SECTION 13855

INSTRUMENTATION AND CONTROL SYSTEMS - GENERAL

PART 1 GENERAL

1.1 SUMMARY

A. Scope
1. Provide labor, materials and equipment to provide systems as specified in these 13800 Series sections of the specifications and as indicated on the DRAWINGS, including accessories as required for fully operational installations.
2. As part of this project, the contractor shall furnish flow meters, automatic control valves, temperature transmitters, pressure transmitters, pressure switches, pressure differential switches, level transmitter and level switches for the expansion of the Chilled Water/Compress Air Control System. The furnishing, mounting and wiring of the panels shall be under other sections.

B. Description Of System
1. Instrumentation and control systems shall be direct digital controller type as specified and indicated on the DRAWINGS.

C. Related Instrumentation And Control Work Specified In Other Sections
1. Instrumentation and Control Systems – Electrical Work – Section 13856.
2. Control Systems Equipment – Section 13865.
3. Automatic Control Valves – Section 13865A.
4. Flow Meters – Section 13865B.
5. Refrigerant Gas Detection System – Section 13870.
6. I&C Systems Start-Up and Final Acceptance Testing – Section 13875.

D. Equipment Furnished And Installed Under The Contract
1. Provide all required inter-connecting controls and instrument piping and wiring between field mounted instruments and controls, and all associated control and monitoring panels for proper operation of equipment.
2. All installation work provided shall be per the recommendations of the equipment manufacturers and as required by the manufacturers installation instructions and Shop Drawings.
3. Plan Drawings do not show environmental equipment, mounted devices, and independently mounted equipment. Determine the exact mounting requirements and coordinate device locations with work under the 15000 Series Sections.
4. Provide all required instrumentation and control equipment adjustments and calibration.
5. Coordinate installation scheduling of in-line piping and duct work devices to preclude the possibility of causing construction delays to other trades. Where required, initially furnish and install spool pieces to allow construction to proceed and install the in-line devices at a later date as scheduled. In all cases be responsible for all costs associated with the installation of any temporary devices.

E. Equipment Furnished Under Other Contracts
   1. Pressure taps and associated root valves are provided under other contracts. Be responsible for providing of impulse lines, instrument manifolds, and all connections to instrument and control devices provided under the Contract.
   2. Pipe taps for temperature sensors are provided under other contracts. Taps will be NPT with threaded watertight removable plug. Furnish and install all thermowells and conducting paste compatible with the instruments provided under this contract. Installation of thermowells shall be scheduled and coordinated with Consultant to allow for proper scheduling of Mechanical Work.
   3. Electrical power in the form of 120/460V 3 phase 4W service will be available at receptacle panels throughout the facilities. Spare 20A circuit breakers will be available at each panel for use under this Contract. Provide additional breakers when required. Breakers shall match the existing breakers within the panel.

1.2 SYSTEM SOURCE

A. Integrated Control Environmental, LLC.
   Pete Aiello
   Phone 718-672-8363 Ext. 201

B. Integrated Controls is an acceptable supplier for automated logic (ATC) work. Other contractors meeting the requirements of Section 13855.1.3.D are acceptable.

1.3 QUALITY ASSURANCE

A. Referenced Standards
   1. All systems, devices etc. shall be per applicable provisions of the following:
      a. ANSI - American National Standards Institute, Inc.
      b. ASME - American Society of Mechanical Engineers
      c. ASTM - American Society for Testing & Materials
      d. ISA - Instrument Society of America
      e. NEC - National Electrical Code of NFPA
      f. NEMA - National Electrical Manufacturer’s Association
      g. UL - Underwriters’ Laboratories, Inc.

B. Requirements Of Regulatory Agencies
   1. Provide materials and equipment and execute the Work, including test and inspections, per applicable provisions of Federal, State and local Government laws and ordinances and referenced codes and standards. Governing laws, ordinances, codes, and standards constitute minimum mandatory requirements.

C. Source Quality Control
   1. Perform manufacturer’s standard shop tests for each component to ensure compliance with intent of these Specifications.
   2. Materials and equipment shall be the products of manufacturers regularly engaged in the manufacture of such products, shall essentially duplicate equipment that has been in satisfactory service prior to issue date of the Contract and shall be supported by a service organization that is reasonably convenient to the site.

