GENERAL REQUIREMENTS FOR AUTOMATION SYSTEM

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of the general requirements for the automation system for the work.

.2 Provide all Facility communications networks and infrastructure components associated with automation system, including but not limited to design, supply, install, configure, test and commission the following:

.1 Automation system PLC cabinets.

.2 Marshalling panels.

.3 Miscellaneous automation system equipment, network cabinets and switches.

.4 Fibre optic panels and cabling.

.5 Automation system servers, operator workstations, communications infrastructure and associated network equipment.

.3 Automation system programming, configuration, testing and commissioning to be responsibility of the automation system integrator under the supervision of the controls (automation system) lead.

.4 All automated equipment in the Facility to be integrated with the automation system.

1.2 Standards

.1 WSTP Automation Design Guide in Appendix 18D – City Standards.

.2 ANSI-J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

.3 IEC 61131-3 - Programming Industrial Automation Systems.

.4 IEC 61850 - Communication Networks and Systems in Substations.

.5 IEEE 802.3 - Standard for Ethernet.

.6 IEC 61511 – Safety Instrumented Systems for Process Industries.

1.3 Submittals

.1 Shop Drawings Submittals in accordance with Sections 01300, 16010 and 17800 and include the following:

.1 System overview drawing (including one-line network topology).

.2 Schematic diagrams showing all components and cabling requirements.

.3 Detailed drawings for automation system communications and server cabinets, including BOM for each cabinet, network port designations device layout and input/output (I/O) terminal block designations.

.4 Detailed information for the system hardware and software.

.5 Installation and maintenance instructions.

.6 Automation system I/O interface schedule

.2 Nameplate schedules in accordance with City Nameplate Standards.

.3 Test program (factory acceptance test) for automation system panels.

.4 Testing and commissioning schedule outlining all activities and tests.

.5 Submit testing and commissioning schedule outlining all activities and tests.

.6 Process Control Narratives.

.7 Functional Requirements Specifications.

1.4 Quality assurance

.1 Automation system panel manufacturer to be Schneider Electric certified and CSA approved for the type of Work and installation required.

.2 Automation system integrator to have at least five (5) years' proven corporate experience using Schneider Electric trained technicians and completed at least five (5) industrial process projects in the last five (5) years of similar scale and complexity as the Project configuring and programming PLC control system software using:

.1 Schneider Electric Modicon as per Appendix 18E – Standardized Goods.

.2 Unity Pro software as per Appendix 18E – Standardized Goods.

.3 Or approved equivalent.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Product:

.1 Schneider Electric Modicon M580 Control System as per Appendix 18E – Standardized Goods.

2.2 Configuration, Components and Features

.1 Service Conditions:

.1 Provide electrical power from each independent UPS system (dual supply) to each Automation System PLC, marshalling and network cabinet.

.2 Locate PLC panels and network cabinets in an automation room or an air conditioned electrical room.

.2 Configuration:

.1 All configuration services to be provided by the automation system integrator for the Project.

.2 Program the automation system to function as set out in Process Control Narratives.

.3 Automation system controllers to be configured to execute defined control strategy including but not limited to; scanning of all input signals, generation of control actions based on configured control strategy, output to a final element, and transfer data to servers. The Design Builder shall provide the following to the DB system integrator for the automation system configuration:

.1 Completed I/O database files.

.2 Process Global Overview Diagrams.

.3 P&ID Diagrams.

.4 Control schematics.

.5 Process Control Narratives.

.6 Functional Requirement Specifications.

2.3 Equipment and System Controls

.1 PLC Panels:

.1 PLC Panels to connect to MCCs, manufacturer supplied equipment controls, PMCS, UPS units, and I/O cabinets using Ethernet interface via a fault-tolerant Ethernet RIO ring network.

.2 Provide accessories necessary for Schneider PLC equipment and communication interfaces in the PLC panels.

.3 Provide passive cooling for the cabinets. If a cabinet is installed in a corrosion controlled environment conditions, use circulation fans for forced cooling.

.4 Provide power supplies, data switches, power conditioners, terminals and all other components required for the PLC Panels.

.5 Supply of terminal blocks, single phase control power circuit breakers, and all associated materials is the responsibility of the panel manufacturer.

.6 The PLC and interface requirements to include the latest technology provided by Schneider Electric available at the later of the following dates:

.1 No earlier than two (2) years after the Effective Date, or

.2 No later than one (1) year prior to the anticipated Functional Completion date of the automation system as set out in the Project Schedule.

.2 PLC Panels:

.1 Provide PLC panels as set out in the Final Design.

.2 PLC panels to connect to field instrumentation or equipment panels and controller cabinets for field wiring using Ethernet interface.

.3 Design, fabricate and install cabinets with all necessary components in the process areas as set out in the Final Design and confirmed by the suppliers.

.4 Example of typical hot-standby rack arrangement and architecture is provided in the Automation Design Guide.

.5 Example of typical Mid-Grade PLC and I/O Rack arrangement and architecture is provided in the Automation Design Guide.

.6 Example of typical Remote I/O Rack arrangement and architecture is provided in the Automation Design Guide.

.7 Supply of terminal blocks, single phase control power circuit breakers, and all associated materials is the responsibility of the panel manufacturer.

.3 Automation System Information Management Hardware:

.1 The automation system will have a minimum of dual pair virtual servers consisting of aspect/domain and connectivity servers, and a minimum of two (2) historian servers. The servers are to be installed in a VMWare ESXi virtual environment.

.2 Servers to be temporary and meet the minimum requirements of hosting all the local servers simultaneously required for a functional headworks system.

.3 Servers must also have the following minimum requirements:

.1 Memory:

.1 16 GB RAM (min.).

.2 Redundant Power supply and fan.

.3 Rack mount or workstation type.

.4 Storage:

.1 Sufficient amount for 5 years of continuous data storage for the headworks PCS.

