING SYSTEM ALARM (20% LEL)			1		Gas Monitoring Panel (GM-1)	SCADA Panel	
COMBUSTIBLE GAS MONITORING SYSTEM ALARM (50% LEL)			1		Gas Monitoring Panel (GM-1)	SCADA Panel	
COMBUSTIBLE GAS MONITORING SYSTEM TROUBLE			1		Gas Monitoring Panel (GM-1)	SCADA Panel	
FIRE ALARM PANEL ALARM			1		Fire Alarm Control Panel (FACP)	SCADA Panel	
FIRE ALARM PANEL TROUBLE			1		Fire Alarm Control Panel (FACP)	SCADA Panel	
PRIMARY BUBBLER SYSTEM FAILURE			1		Primary Bubbler Control Panel (BCP47-001)	SCADA Panel	
SCADA PANEL A/C CONTROL POWER FAILURE			1		SCADA Panel	SCADA Panel	
MFP-1 IN STANDBY			1		Control Panel	SCADA Panel	Selector Switch Mounted On Control Panel
MFP-2 IN STANDBY			1		Control Panel	SCADA Panel	Selector Switch Mounted On Control Panel
MFP-3 IN STANDBY			1		Control Panel	SCADA Panel	Selector Switch Mounted On Control Panel
WET WELL HIGH WATER ALARM FLOAT SWITCH (LSH-008) CLOSED			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel
LAG PUMP START FLOAT SWITCH (LS-008D) CLOSED			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel

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DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
LEAD PUMP START/LOW FLOW PUMP STOP FLOAT SWITCH (LS-008C) CLOSED			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel
LOW FLOW PUMP START FLOAT SWITCH (LS-008B) CLOSED			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel
MAIN FLOW PUMPS RUN INHIBIT FLOAT SWITCH (LS-008A) CLOSED			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel
LOW FLOW PUMP FLOAT SWITCH (LS-008) CLOSED			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel
WET WELL LOW WATER ALARM FLOAT SWITCH (LSL-008) CLOSED			1		Control Panel	SCADA Panel	Field Device Wired to Control Panel
OPERATING VIA SERVICE NO.1			1		ATS	SCADA Panel	
OPERATING VIA SERVICE NO.2			1		ATS	SCADA Panel	
SERVICE NO. 1 POWER FAILURE			1		ATS	SCADA Panel	
SERVICE NO. 2 POWER FAILURE			1		ATS	SCADA Panel	
ATS FAILURE			1		ATS	SCADA Panel	
ATS IN BYPASS MODE			1		ATS	SCADA Panel	
SERVICE NO. 1 MAIN BREAKER CLOSED			1		Switchboard	SCADA Panel	
SERVICE NO. 1 MAIN BREAKER OPEN			1		Switchboard	SCADA Panel	
SERVICE NO. 1 MAIN BREAKER TRIPPED			1		Switchboard	SCADA Panel	
SERVICE NO. 2 MAIN BREAKER CLOSED			1		Switchboard	SCADA Panel	
SERVICE NO. 2 MAIN BREAKER OPEN			1		Switchboard	SCADA Panel	
SERVICE NO. 2 MAIN BREAKER TRIPPED			1		Switchboard	SCADA Panel	

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ATTACHMENT 1

I/O TABLE FOR PROGRAMMABLE LOGIC CONTROLLER (PLC-SP47-03) LOCATED IN SCADA PANEL (SP47)

The Input and Output (I/O) List reflects the minimum requirements and is not limited to the listed items. The I/O List shall accommodate input and output signals that are required or available based on the specific selected vendor and equipment. Additional I/O shall be provided to ensure proper operation. Provide an additional 10% spare I/O of each type.

DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
RECIRCULATION PIPE VALVE FULLY OPEN (ZSO-009)			1		Recirculation Valve Actuator	SCADA Panel	Field Device
RECIRCULATION PIPE VALVE FULLY CLOSED (ZSC-009)			1		Recirculation Valve Actuator	SCADA Panel	Field Device
PILOT LIGHT TEST			1		Control Panel	SCADA Panel	Push Button Mounted On Control Panel
OPERATING VIA UPS POWER			1		SCADA Panel	SCADA Panel	UPS Mounted In SCADA Panel
UPS LOW BATTERY WARNING			1		SCADA Panel	SCADA Panel	UPS Mounted In SCADA Panel
UPS FAULT/OVERLOAD			1		SCADA Panel	SCADA Panel	UPS Mounted In SCADA Panel
SUMP PUMP OPERATING IN AUTO MODE			1		Sump Pump Control Panel (CP-SP1)	SCADA Panel	
SUMP PUMP FAULT			1		Sump Pump Control Panel (CP-SP1)	SCADA Panel	
SUMP PUMP RUNNING			1		Sump Pump Control Panel (CP-SP1)	SCADA Panel	
SUMP PUMP HIGH WATER ALARM			1		Sump Pump Control Panel (CP-SP1)	SCADA Panel	
AEGIS PANEL INTRUSION ALARM			1		AEGIS Control Panel	SCADA Panel	
AEGIS PANEL ENTRY KEY IN NON-ALARM POSITION			1		AEGIS Control Panel	SCADA Panel	
AEGIS PANEL POWER AVAILABLE			1		AEGIS Control Panel		
AEGIS PANEL DIALER FAULT			1		AEGIS Control Panel		