D. Contractor Qualifications
   1. The System Supplier shall have a successful history in the design and installation of control systems and shall evidence this history as condition of acceptance of bid.
   2. In addition, the System Supplier shall have an office which is staffed with factory trained engineers fully capable of providing instructions and routine emergency maintenance service on all system components, within 8 hours of notification.
   3. Installation of control components shall be by qualified control personnel. The requirements of "Qualified Control Personnel" shall be interpreted to mean personnel who specialize in control and instrumentation work.

E. Workplace Safety And Hazardous Materials
   1. Provide a safety program in compliance with the Contract Documents.
   2. The Contractor and its employees and subtrades comply with Federal, State and local safety regulations.
   3. The Contractor shall ensure that all subcontractors and employees have written safety programs in place that cover their scope of work, and that their employees receive the training required by the OSHA have jurisdiction for a least each topic listed in the Safety Certification Manual.
   4. Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.
   5. Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the Consultant or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.
   6. The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.
   7. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.
   8. The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

1.4 SUBMITTALS

A. General
   1. Furnish submittals for items that are identified in this Section by a different typeface and a bracketed code . Refer to Section 01300 for definition of codes for types of submittals and the administrative requirements governing submittal procedure. Additional submittal requirements pertaining to this Section are specified herein under this Article.

B. Shop Drawings And Product Data
   1. For work that interfaces with work under other contracts or other trades, clearly illustrate and define the interfaces, including:
      a. System, subsystem and specific component interfaces.
      b. Specific signal levels, functions and actions.
      c. Normal and abnormal conditions.
      d. Specific connections including terminal numbers.
      e. Partial P & ID's as required to show the operational interface between systems.

2. Submit data sheets, catalog cuts, and technical information for all devices and equipment. Information shall include range, units, line size, ratings, power supply requirements, input and output signal descriptions, contact ratings, outline dimension drawings and internal schematic diagrams.
3. Provide control panel front view and interior drawings complete with outline dimensions and Bills of Material for all panel front and interior mounted equipment.
4. Provide P & ID's including indication of primary elements, controller functions and controlled elements. Utilize ISA standard S.5.1 and S.5.2 or Owner-approved alternate for development of P & ID's.
   a. In addition, include Bills of Material for all field equipment/devices and for local panel mounted equipment not provided under Paragraph .4 above. Instrument ranges, setpoints, etc., shall be indicated by each device.
5. Provide typical loop diagrams, logic diagrams, input/output drawings, etc., indicating format and information presentation for approval. The format shall be utilized on all diagrams and drawings submitted for record purposes.
6. Provide instrument installation details, and typical field conduit/wiring and field tubing drawings to indicate contractor's intent as to field installation of equipment.
7. Resubmit all reviewed shop drawings which have been modified subsequent to field release.
8. Submit flow calculations for each flow element.
9. Where control panel equipment is provided, include a separate bill of material for panel mounted controls and display instrumentation. The bill of material shall include all service descriptions and tag number, nomenclature engraving strips for identification of panel front mounted control devices or display instrumentation service legend.
10. Provide typical plan drawings showing the installation of wiring and conduits, cable trays, etc., and standard installation details to be used throughout the work.

C. Shop Drawings Submitted For Record
1. Provide, for record purposes only, complete instrumentation and controls documentation necessary for operating, maintaining and trouble-shooting of equipment/systems by the Owner.
2. Provide control panel drawings which show all main dimensions, materials of construction, interior equipment and sub-assembly mounting panels. Drawings shall include front and rear elevations and sections to fully describe the panels. Typical control panel drawings will not be acceptable. Provide nameplate engraving legends for all nameplates, both on panel face and panel interiors.
3. Provide complete interconnection diagrams showing internal wiring and piping connections between panel mounted components and field terminal boards within the panels.
4. Provide master instrument loop diagrams for each process or treatment area, illustrating the relationship between individual loops and the process or treatment equipment including distributed control systems according to the latest Instrument Society of America "Standards and Practices for Instrumentation" S5 Sections.
5. Provide individual loop drawings for each instrument loop. Loop diagram consists of the complete electronic connections between devices which comprise a control and or monitoring function. (Example: Flow element to an electronic transmitter, to a controller, then to a control valve). Include all components as well as electrical and schematic diagrams for those loops requiring relay and control device logic external to the analog

instruments. Provide a written sequence of operation fully describing loop function and operation, and identify all components and component electrical terminals on the loop diagrams. Loop drawings shall also show all software functions provided by a programmable controller, or computer.