.5 Symantec Endpoint Protection – DB shall use the City's existing bulk license. If technical reasons prohibit this provide:

.1 McAfee virus scan suite

.2 Or approve equivalent.

.4 The server minimum requirements to be updated to include the latest technology recommended by Schneider Electric available at the later of the following dates:

.1 No earlier than two (2) years after the Effective Date; or

.2 No later than one (1) year prior to the anticipated Functional Completion date of the automation system as set out in the Project Schedule.

.5 All units are to come with the following accessories:

.1 A keyboard;

.2 A video and mouse switch (KVM) set composed of a 17" LCD display; and

.3 An optical mouse.

.6 All computers supplied to be complete with application software and all applicable licenses. The computers to be pre-configured with all software and configuration files and ready to connect and operate when delivered to the site.

.7 Network components (managed switches):

.1 Primary/secondary LAN and HMI:

.1 CISCO.

.2 Schneider Electric.

.3 Or approved equivalent.

.2 Primary/secondary Control:

.1 CISCO.

.2 Schneider Electric.

.3 Or approved equivalent.

.3 Automation system and plant maintenance network:

.1 Schneider Electric.

.2 Westermo.

.3 Or approved equivalent.

.4 Security appliance (router/firewall):

.1 Hirschman.

.2 Tofino.

.3 Or approved equivalent.

.5 Field devices and remote I/O Ethernet Switches:

.1 Schneider Electric as per Appendix 18E – Standardized Goods.

.8 The network components to include the latest technology recommended by Schneider Electric available at the later of the following dates:

.1 No earlier than two (2) years after the Effective Date; or

.2 No later than one (1) year prior to the anticipated Functional Completion date of the automation system as set out in the Project Schedule.

.9 Operator and engineering stations to serve as control stations by monitoring the devices in the system, recording events, indicating alarm conditions, and displaying and logging device data. Workstations to have the following minimum requirements:

.1 Processor: Dell Optiplex Quad Core Intel Xeon Processor 2.4 GHz or faster.

.1 Or approved equivalent.

.2 Memory: 8 GB DDR3 (min.).

.3 Operating System: Windows Server 2016 or greater.

.4 Hard Drive: 1 TB (min).

.5 2 GB or better Graphics Card.

.6 Mouse: optical two-button mouse, USB.

.7 Network Adapter: 2 x Intel PRO 1000PT dual port server adapter.

.1 Or approved equivalent.

.8 2 x Video Monitor LCD 24”.

.9 Power Supply: Energy Smart redundant power supply.

.10 Office basic.

.11 Symantec Endpoint Protection – DB shall use the City's existing bulk license. If technical reasons prohibit this provide:

.1 McAfee virus scan suite

.2 Or approve equivalent.

.10 Supply and install communication and server cabinets as set out in the Final Design.

.11 Network and communications cabinets:

.1 DELL Netshelter SX 42U.

.2 Or approved equivalent.

2.4 Ease of Integration

.1 The automation system to import or export process data from the following:

.1 Wonderware Historian by Schneider as per Appendix 18E – Standardized Goods.

2.5 Design Life Cycle

.1 Provide a system that will have an asset service life and technology life cycle of not less than ten (10) years from the Handover. Include a defined technical migration path for future upgrades and phased equipment replacement beyond ten (10) years.

.2 Provide firmware and software upgrades during the Performance Period to all installed automation system equipment to maintain uniformity at the most recent revision available.

.3 Use components that use an industry recognized open standard (IEEE802 Ethernet) and are interchangeable for other common components supporting similar standards. Proprietary technology is not permitted.

2.6 Support

.1 Provide a maintenance support agreement for automation system support services that includes local expertise and support capability within Manitoba.

.2 Provide an automation system that City persons are able to carry out routine maintenance, adjustments and upgrades without third party support or equipment.

.3 Provide documentation and electronic media support training materials to enable City persons to create, capture and retain system knowledge and local support services sufficient to assure that City persons are able to sustain the automation system knowledge in accordance with the Technical Requirements.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

.3 The system integration shall perform all automation system hardware and software start-up and testing. Start-up and testing including, but not be limited to:

.1 Power-up and verification of all system components including automation system virtual servers and automation system clients.

.2 The verification of proper communication between all CPU's cabinets, servers and client workstations.

.3 The verification of proper communication between all CPU's cabinets, MCC's, I/O Cabinets, field remote manufacturer supplied controllers and other Facility systems (BMS, Security, Fire Alarm, CCTV).

.4 Install automation system cabinets in each electrical room.

.5 Install all power wiring and grounding required to meet the automation system manufacturer's recommended practices and Good Industry Practice.

.6 Install all power, control and instrumentation wiring to automation system controller cabinets, field marshalling panels, interconnection to field controls, motor control and other monitoring or control equipment to the automation system.

.7 Install and connect all services required for the CPU's, including the AC power supply, from the UPS distribution panels. Provide equipment grounds up to and including clean instrumentation ground.

.8 Install all communication cabling required to interconnect the smart MCC's to communication modules located in the controller cabinets.

.9 The doors are hinged on the left side of the cabinet set. This applies to both, the front and the rear door.

.10 Provide redundant power feeders from the installed UPS distribution panels as set out in the Final Design.

.11 Supply, install, fasten, test, and terminate all control circuits, and all branch circuits from automation system panels and I/O panels.

.12 Complete equipment checkout, functional and operational testing activities for automation system in accordance to Section 17908.

END OF SECTION

CONTROL DEVICES

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of control devices for the Work.

1.2 Standards

.1 CSA C22.2 No. 14 – Industrial Control Equipment.

1.3 Submittals

.1 Submit Shop Drawings in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Omron.

.2 Schneider Electric.

.3 Allen Bradley.

.4 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Control Relays:

.1 Provide flat-pin encapsulated type plug-in relays.