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DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
ALARM ACKNOWLEDGE			1		Control Panel	SCADA Panel	Push Button Mounted On Control Panel
SECONDARY BUBBLER SYSTEM FAILURE			1		Secondary Bubbler Control Panel (BCP47-002)	SCADA Panel	
EF-1 IN HAND MODE			1		EF-1 Starter	SCADA Panel	EF-1 is located in MCC
EF-1 IN AUTO MODE			1		EF-1 Starter	SCADA Panel	EF-1 is located in MCC
EF-1 MOTOR OL			1		EF-1 Starter	SCADA Panel	EF-1 is located in MCC
EF-1 RUNNING			1		EF-1 Starter	SCADA Panel	EF-1 is located in MCC
EF-2 IN HAND MODE			1		EF-2 Starter	SCADA Panel	EF-2 is located in MCC
EF-2 IN AUTO MODE			1		EF-2 Starter	SCADA Panel	EF-2 is located in MCC
EF-2 MOTOR OL			1		EF-2 Starter	SCADA Panel	EF-2 is located in MCC
EF-2 RUNNING			1		EF-2 Starter	SCADA Panel	EF-2 is located in MCC
MFP-1 SCADA CALL				1	SCADA Panel	MFP-1 Starter	MFP-1 Starter Located in MCC
SCADA ALARM ACKNOWLEDGEMENT				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
PRIMARY LEVEL TRANSDUCER FAILURE				1	SCADA Panel	Control Panel	
LEAD PUMP CALLED FOR				1	SCADA Panel	Control Panel	Pilot Light Mounted On Control Panel
LAG PUMP CALLED FOR				1	SCADA Panel	Control Panel	Pilot Light Mounted On Control Panel
MFP-2 SCADA CALL				1	SCADA Panel	MFP-2 Starter	MFP-2 Starter Located in MCC
DRY WELL HIGH TEMPERATURE				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
DRY WELL LOW TEMPERATURE				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
SECONDARY LEVEL TRANSDUCER FAILURE				1	SCADA Panel	Control Panel	

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DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
BUBBLER SYSTEM WET WELL HIGH WATER ALARM				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
BUBBLER SYSTEM WET WELL LOW WATER ALARM				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
SECONDARY BUBBLER SYSTEM FAILURE				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
BAR RACK CLOGGED				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
ELECTRICAL ROOM HIGH TEMPERATURE				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
ELECTRICAL ROOM LOW TEMPERATURE				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
MFP-3 SCADA CALL				1	SCADA Panel	MFP-3 Starter	MFP-3 Starter Located in MCC
SPARE OUTPUT TO ANNUNCIATOR PANEL				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
SPARE OUTPUT TO ANNUNCIATOR PANEL				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
SCADA PANEL PLC TROUBLE				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted on Control Panel
SCADA PANEL PLC FAILURE				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted on Control Panel
LFP-4 SCADA CALL				1	SCADA Panel	LFP-4 Starter	LFP-4 Starter Located in MCC
PUMP OPERATION VIA BUBBLER CONTROL				1	SCADA Panel	Control Panel	Pilot Light Mounted On Control Panel
PUMP OPERATION VIA FLOAT CONTROL				1	SCADA Panel	Control Panel	Pilot Light Mounted On Control Panel
SCADA PANEL UPS LOW BATTERY				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted on Control Panel
SCADA PANEL UPS FAULT /OVERLOAD				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted on Control Panel

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DESCRIPTION	AI	AO	DI	DO	From	To	Remarks
SPARE OUTPUT TO ANNUNCIATOR PANEL				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
SPARE OUTPUT TO ANNUNCIATOR PANEL				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
PRIMARY BUBBLER SYSTEM FAILURE				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
SPARE OUTPUT TO ANNUNCIATOR PANEL				1	SCADA Panel	Annunciator Panel	Annunciator Panel Mounted On Control Panel
MFP-1 MOTOR CURRENT TRANS. (IT-001)	1				MFP-1 Starter	SCADA Panel	MFP-1 is located in MCC
MFP-1 FLOW METER TRANS. (FIT-001)	1				MFP-1 Flow Meter	SCADA Panel	Field Device
ELECT. ROOM THERMOSTAT (TT-402B)	1				Elec. Room Thermostat	SCADA Panel	Field Device
RECIRCULATION FLOW METER TRANS. (FT-010)	1				Recirc. Flow Meter	SCADA Panel	Meter mounted On Control Panel
UPSTREAM BAR RACK LEVEL TRANS. (LIT-007A)	1				Upstream Bar Rack Level Trans.	SCADA Panel	Field Device
DOWNSTREAM BAR RACK LEVEL TRANS. (LIT-007B)	1				Downstream Bar Rack Level Trans.	SCADA Panel	Field Device
WET WELL LEVEL TRANS. (LIT-008A)	1				Primary Bubbler Control Panel (BCP47-001)	SCADA Panel	Field Device
WET WELL LEVEL TRANS. (LIT-008B)	1				Primary Bubbler Control Panel (BCP47-002)	SCADA Panel	Field Device
MFP-2 MOTOR CURRENT TRANS. (IT-002)	1				MFP-2 Starter	SCADA Panel	MFP-2 is located in MCC

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