6. Provide field wiring diagrams showing: all power supply connections; control wire connections to remote instruments and control devices; all wire connections to motor starters. Show all wire numbers and terminal designations including terminal designations used on motor control centers.
7. Provide ladder type schematic, or Owner-approved alternate diagrams and written operation sequences for all control equipment including all motors, dampers, solenoid valves, field sensing devices, etc. Typical diagrams will not be acceptable. Include specific wire and terminal number information for all devices.

D. Test Reports
1. Deliver copies of the system data required by the Contract Documents and as supplemented herein.
2. Test data shall include set points, calibrated ranges and tuning constants of control devices.
3. Provide typical detailed factory and field test procedures for formal approval at least 14 days before scheduled testing. Provide 4 copies of final test procedure to Construction Manager at least 5 days before the actual testing begins.

E. Operation And Maintenance Data
1. Provide per Section 01300 and as supplemented herein.
2. Provide loose leaf bound manuals and CDs which contain operating, maintenance and spare parts data for equipment provided under the 13800 Series Sections with the exception of typical commodities such as pipe and tubing.
3. Provide manuals which include:
   a. System components and assembly drawings as corrected or as-built.
   b. System “as-built” Drawings if not part of the equipment.
   c. Equipment brochures, data and catalog cuts showing: Performance; Installation; Operation; Maintenance and repair; Nearest authorized representative and stocking spare parts source; Recommended spare parts.
   d. Diagrams showing: Functional type; Control sequence; As-built control; As-built wiring.
4. Bind each copy of each set of manuals in three ring binders with piano hinge covers for convenience in handling. In binder table of contents, identify each item point of use. Set up manual format and content such that integration of manuals into system manuals prepared by others may be accomplished with minimal effort. Include names and phone numbers of equipment suppliers and subcontractors.
5. Incorporate in the manuals such data as drawings, flow diagrams, brochures and operating instructions in sufficient detail to enable operators to understand the facility, its potentialities, limitations and maintenance needs. Include data on design, construction, installation and operating features required by regulation of Federal, State or Local governing authorities and the Insurance Underwriters, if required.
6. Assemble Operating and Maintenance Manuals for preliminary approval of content. Deliver one copy to the Consultant and one copy to Owner not less than 30 working days prior to scheduled operating and maintenance personnel training date and retain one

copy for a “master”. Upon approval of submittal, deliver within 5 working days, specified number of bound copies, excluding Owner’s preliminary copy.

F. Maintenance Materials
   1. Provide list of spare parts required for one year’s continuous operation including parts numbers and names and addresses of supply sources.

G. Posted Operating Instructions
   1. Prepare two sets of instructions for posting with each control panel. These instructions shall include such items as equipment, electrical and piping layouts, simplified narratives instruction and material necessary to aid in the operation of the equipment at the local control panels.

1.5 OPERATING AND MAINTENANCE PERSONNEL INSTRUCTIONS

A. Provide a coordinated training program encompassing equipment and systems for operating and maintenance personnel. Submit a training agenda for approval before any scheduled training.

B. Utilize corrected equipment and system shop drawings, manuals, demonstration apparatus and installed, functioning equipment.

C. During system commissioning and at time acceptable performance of the system hardware and software has been established, provide on-site operator and maintenance personnel instruction. Instruction shall be by acceptable competent representatives familiar with the systems and programmable controller hardware and accessories.

D. Provide training aids which include video tapes, slides, color layouts, transparencies and handouts, as well as the maintenance manuals. All materials shall become the property of the Owner. Training materials shall be site specific for the equipment and systems installed or interfaced under this Contract.

PART 2 PRODUCTS

2.1 SYSTEMS MATERIALS

A. Control And Instrumentation Copper Tubing
   1. Tubing (All Sizes) : Copper; ASTM B 280 No. 122.
   2. Fittings (All Sizes) : Solder type:
      .1 Mueller Brass “Streamline”.
      .2 Nibco, Inc.
      .3 Chase Brass & Copper Co.
      Compression type:
      .1 Crawford “Swagelok”.
      .2 Hoke “Gyrolock”.
      .3 Parker-Hannifin “CPI”.
   3. Pipe nipples Red brass.