.2 120 VAC relays to be Idec RH2B-ULC type, 2PDT, plug-in, complete with test button, operation indicator, and surge suppressor.

.3 24 VDC relays to be Idec RH2B-ULC type, 2PDT, plug-in, complete with test button, operation indicator (red), and surge suppression RC Circuit. RC circuit may be external to relay using manufacturer's approved components, soldered and insulated using heat-shrink sleeves.

.4 Relay contacts to be form C rated 110 VAC, 10 A resistive and 7.5 A inductive.

.5 The quality and type of relays to be based on Idec types.

.1 Acceptable Products:

.1 Omron LY 2PDT (120 VAC) and MY 2PDT (24 VDC).

.2 Or approved equivalent.

.2 Timing Relays:

.1 Do not use plug-in timer relays.

.3 Pushbuttons:

.1 Minimum standard is heavy duty, oil tight, Push-to-test, or as specified for field-located devices.

.2 Operator colour coding: green for start, red for stop and black for reset.

.3 Operator style: flush for start and reset, extended for stop, mushroom head for emergency stop.

.4 Contact arrangement to suit control requirements.

.5 Provide NEMA 4X legend plates and nameplates in accordance with the Standard Details.

.6 Acceptable Product:

.1 Schneider products.

.2 Or approved equivalent.

.4 Limit Switches:

.1 Standard is for heavy duty and oil tight limit switches.

.2 Adjustable wand type operating levers.

.3 Acceptable Product:

.1 Schneider products.

.2 Or approved equivalent.

.5 Selector Switches:

.1 Minimum standard is heavy duty, oil tight, or as specified for field-located devices.

.2 Maintained, spring return, 2, 3 or multiple positions.

.3 Operator style:

.1 Manufacturer standard.

.4 Contact arrangement to suit control requirements.

.5 Provide NEMA 4X legend plates and nameplates in accordance with the Standard Details.

.6 Acceptable Product:

.1 Schneider products.

.2 Or approved equivalent.

.6 Indicating Lights:

.1 Minimum standard is heavy duty oil tight, or as specified for field-located devices.

.2 24 V or 120 VAC transformer type push-to-test, LED type.

.3 Lens colours: green for running, red for stop or fault, white (clear) for normal condition or as indicated in the Final Design.

.4 Provide NEMA 4X legend plates and nameplates in accordance with the Standard Details.

.5 Acceptable Product:

.1 Schneider products.

.2 Or approved equivalent.

.7 Control Circuit Transformers:

.1 Single phase, dry type.

.2 Provide dead-front primary fuse required by CSA/EEMAC.

.3 Indicating-type secondary fuse as required by load being served.

.4 Close voltage regulation as required by magnetic and solenoid coils.

.5 VA rating as required by loads being serviced plus an allowance of 20% for future requirements.

.8 Control Fuse Holders and Fuses:

.1 Provide fuse protection for all control circuits including primary and secondary windings of instrument transformers, voltage sensing circuits, and current sensing circuits.

.2 Type and size as selected by panel builder for optimum protection of equipment being served.

.3 Door mounted fuse holders for small dimension fuses 6.4 mm x 31.8 mm (¼ inch x 1¼ inch) Bussmann. Use different models for different voltages including:

.1 120 VAC circuits, Type HKL with clear octagon knob.

.2 12 VDC circuits, Type HKT with amber octagon knob.

.3 24 VDC circuits, Type HKX with amber flat sided knob.

.4 Fuse holder mounted on back pan to be dead-front type (Finger-Safe) Ferraz Shawmut Ultrasafe complete with blown fuse indicator. All control power fuse holders to be complete with blown fuse indicators, LED lights. Blown fuse indicators to be located on the inside of the equipment enclosure.

2.3 Spare Parts

.1 Include the following in the Spare Parts list:

.1 Three (3) spare fuses for each type and size of fuse used.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

PROGRAMMABLE LOGIC CONTROLLERS

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of programmable logic controllers (PLC).

.2 Provide PLC based control systems for each building and process area where specified in the process and HVAC sections of the technical requirements. All new PLC systems shall be provided in accordance with the Technical Requirements, and the Automation Design Guide.

.3 Unless otherwise specified, all PLC and HMI systems software, licensing, and programming services shall be provided by the DB systems integrator.

.1 Design Builder shall notify the City before purchasing any software licences. If the City has a bulk license for the required software the City may require the Design Builder to use their copy of the license.

.4 Provide PLC based control systems when specified as part of a stand-alone vendor equipment package in accordance with the requirements detailed in Divisions 11 and 15. PLC based control systems supplied as part of a vendor equipment package shall conform to the extent possible with the Technical Requirements, and the Automation Design Guide.

.5 Where PLC based control systems are supplied as part of a vendor equipment package, the equipment vendor shall supply all PLC hardware components, HMI station, data communications hardware, termination accessories, special interface modules and associated software and licences. The equipment vendor shall program the system and provide a fully functional, tested and operational system, and shall cooperate with the DB systems integrator to test and commission the package interface to the plant SCADA.

.6 Provide the testing and commissioning of the entire PLC communications network to the automation system using Ethernet protocol.

.7 Conform to the requirements of Divisions 15, 16, 17, the Technical Requirements, and the Automation Design Guide.

1.2 Standards

.1 CAN/CSA E61131-2 – Programmable Controllers – Part 2: Equipment Requirements and Tests.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

.2 A copy of the documented PLC and HMI program files are to be submitted in electronic form.

1.4 Quality Assurance

.1 Factory acceptance testing in accordance with this Section.

.2 Provide manufacturer's representative to witness testing and commissioning of field operation of the equipment and communication connection to the automation system.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Provide the following Schneider Electric PLC and HMI products as per Appendix 18E – Standardized Goods:

.1 Processor M580; with Hot/Standby abilities for critical processes.

.2 Communication modules.

.3 HMI Magelis GTO 12.1" or higher.

.4 Vijeo Designer environment.

.5 Citect SCADA software.

2.2 Performance Criteria

.1 Function:

.1 PLC systems to be control panel mounted, fully programmed, functional and operational as a stand-alone control system ready to be integrated with the automation system.

.2 When required by the application or when specified, provide a Schneider Electric HMI, as per Appendix 18E – Standardized Goods, for equipment operation and alarming, completely configured and programmed.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

.3 Factory Acceptance Testing:

.1 Provide all applicable testing and testing forms in accordance with Section 17905 and 17907.

.2 Provide factory acceptance testing of manufacturer supplied and programmed equipment system prior to shipment.

.3 Testing of manufacturer supplied and programmed system to consist of a complete simulation of the process or equipment to be controlled and verification of interlocking and operator station controls and alarming.

.4 Additional testing includes, but is not limited to, testing of all PLC I/O panel wiring connections, testing of all HMI screens and pushbutton functions, testing of all interlocks with equipment supplied by others, confirming the operation integrity of all network communications including the link and "failure relay".

3.2 Installation

.1 PLC and HMI:

.1 Install PLC hardware and HMI in accordance with the manufacturer’s latest installation publication.

.2 Utilize "single slot" I/O addressing as defined by the Schneider Electric programming manual for the system.

.3 All PLC discrete I/Os to be 120 VAC. All equipment I/O points are to be isolated points powered from the equipment being controlled.

.4 When specified or required, provide a Schneider Electric HMI for equipment operation and alarming, completely configured and programmed and complete with programming software.

.5 Configure and wire HMI in accordance with the manufacturer’s installation and programming manual. Contact Engineer of Record for address assignments when the HMI or PLC is connected to the plant control or maintenance Ethernet network.

.6 Provide manufacturer's representative for a minimum of two (2) Business Days for witness testing and commissioning of each complete packaged system.

.2 Miscellaneous:

.1 Unless specified otherwise, complete installation in accordance with CSA C22.1 and as amended for use in the Province Manitoba by the Manitoba and local electrical authorities.

.2 Provide 25 percent spare slots in the PLC rack.

.3 Discrete output cards to carry rated connected loads without the need for interposing relays.

.4 Mount the PLC and HMI on a control panel at an ergonomically correct operating height.

.5 Provide a minimum of two (2) software licenses for the HMI and programming software unless a City copy of the license is being used.

.3 Wiring:

.1 All wire and cable to meet requirements of Sections 16122 and 16124.

.2 Conform to the requirements of Section 16160 for panel wiring.

.3 Use 16 AWG conductors from I/O wiring arm to panel terminal blocks only: all field and equipment conductor sizing and wiring types to meet requirements detailed in Section 16122.

.4 Wire all I/O to terminal blocks, whether used or spare.

.4 Grounding and Bonding:

.1 Ground and bond PLC and HMI to the ground bus within the control panel in accordance with the manufacturer's latest grounding publication and the CEC.

.2 Use a minimum 8 AWG copper conductor to ground HMI and I/O chassis.

END OF SECTION

PLC PROGRAMMING GUIDELINES

1. GENERAL

1.1 Summary

.1 This Section covers the programming guidelines to be observed when Schneider Electric Modicon PLC hardware provides the control logic for packaged equipment for the Work.

.2 Conform to the requirements of Section 17905.

.3 Use this specification in conjunction with Section 17831.

.4 Use the configuration provided within the City Standards.

1.2 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

.2 Provide three (3) copies of documentation detailed in of this Section. Each copy to consist of:

.1 Printout of program showing all descriptors and including address references. Outputs only cross references are to be shown below the rung.

.2 Copy of the program and documentation files on a DVD disk. The disk will include the latest version of all required files.

.3 Print outs to be printed on 11 x 8.5 in. paper in landscape mode, bound in 3 ring binders of a maximum of 3 inch thick, printed at 8 lines per inch and 12 characters per inch resolution, and program sections to be separated and identified by tabs.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Schneider Electric Vijeo Citect HMI development software as per Appendix 18E – Standardized Goods.

.2 Schneider Electric Unity Pro XL PLC programming software as per Appendix 18E – Standardized Goods.

.3 Schneider Electric Wonderware Historian client as per Appendix 18E – Standardized Goods.

.4 Schneider Electric SoMove motor control equipment configuration software or approved equivalent.

.5 MDT AutoSave change management software or approved equivalent.

.6 Schneider Electric approved Process simulation software acceptance testing and operating training system software or approved equivalent.

2.2 Performance Criteria

.1 Program Documentation:

.1 Refer to the Automation Design Guide for programming language preferences and related justification. Function block is generally preferred for most general applications and ladder logic may be used where analog operations are not required. Instruction list, structured text and SFC are generally not recommended except for special circumstances where the preferred languages prove to be too cumbersome or inefficient.

.2 The foremost consideration in program documentation is that it is meaningful to maintenance staff.

.3 Provide program documentation in detail that City staff experienced in PLCs but inexperienced in the process area are able to troubleshoot maintenance calls without extensive training. Provide all documentation in the English language.

.4 The standards in this guideline give minimum levels of documentation and are not meant to limit the documentation supplied.

.5 Provide a symbol and address comment for all word and bit addresses.

.6 Where address comments are inappropriate use instruction comments to improve clarity and understanding.

.7 Provide rung/block comments of sufficient detail to provide a clear definition of program functionality and how it relates to process flow.

.8 Provide rung/block comments at least every five (5) rungs/blocks to describe functional groups of program. Provide at every rung/block if program complexity requires explanation.

.9 A description of the sequence of operation is required separate from the ladder logic/functional block documentation.

.10 Provide supplemental documentation where rung/block comments do not provide sufficient detail for maintenance functions. Supplemental documentation will include, but not be limited to, details of:

.1 Intelligent modules.

.2 High level programs.

.3 Sequencers.