4. Solder — Tin-Antimony; ASTM B32, Alloy Grade 95TA.

B. Control And Instrument Plastic Tubing

1. Tubing (All Sizes) : Black virgin polyethylene, ASTM D 1248, Type 1, Class C, Grade 5; meeting stress crack test performance required by ASTM D 1693. Multi-tube harness material shall be as specified above with polyester film barrier and vinyl jacket not less than 0.062 inch thick. Tubing shall conform to all federal, state and local codes associated with flame and smoke retardation.
2. Fittings (All Sizes) : Compression type:
   - .1 Crawford "Swagelok KN"
   - .2 Hoke "Gyrolock".
   - .3 Parker-Hannifin "Poly-Tite".

C. Instrument Isolation Valves

1. Instrument Isolation Valve: Socket welding or butt welding gate or globe valves or a forged steel gate valve with socket/butt welding end on system side and threaded end on the instrument side.
   a. Vogt.
   b. Swagelok.Parker

D. Pressure Reducing Stations

1. Pressure reducing station: Provide complete with pressure reducing valve, particulate filter, valved bypass, valved pressure indicator upstream of station, valved pressure indicator downstream of station and regulated air pressure relief valve. Tamper resistant.
2. Pressure regulator shall be relieving type.
   a. Fisher Controls Co.
   b. Norgren.
   c. Wilkerson.
3. Filter shall remove one micron particles and be provided with manual drain cock and metal bowl guard if bowl is polycarbonate.
   a. Deltech.
   b. Norgren.
   c. Wilkerson.
4. Filter shall be approximately 99% efficient for dust particles of 0.5 microns and three microns and larger particles of lubricating oil.
   a. Deltech 810 Series.
   b. Norgren F44 Series.
   c. Wilkerson F Series Type A Element.
5. Pressure relief valve shall be sized for capacity of the low pressure side of the pressure regulator. Set valve for not more than 20% above the low side pressure. Rate and label per ASME Code. Seat material suitable for the service.
   a. Anderson Greenwood and Co.
   b. Consolidated.
   c. Teledyne-Farris.
6. Pressure indicators shall be two inch with scale selected for midpoint of operation.

E. Electrical Wiring
   1. Provide electric wiring, cabling, devices and motor controls per requirements of Section 13856.

F. Calibration Fitting
   1. Calibration fitting: Provide where indicated on the Drawings or at each instrumentation pressure connection, level transmitter, differential pressure transmitter and the like.
      a. Transamerica DeLaval, Minicheck coupling.
   2. Three way or five way manifolds: Provide as required on all transmitters for zeroing and calibrating instruments without removing them.
      a. Anderson Greenwood and Co.
      b. ALCO Valve.
      c. HEX Valve.

G. Process Indicators
   1. All field mounted transmitters or primary elements shall include a process indicator. The indicator shall be located to be easily read from the operating floor.
      a. Newport
      b. Red Lion
      c. Weschler

H. Impulse And Sensing Lines
   1. Lines shall be of copper, stainless steel, etc., compatible with the process fluid. Design impulse lines to reduce temperatures to suit instrument capability.

I. Thermowells
   1. Thermowells: Type 316 stainless steel or monel sized as required for the pipe or vessel. Provide non-solidifying heat conducting paste.

J. Transmitters - General
   1. Transmitter failure position shall be to minimum or maximum as required by system safety.

2.2 CONTROL PANEL REQUIREMENTS

A. General
   1. Control panels shall be NEMA 12 as indicated or as required by the environment in which the panel is mounted. Conduit, pipe, tubing shall be side or bottom entry and roof of panel shall be waterproof.
   2. Control panels shall be sized as indicated or as required to provide a minimum of 25% spare usable space within the panel for panels less than 1500 sq. in. in size and 15% spare usable space for panels above 1500 sq. in. in size.
   3. Control panel doors shall not be greater than 36 inches. Panels requiring a door greater than 36 inches in width shall use double doors. Control panels higher than 42 inches shall come equipped with legs if required and shall be suitable for floor mounting.
   4. Panel doors shall come with key locked latch. When panel comes with more than one door, latching mechanism shall lock all doors. Provide four keys.