.4 PID controls.

.5 Program flow.

.6 LAN communication (Ethernet IP, Modbus TCP).

.7 Data flow diagrams for analog modules.

.11 Samples of documentation have been provided by the City.

.12 Document all unused input or outputs supplied as "SPARE" in the address comment.

.13 Name program files as related to content in that file.

.14 Any user made function blocks must contain an accurate description of its logic and purpose.

.15 Provide a searchable compiled PDF compiled of all custom function blocks including a description, implementation example with an explanation of the example, and a reference to where it can be found in use in the system. Provide a guide of how to integrate each custom function for new applications.

.2 Programming Guidelines:

.1 Refer to the Automation Design Guide for programming language preferences and related justification. Function block is generally preferred for most general applications and ladder logic may be used where analog operations are not required. Instruction list, structured text and SFC are generally not recommended except for special circumstances where the preferred languages prove to be too cumbersome or inefficient (for example, mathematical calculations/formulas).

.1 Structured text is shall be used if possible when constants, settings or parameters must be hard-coded.

.2 Structured text or ladder logic shall be used when possible for mapping physical I/O.

.2 These programming guidelines exist for the purpose of allowing maintainable programs to be developed and to facilitate the implementation of reliable control systems. All applications have unique properties and all programs cannot therefore be identical. These guidelines are intended as an aid to keep program structure consistent across the City.

.3 The guideline in no way inhibits innovative ideas, new engineering applications or methods of the design. Obtain approval from the Engineer of Record prior to deviations from the guidelines. Comprehend the basic requirements of the equipment and ensure the engineering design and programming concepts reflect the Specifications.

.4 Maintain revisions list corresponding to program changes by the programmer and record, along with the date, in the program title as follows:

.1 All dates shall be in X.Z –YYYY – MM – DD format.

.2 Where X is a major change and Z is a minor change number.

.5 Program Files:

.1 Break programs up into multiple program files to provide better program organization. Program file lengths to be determined by the individual process. Program files to be less than fifty (50) rungs in length.

.2 Do not exceed forty (40) program files in total number per process area and sorted appropriately.

.3 Locate program file breaks at logical breaks in the process.

.4 Program flow will follow a pattern of process flow.

.5 Use program file MainProgram file to schedule all other files. Limit control logic to program files other than file MainProgram file.

.6 Limit control program file nesting to two (2) levels deep.

.7 Use non-control program files to isolate control rungs and make troubleshooting easier.

.8 Non-control program files to reside as the last files and may include the following:

.1 Diagnostic Files: ethernet, debugging, system health, and process considerations.

.2 Calculations.

.3 Data Block Transfers.

.4 Traps.

.9 Schedule non-control program files on a time or event basis in order to minimize scan times, if they are not required to run continuously.

.10 Other control program files may include: Fault Routine for orderly shutdown or power-up; Selectable Timed Interrupt file – use only when necessary and ensure the interrupt time selected is longer than the scan time of the interrupt file.

.6 Logic.

.1 Do not multiplex logic unless memory requirements are critical.

.2 Any parameter passing between program files to be explicit in the logic.

.3 Avoid indirect and indexed addressing.

.4 Most likey to be false instructions to be left most on rungs in order to minimize scan times.

.5 Do not use latched (OTL) instructions on output rungs except where status must be retained on power outage.

.6 Do not exceed display size for control rungs; with symbols on and comments off. Rungs to be printable on one (1) page.

.7 Minimize the number of intermediary (store) points.

.8 Diagnostic rungs to be a minimum 10 percent of program size and include, but not be limited to, reporting of I/O rack status and the battery low indication.

.7 Block Transfers and Message Instructions.

.1 Instructions to be time or event scheduled.

.2 Provide data integrity logic including, but not limited to:

.1 Buffered and synchronized data where appropriate.

.2 Error checking using block transfer and message instruction status bits.

.3 Checking queue full bits and taking appropriate action.

.3 Do not use continuous mode.

.4 Provide logic to set all data to a safe state in the event communications is lost.

.8 Valuable data (setpoints, constants, settings) shall be protected from data loss in the event of a PLC cold start. Design Builder shall use the Schneider recommended method of assigning these %MW addresses and disabling initialization of %MW on cold start. Use of the %S94 bit for this purpose is not allowed unless otherwise directed by the City.

.9 PLC hardware alarms shall be read by SCADA directly from the PLC's system words, there shall be no intermediate PLC logic used to generate PLC hardware alarms that are available from the PLC's system words.

.10 The following M580 configuration settings shall be enabled to allow online modification of PLC programs:

.1 Online Modification in Run or Stop

.2 Allow Logic Mismatch (for Hot Standby configuration), using the default value of 20 for the allowed number of logic mismatched

.11 Analog inputs shall be configured such that readings within the range of 3.8 - 20.5 mA are allowed, and any reading outside this range will be treated as faulted.

.12 I/O addressing in the PLC shall match the PID drawings in order to facilitate troubleshooting.

.1 Topological addressing shall be used for local I/O.

.2 Device DDT addressing is used for remote I/O, and module names shall reflect the physical module location (bus, drop, rack and slot – e.g. EIO1.D1.R1.S1).

.3 In mixed applications (i.e. local and remote I/O) Device DDT type I/O shall be used for both.

.13 Nested custom derived function blocks (DFBs) shall be avoided whenever possible.

.14 Elementary variables shall be used for links between different programming sections.

.1 Avoid the use of DFB pin names for inter-section links.

.2 Use connectors/links for connections within a section.

.15 Communication to all field network devices shall utilize DTMs from Schneider's DTM library.

.1 In no case shall manually polling data using read/write function codes be used unless permission is gained from the City. Each instance of manually polling requires separate permission. When gaining permission, this specification and clause shall be referenced.

.16 Program tasks shall be structured in sequential order as follows: "Inputs Mapping Sections", followed by "Process Sections", followed by "Outputs Mapping Sections".

.1 Monitoring, alarms, or configuration sections shall be located at either the head or end of the task.

.3 Ethernet:

.1 Data integrity is of paramount importance whenever a serial link is used in control involving personnel safety, equipment safety, and avoidance of environmental impact. Serial links used for control and operator I/O (live displays or stop-starts) to incorporate a watchdog timer causing an orderly shutdown to a safe state and initiating an alarm on failure of the serial link.

.2 Real-time control shall be performed by the local PLC.

.3 Structure programs to synchronize loading data from unsolicited communications into the control program.

.4 Include programs to monitor the processors on the data highway and take appropriate actions if one goes off line.

.5 Provide every device on a highway that uses only the Basic Command Set, with a separate Integer file to be assigned in all PLCs on that highway which communicate with it. The Integer file number (in decimal) must correspond to the station number (in octal) of the Basic Command Set device.

.6 Make file assignments and reserve necessary files in all PLCs communicating on the highway.

.7 The method of error checking on the asynchronous link is CRC.

.8 Minimize highway traffic by reporting the exception with unsolicited writes.

.1 Partition data into separate files as opposed to data blocks within one (1) file to allow for better memory management. Allow for expanding and contracting file sized without affecting adjacent data table areas.

.2 Keep data table files smaller than one hundred (100) elements and segmented by physical production areas.

.3 Arrange data tables in a fashion that facilitates easy troubleshooting and maintenance. Include the grouping of related functions (motor starters and controls) into logical areas and patterns that reflect the process sequence.

.4 If more space is required, store most frequently used data in the memory areas indicated above. Position references to data in higher addresses further right on a rung so their instructions are less likely to be executed during each program scan.

.5 Create data table files with 25 percent spare storage capacity up to a maximum of one hundred (100) spare elements. Create a minimum fifty (50) elements for each data table type.

.6 To set to a safe state, provide logic in the appropriate Input area of the data table associated with each active chassis and set the inhibit bit(s) in the event that any of these racks fault. Input field data to remain in its last state upon a chassis failure. Logic is required to periodically attempt to reset the failed chassis as appropriate to the application.

.7 Use input file 1 and Output file 0 for field device state data only.

.8 Setup an I/O status file to allow for masking and reporting of rack status.

.4 PLC Processor Configuration:

.1 Use the major fault bit to force the processor into program mode upon power up if the process requires this feature.

.2 Provide a minimum of 25 percent unused I/O capacity above the machine's initial requirements for future expansion.

.3 Provide a minimum of 25 percent user logic memory above the systems initial requirements.

.4 Do not use complimentary I/O chassis techniques.

.5 Do not install EEPROM's in the processor.

.6 Configure the PLCs for Automatic Start in Run.

.7 All PLCs' time shall be synchronized to the primary and secondary HMI servers using the primary as the primary NTP source.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 The Project includes supplying and installing of instrumentation and control equipment for the Facility. Detailed requirements for specific instrumentation devices, installation requirements are specified in other Sections of Appendix 18A.

.2 Provide all instrumentation including all installation, certification, adjustment and start-up of a complete, coordinated system that will reliably perform the intended functions.

.3 Provide all final power and signal connections, hydraulic, pneumatic and electric, to all elements provided under this Section and all other instrumentation and control equipment required.

.4 For all elements provided under this Section, and all elements interfaced to the automation system, provide verification and certification the final signal connections and correctness of adjustment are complete.

.5 The Project will include but not be limited to:

.1 Provision of all instrument and control devices, mounting hardware, installation materials, cable and terminations required for completed and correctly operating systems.

.2 All testing and commissioning of equipment, devices and/or systems in this Section to be provided. Testing and commissioning will to be in accordance with Sections 16020 and 17908.

.3 The Project will include a fully tested and commissioned complete control system, including the automation system equipment and software.

1.2 Standards

.1 NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

.2 NEMA ICS 6 - Enclosures for Industrial Control and Systems.

.3 IEEE 472 - Surge withstand standard.

.4 NEMA IA 2.2 - Programmable Controllers Part 2: Equipment Requirements.

.5 IEC 61131-2 - Programmable Controllers Part 2: Equipment Requirements and Tests.

.6 ISA/ANSI S5.4 - Instrument Loop Diagram Standards.

1.3 Definitions

.1 Words and Terms:

.1 Advanced Control:

.1 Multi-variable, constraint and optimizing controls to be labeled advanced controls. This includes supervisory controls.

.2 Application Software:

.1 The software written specifically to perform functional requirements for an individual plant when standard software packages cannot be configured to meet the requirements. Application software works with the standard operating software; it does not modify any standard software.

.3 Automation System:

.1 A process automation, control, and diagnostic system that is composed of distinct modules. These modules may be physically and functionally distributed over the Facility. The automation system contains all the modules and associated software required to accomplish the regulatory and supervisory control and monitoring of a process plant.

.4 Auto Sense:

.1 Capability by the system to automatically detect and recognize any hardware upon addition to or removal from the system without user intervention.

.5 Auxiliary System:

.1 A control and/or monitoring system that is stand-alone, performs a specialized task, and communicates with the automation system.

.6 Call Up Time:

.1 The time between when the operator initially enters a display request and when all objects, lines, values (good or invalid), trends and other parts of the display have been fully presented to the operator.

.7 Communications Subsystem:

.1 The hardware and software that performs the transmitting and receiving of digital information.

.8 Configurable:

.1 The capability to select and connect standard hardware modules to create a system; or the capability to change functionality or sizing of software functions by changing parameters without having to modify or regenerate software.

.9 Console:

.1 A collection of one (1) or more workstations and associated equipment including printers and communications devices used by an individual to interact with the automation system and perform other functions.

.10 Cycle:

.1 The scanning of inputs, by a PLC, execution of algorithms and transmission of output values to devices.