5. Control panels shall be laid out such that similar type equipment shall be grouped together, and barrier shall be installed between electrical and electronic equipment.
6. In those cases in which electronic equipment is mounted within the panel, interior ambient temperature shall not rise above 85% of manufacturers recommended maximum operating temperature. Provide filtered louvers/circulating fans when necessary to meet this criterion.
7. Terminate all wiring on terminal blocks and tag with wire numbers. When wire numbers are not indicated, develop an approved wire numbering system and utilize that system to identify and tag all wiring within the control panel.
8. Supply each control panel with a complete set of schematic and wiring diagrams associated with all the equipment within that panel. Typical drawings will not be acceptable.
9. Label control equipment mounted within the control enclosure with designations as indicated.
10. Terminate internal and incoming wiring, except plug terminated wiring, to the terminal blocks with a maximum of two wires on each side of the terminal.
11. 120 VAC control wiring within a control panel deriving its power from an outside source shall be yellow and DC power wiring shall be blue.

B. Electrical Control Components
1. Group electrical devices together.
2. Group devices mounted in the control panel carrying line voltage, except where line voltage is 10 V. or less, or a combination of line voltage and control voltage, above or to the side of devices which carry control voltage only.
3. Where control power is derived from the use of line voltage and associated control transformer, the control panel shall come complete with a flange mounted lockable disconnecting device.
4. Control relays, timers and contactors, where possible, shall be supplied by the same manufacturer.
5. All wiring within control panels shall be No. 14 AWG except wiring associated with electronic control equipment which shall be as specified under Electronic Control Components.
6. Where more than five electrical devices are utilized within a control enclosure, supply square duct for routing control wiring. Size duct as required but not less than 1-1/4 inches square.
7. Electrical equipment shall conform to requirements of governing codes and the referenced standards.
8. Terminate field wiring on terminals within the control enclosure. Tag terminals and field wires with wire numbers as indicate. When wire numbers are not indicated, develop a wire number system for approval.
9. Wire between panel mounted devices and door mounted devices through terminals. Wiring from terminal to door mounted devices shall be extra flexible wiring. Wiring shall be neatly tied and supported. Flexible connections bridging the cabinet and its door shall be neatly fastened along the hinge side and protected against abrasion.
10. Provide all enclosures with a suitable ground lug.
11. All pilot lights except those on graphic panels shall be Push-to-Test Transformer Type with 6-8 volt multi-LED lamps or use a common lamp test button.
12. Terminal blocks for control wiring shall be 300 volt rated suitable for tongue connectors.

C. Electronic Control Components
   1. Group electronic equipment together within metallic barrier separation from electrical equipment with voltage 120 VAC or above.
   2. Electronic signal cables except thermocouple (TC) wiring and resistance temperature detector (RTD) wiring shall terminate on terminals, with ground terminals provided for shielded cables as required.
   3. Route thermocouple and resistance temperature detector (RTD) wiring directly to the receiving instrument, and in those cases where the wiring is run in close proximity to wiring carrying A.C. voltage provide protection from induced voltages with flexible metallic conduit or other approved means.
   4. Connect ground terminals together to an isolated ground lug installed within the enclosure.
   5. Wiring between terminal blocks and instruments shall be with No. 18 AWG tinned stranded copper.
   6. Provide an insulated ground bus for connection of all instrument grounds. Connect the grounds direct to an isolated ground.
   7. Provide fused 120 VAC outlet externally on cabinet.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION

A. Control systems shall be complete in all details and shall include electrical wiring and necessary ancillary items to automatically maintain required preset conditions. Even though all items necessary to functioning systems are not specifically mentioned herein, provide and adjust them under this Contract.

B. Conform to the published or written instructions of the manufacturer for installation. Where instruction conflicts with the manufacturer's, notify the Owner or the Consultant.

C. Provide taps in instrument air lines including shut-off valves as required to route instrument air to equipment, PRV stations, etc. Exact location of taps shall be as required by field installation.