.11 Deadband:

.1 The range through which an input signal may be varied without initiating an action or observable change in output signal.

.12 Discrete Control:

.1 Control where inputs, algorithms, and, outputs are based on logical (yes or no) values.

.13 Faceplate:

.1 A graphic element that mimics the front panel of an analog controller instrument, hardwired push-button or switch and the graphical representation on the Operator Interface

.14 Invalid Value:

.1 The state of a tag value which indicates that the quantity being measured or calculated is out-of-range, not measurable or calculable.

.15 Logs:

.1 Files or printouts of information in chronological order.

.16 Mode:

.1 Control block operational condition, including manual, automatic, or cascade conditions.

.17 Module:

.1 An assembly of interconnected components that constitute an identifiable device, instrument, or piece of equipment. A module can be disconnected, removed as a unit, and replaced with a spare. It has definable performance characteristics that permit it to be tested as a unit.

.18 OPC (Object Linking and Embedding for Process Control):

.1 Software application which allows bi-directional real time data flow between two (2) separate applications. These applications may be running on the same or on separate servers.

.19 Operational Data:

.1 The statistical data including alarm limits, tuning parameters, and clamping values.

.20 Operator Console:

.1 A console used by an operator to perform the functions required to monitor and control his assigned units.

.21 Plant Area:

.1 The designated points (inputs, outputs, and calculated values) that belong to a geographic or functional section of a plant or facility or Process Function Code.

.22 Plug and Play:

.1 The ability of hardware equipment to automatically identify itself to the system. When the equipment is powered up it is automatically assigned a unique identity without the need to set any dip or other switches.

.23 Point:

.1 A process variable derived from an input signal or calculated in a process calculation.

.24 Process Data:

.1 The statistical data including input values, output values and set points.

.25 Redundant Configuration:

.1 A system/subsystem configuration that provides automatic switchover, in the event of a failure, without loss of a system function.

.26 Regulatory Control:

.1 The functions of process measurement, control algorithm execution, and final control device manipulation that provide closed loop control of a plant process.

.27 Reliability:

.1 The probability that the system or component will perform its intended function for a specified period of time.

.28 Self-Diagnostic:

.1 The capability of an electronic device to monitor its own status and indicate faults that occur within the device.

.29 Supervisory Control:

.1 Higher level control functions that interface with regulatory controllers and other automation system equipment to provide for integrated control.

.30 System Access Restriction:

.1 Access control by key lock, password or other equivalent method.

.31 System Alarm:

.1 Alarm that occurs as a result of an automation system hardware or software fault.

.32 System Operating Software:

.1 The manufacturer's standard software that performs the basic functions of the system.

.33 Verify or Certify:

.1 Where the term "verify" and "certify" are stated in this Specification, provide formal statements in writing that the particular activity has been accomplished. Execute all required certification and verification tasks in an organized manner that is acceptable to the Engineer of Record.

1.4 Submittals

.1 Submit Shop Drawings in accordance with Sections 01300, 16010 and 17800.

.2 Submittal Documents:

.1 Shop Drawings will demonstrate that the equipment and services to be furnished comply with the provisions of the DBA including schedules and Appendixes and will provide a complete record of the equipment as manufactured and delivered.

.2 Include the following material in the submittal package:

.1 Loop diagrams, which will consist of an individual wiring and/or plumbing diagram for each instrument loop showing all terminal numbers, the location of the DC and AC power supply, the location of any booster relays or common dropping resistors. Loop diagrams to be provided for all analog and digital loops.

.2 Detailed terminal layout drawings for all junction boxes, Local Control Panels, and Marshalling panels for this Project. All panels identified on the plans require detailed terminal layout drawings. Panels include but are not limited to LCP panels, PLC panels, cabinets, and enclosures where wiring installations are made. Drawings will have overall panel dimensions, subpanel layout and terminal connection information indicating device tag and wire numbers.

.3 Detailed Network device and equipment layout drawings including all communications devices not limited to controllers, switches, UPS Systems, and other network devices.

.3 Field Instruments:

.1 Submit complete documentation of all field instruments using ISA-S20 data sheet formats. Submit a complete BOM or Index that lists all instrumentation equipment ordered by the loop numbering system as set out in the Final Design.

.2 Submit separate data sheets for each instrument including:

.1 Plant Equipment Number, descriptor, and ISA tag number per the Drawings.

.2 Product (item) name used in the Final Design.

.3 Manufacturer's complete model number.

.4 Location of the device.

.5 Input output characteristics.

.6 Range, size, and graduations in engineering units.

.7 Physical size with dimensions, enclosure NEMA classification and mounting details.

.8 Materials of construction for enclosure and wetted parts.

.9 Instrument or control device sizing calculations.

.10 Certified calibration data for all flow metering devices.

.11 Two-wire or four-wire device type as applicable.

.12 Recommended calibration schedule.

.13 All other required information specific to the asset type as per Appendix 18H – Asset Data

.3 Submit index and data sheets in electronic format as well as hard copies on 8½" x 11" A size formats. Electronic format to be in Microsoft Excel or Word. Submit electronic copy on CD-ROM or DVD disk. The City will provide templates for this in order to import data smoothly in the OWAM.

.4 Panel Details.

.1 Cabinet assembly and layout drawings to scale. The assembly drawing will include a BOM on the drawing with each panel component clearly defined. The BOM to be cross-referenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.

.5 Panel control schematics, wiring and interconnection diagrams detailing the electrical connections of all equipment in and on the panel. Diagrams will include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering, purpose of terminals for external connections.

.6 Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations will include the recommended type of equipment required for both heating and cooling.

.7 Submit evidence that all control panels to be constructed in conformance with UL 508 and CEC Part 2 and bear the cUL or CSA seal confirming the construction.