3.2 CONTROL AND INSTRUMENT AIR TUBING INSTALLATION

A. General
   1. Conceal tubing except in areas where other piping is exposed. Arrange multiple tube runs neatly. Use bends rather than fittings for changes in direction.
   2. Mechanically attach tubing to supporting surfaces. Do not use adhesives. See additional requirements under "Vibration Isolation". Make tubing penetrations of concrete surfaces through minimum one inch IPS Schedule 40 steel sleeves. In the case of copper tubes routed through the steel sleeve, provide approved dielectric isolation between tubing and sleeve. Extend sleeve six inches above floors and one inch below bottom surface of slabs. Where water or vapor barrier sealing is required, provide 1/2 inch deep elastomer caulk to surfaces clean and free from oil and other deleterious substances.

3. Periodically purge tubing with dry, oil-free compressed air to rid system of impurities generated during joint making and installation. Also purge to remove atmospheric moisture before connecting to control instruments.

B. Copper
1. Cut tubing with mechanical joints square and remove burrs with approved cutting and reaming tools. Exercise care not to work-harden copper. In case of doubt, cut off or anneal tube ends by heating and air cooling per the manufacturer's instruments.
2. Cut the tubing for solder joints square and remove burrs with approved cutting and reaming tools. Clean the inside surfaces of fittings and outside surfaces of tubes in joint areas before assembly of joint. Apply joint flux, filler material and heat source per manufacturer's instructions to provide proper capillary action to fill the socket space and to achieve 100% of shear line strengthen capability. Valves in copper piping shall have screwed ends with end adaptors to suit mechanical connections, unless solder jointing is specified or indicated for a given application. Remake copper joints which fail pressure tests with new materials including pipe or tubing fittings, and filler metal.
3. Use hard drawn copper tubing in exposed areas and either hard drawn or annealed if concealed.
4. Fittings for supply system copper tubing shall be wrought copper solder joint-type except as connection to apparatus, where specified brass mechanical and IPS thread adapter fittings shall be used. Tool made bends in lieu of fittings are acceptable.
5. Horizontal support for less than three tubes shall be rigid 1 x 3/8 inch metal channel and proprietary metal tube race for three or more tubes.
6. Tubing runs embedded in concrete shall be annealed and routed in metallic conduit.

3.3 ELECTRICAL

A. General
1. Provide necessary conduits, fittings and wiring for the control systems. Include the low level instrumentation signal wiring such as thermocouple, RTD and other mV signals; high level signal wiring such as 4-20 mA, 0-135 OHM resistance signals, 120 VAC and DC control wiring. Provide all 120 VAC control wiring from local or remote control panels or control hardware, or motor starters. Specific examples of wiring to be installed include:
   a. Control transmitters to the control cabinet.
   b. Hand/Auto control stations to the control cabinet.
   c. Control cabinet to the final drive unit.
   d. Status inputs (pressure, flow, temperature, limit switches or breaker auxiliary contacts) to the control cabinet.
   e. Annunciators to the actuating contacts.
   f. Recorders or indicators mounted on the panel to the source transmitter.
   g. 120 VAC control wiring from the terminal blocks of the control panels to the motor starters.
   h. 120 VAC control wiring from interlock switches (pressure, flow, temperature, limit switches or breaker auxiliary contracts) to motor starters.
   i. 120 VAC control wiring from local start, stop, jog or lock-out pushbutton stations to motor starters.

j. 120 VAC control wiring inside motor starter and MCC's (only for motors which are controlled from equipment or panels supplied under this CONTRACT).
k. 120 VAC and 24 V power wiring from receptacle panels to all instruments and control panels unless otherwise indicated.
l. Ground leads from the control panel grounds to the ground mat system.

B. Wiring
1. Route RTD, 4-20 mA analog and low level D.C. signal wiring in conduits separate from all other wiring unless otherwise indicated. Wiring shall be minimum #18 shielded; 2,3 or 4 conductor as required. Where multi-conductor cables are used, use twisted pair cable with each pair shielded.
2. All 120 VAC and 24 V service to instruments, controllers, control panels, etc. provided under this CONTRACT shall be connected to power sources as indicated on the DRAWINGS.
3. All 120 VAC service to equipment shall include a ground wire sized per NEC for the load being served.
4. Splices in instrument signal cables, i.e. 4-20 ma DC, 1-10V DC, RTD, Thermocouple, etc. are not allowed. In those case where continuous runs are not possible, provide approved terminal cabinets. Mount cabinets no higher than 6'-0" above finished floor or platform.
5. Provide a minimum of 20% spare conductors (no less than 2) between main conduit runs. Roll up spares at each end within pull boxes or cabinets and label as spare, i.e., SP-1, SP-2, SP-3, etc.

C. Conduit And Fittings
1. Install conduits and fittings per requirements of Section 13856 and as supplemented herein.
2. Provide all required sealing materials and devices when penetrating fire rated walls and draft curtains. Submit installation details to Consultant for approval prior to proceeding with the Work.
3. Provide all required sealing materials and devices when penetrating roofs. Coordinate with Consultant and submit details for approval prior to proceeding with the Work.
4. Verify electrical construction requirements such as hazardous areas, corrosive areas, etc., and provide materials suitable for the area installed.

3.4 INSTRUMENTS AND COMPONENTS

A. Locate controls, relays, instruments, switches, valves, devices and accessories so they are readily accessible for adjustment, service and replacement or as indicated. Install and route tubing, sensing lines, cables, and conduits in parallel banks with changes of direction made at 90 degree angles.

B. Locate, size, and support temperature sensing elements in air streams to properly sense the representative flow or temperature. In the case of controlling, and transmitting elements, the sensing device shall be located, sized and of the type to sense the average condition. In case of safety elements, the sensing device shall be located and of the type to sense the extreme condition. Sensing elements in double wall casings and insulated ducts shall have the entire active portion within the air stream.

C. Install temperature sensing elements in fluid lines and vessels with Type 316 stainless steel or Monel thermowells filled with a nonsolidifying heat conducting paste. Locate sensing elements such that they are in the path of moving fluid and not positioned in stagnant, dead end or turbulent locations. Wells shall not obstruct the flow of the fluid being measured. Pipes one inch and smaller shall be increased at least one pipe size at point of insertion.

D. Locate pressure sensing taps on fluid lines in straight runs of pipe with a minimum length of five pipe diameters both upstream and downstream of pressure tap unless otherwise approved. Provide an isolation valve in sensing line at each pressure tap. Provide isolating seal where fluid can injure measuring element. Install pressure sensing elements in ducts and casings with clean sharp taps to accurately read true static pressure velocity and turbulence influences.

E. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the opening air and vapor tight. Where control devices are to be located on insulated surfaces, provide brackets to clear the finished surface of the insulation, avoiding punctures of the vapor seal.

F. Locate support, enclose, and install control devices and equipment such that they will not be subject to vibration, excessive temperatures, dirt, moisture or other harmful effects or conditions beyond their rated limitations. If devices must be located such as to be subjected to conditions beyond their recommended or rated limitations, provide the necessary protective enclosures or furnish the equipment constructed of materials and features capable of withstanding the adverse conditions. Controls and devices subject to wetting or to the weather shall have corrosion resistant weathertight enclosures. Where not specifically indicated on the DRAWINGS, instruments shall be located in easily accessible areas for periodic maintenance and calibration.

G. Provide necessary relays, switches, valves, brackets, linkages, control devices, auxiliaries, fasteners, accessories and connections to result in complete and operable control systems as specified herein and shown on the drawings.

H. Control valve and damper operators shall be capable of smoothly positioning under load through the full ranges and strokes indicated in both directions without binding or fluttering and shall be further capable of holding steady in any intermediate or extreme position while the respective systems are functioning at design flows, temperatures, and pressures. When indicated, furnish valve and damper operators with an adjustable pilot positioning feedback relay mounted directly on each operator. Pilot positioner shall be capable of automatically making available the full operator power at any time in holding or repositioning. If indicated or specified, valve and damper operators shall be capable of being sequenced within the indicated ranges. Provide multiple operators on dampers where required to smoothly position damper under operating conditions.

I. Provide permanently attached stainless steel instrument tags for all field mounted devices. Imprint tag with instrument number and service conditions.

3.5 PRESSURE REDUCING STATIONS

A. Provide required pressure reducing stations for supplying instrument air at the pressure and in the quantities necessary for the equipment furnished plus indicated future requirements and for other equipment shown.

B. Provide each station with a pressure relief valve set at a maximum of 20% above downstream controlled pressure but in no case above the lowest limiting rating of any fitting, control or device downstream. Provide each regulator with 2-1/2 inch diameter gauges and shut-off valves both up and downstream. Each regulator shall have a globe valve bypass.

C. Logically group PRV station equipment and valves and surface-mount on a rigid panelboard with nameplates.

D. Size and select PRV stations by control system manufacture to deliver and regulate the required pressure and volumes from zero to maximum demand flows without surging, hunting or pressure variations.

3.6 VIBRATION ISOLATION

A. Vibration-isolate components either by location or by mounting devices.

B. Install tubing and conduit to preclude nullification of provisions for vibration isolation of equipment and ducting. Mount single tube runs in aircraft type clamps containing an elastomer insert. Mounting shall prevent contact with ducting and fan, casing or enclosure. Multiple runs shall conform to the same isolation requirements but details of mounting shall be submitted for approval. Provide looped rubber hose connection when tubing crosses flexible duct and equipment connectors.

3.7 FASTENING TO BUILDING STRUCTURES

A. The methods of attaching or fastening equipment or equipment support or hangers to the building structure shall be subject to approval by the Consultant. Submit shop drawings or samples for approval before processing with the WORK.

B. Drilling, welding or the use of explosive driven fasteners on building structures shall require written prior approval by the Consultant for each type of application except where indicated.

C. Equipment shall not be attached to or supported from the roof deck, from removable or knockout panels, or temporary walls or partitions.

D. Electrical equipment mounted against exterior masonry walls shall be mounted at least one inch away from the wall surface.

3.8 FIELD QUALITY CONTROL

A. After the inspection has been completed, check systems for continuity.

B. After completion of control and instrument piping and wiring, connect, test, adjust, and readjust as necessary, all control equipment in terms of design, function and performance, and otherwise make ready for systems acceptance tests.

C. After systems acceptance and after the systems have operated in normal service for two weeks, check the adjustment on instruments and devices and correct items found to be out of order. Readjustments necessary to accomplish the specified results shall be made for one year of operation upon request.

D. Test pneumatic systems per Tentative Recommended Practice RP 7.1 of the Instrument Society of America, “Pneumatic Control Circuit Pressure Test”. System pressure shall not exceed 30 PSI.

E. Provide equipment for the calibration of instruments provided under this CONTRACT and provided under other contracts which are connected to systems provided under this CONTRACT. Instruments not in calibration, shall be recalibrated to function as required, or shall be replaced, by the supplier of that instrument or device.

F. All instruments and control loops be calibrated and tuned for proper control action. Tuning shall consist of adjusting proportional, integral and derivative actions of controllers (hardware or software) to meet the accuracy of the environment or process indicated. Unless otherwise specified or indicated on the Drawings the following minimum requirements shall be met:
   1. Environmental:
      a. Temperature - +/-2.5 degF.
      b. Humidity - where humidity control is indicated on Drawings or specified - +/- 10% RH
   2. Process:
      a. Temperature - +/-1 degF of set point.
      b. Flow - +/-1% of set point.
      c. Pressure - +/-1% of set point.
      d. pH - +/-0.5 pH of set point.

G. Calibrate and adjust control devices, linkages, accessories, and components for stable and accurate operation to meet the design intent and to obtain optimum performance from the equipment controlled. Final adjustment, calibration and checking shall be performed while the respective controlled systems are in full operation. Cause every device to automatically function as intended to insure its proper operation.

H. After calibration, adjustment, and checking have been completed and systems are operational, demonstrate to the Administrative Authorities having jurisdiction and to the Owner the complete and correct functioning of all control systems and equipment. These demonstrations shall consist of operating the controls through their normal full ranges and sequences. Simulate abnormal conditions to demonstrate proper functioning of safety devices. Readjust settings to their correct design values and after sufficient time, observe ability of controls to establish the desired conditions, noting abnormal deviations. Make necessary repairs, replacements or adjustments on items which fail to perform satisfactorily and repeat tests to demonstrate compliance with the design intent.

END OF SECTION

Revision History	
Date	**Rev. No.**
A	0
B	0
C	0
D	0
E	0
F	0
02-19-09	0

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