.8 Point-to-Point I/O Wiring Diagrams: Point to point I/O wiring diagrams depicting wiring within the panel as well as connections to external devices. Field device wiring will include the device ISA-tag and a unique numeric identifier. If ISA loop wiring diagrams are also specified, equipment external to the control panel and related external connections do not need to be shown on the point-to-point I/O wiring diagrams. The diagrams will identify all device terminal points that the system connects to. Wiring labeling used on the drawings will match the Final Design. I/O wiring to be numbered with rack number, slot number, and point number. Two-wire and four-wire equipment to be clearly identified and power sources noted. Submit final wire numbering scheme. Point-to-point drawings to be 11” x17” (B) size.

.9 Loop wiring diagrams: detailed loop wiring diagrams showing requirements for each loop which is shown in the Final Design. The loop drawings to be prepared in accordance with City Standards. Loop drawings to be 11”x17” (B) size. The information required on the loop drawings in order to satisfy the “minimum” and “optional” requirements is as follows:

.1 Identification of the loop and loop components as set out in the Final Design.

.2 Word description of loop functions within the title. If not adequate, use a supplemental note. Identify any special features or functions of shutdown and safety circuits.

.3 Indication of the interrelation to other instrumentation loops, including overrides, interlocks, cascaded set points, shutdowns and safety circuits.

.4 All point-to-point interconnections with identifying numbers or colors of electrical cables, conductors, and individual pneumatic and hydraulic tubing. This identification of interconnections includes junction boxes, terminals, bulkheads, ports, and grounding connections.

.5 General location of devices including field, panel, auxiliary equipment, rack, termination cabinet, local control panels, PLC panels, electrical room, and I/O cabinet.

.6 Energy sources of devices, including electrical power, air supply, and hydraulic fluid supply. Identify voltage, pressure, and other applicable requirements. For electrical sources, identify circuit or disconnect numbers.

.7 Process lines and equipment sufficient to describe the process side of the loop and provide clarity of control action. Include what is being measured and what is being controlled.

.8 Actions or fail-safe positions (electronic, pneumatic, or both) of control devices including controllers, switches, control valves, solenoid valves, and transmitters. These are to be identified in accordance with ISA-5.1, “Instrumentation Symbols and Identification”.

.10 Other required items – The following information to be provided on loop drawings, in a tabular format, in order to meet this requirement:

.1 Process equipment, lines, and their identification numbers, source, designation, or flow direction.

.2 Reference to supplementary records and drawings, including installation details, P&IDs, location drawings, wiring diagrams or drawings, and instrument specifications.

.3 Specific location of each device, including elevation, area, panel subdivision, rack or cabinet number and location and I/O location.

.11 Cross reference between loops that share a common discrete component including dual indicators.

.12 References to equipment descriptions, manufacturers, model numbers, hardware types, specifications or data sheets and purchase order numbers.

.13 Signal ranges and calibration information, including set point values for switches, and alarm and shutdown devices.

.14 Software reference numbers, including I/O addresses, control block types and names, network interfaces and point names.

.15 Engraving or legend information that helps identify the instrument or accessory.

.16 Accessories, tagged or otherwise identified, including regulators, filters, purge meters, manifold valves and root valves.

.17 References to manufacturer's documentation including schematics, connection details, and operating instructions.

.18 Color code identification for conductors or tubes that use numbers for differentiation.

2. PRODUCTS

2.1 Performance and Design Criteria

.1 Instrumentation and equipment to be designed for service life requirements set out in Appendix 18D and under conditions specified herein, including, but not limited to, corrosive atmospheres and intermittent or continuous operation.

.2 Provide equipment specifically designed for reliable operation in an emergency and after extended periods of non-operation.

.3 All wearing parts and items requiring adjustment to be readily accessible. Equipment to be located, mounted and guarded as to protect it from accidental damage or from deterioration from exposure.

.4 Submit certification that the instrument manufacturer approves the selection of materials of primary elements which are in contact with the specified process fluid to be inert to the effects of the process fluid.

.5 All instrumentation and equipment to be designed to meet the specified conditions and to operate at Winnipeg elevations.

.6 Instrumentation equipment to be the standard product offering of the manufacturer.

.7 Ensure compatibility of all signals, power supplies and interconnected devices. Provide isolation, shielding, grounding, and protection as required for a properly functioning installation. Any equipment, hardware or testing required to achieve this result to be included in the Project.

.8 Bus Networks and Segment Drawings:

.1 The final bus networks and segment/loop drawings to be updated and provided following the submission of Shop Drawings and the various procured equipment suppliers. Allow for all necessary and appropriate installation requirements.

.2 Provide all the necessary allowance for all cables, conduits and connections to equipment and control panels, and between equipment components, as set out in the Final Design.

.9 Summary:

.1 All equipment supplied to be selected for its superior quality and intended performance.

.2 Unless specified otherwise, electric power supply to loop powered instruments to be 24 VDC and to AC powered instrumentation and controls to be 120 VAC.

.3 Signal Characteristics:

.1 Analog signals to be 4-20 mA DC with HART and will conform to the compatibility requirements of ISA Standard S50.1. Circuits to be Type 2 - 2 wire. Transmitters will have a load resistance capability conforming to Class L. Transmitters and receivers to be fully isolated.

.2 Pulse frequency signals will use dc pulses whose repetition rate is linearly proportional to the process variable over a 10:1 range. Pulses may be generated by contact closures or solid state switches. Power source to be less than 30 VDC.

.3 Discrete signals are two-state logic signals of two (2) types. Control and alarm signals will utilize 120 VAC sources.

.4 Profibus signals will conform to the Profibus technical guidelines as developed by PROFIBUS International.

.4 Environmental Conditions:

.1 Equipment to be provided for the following environmental conditions:

.1 Temperature: 2 to 40ºC.

.2 Relative Humidity: 10 to 90 percent.

.3 Enclosure Rating: NEMA Type 12.

.5 Metering Accuracy:

.1 System metering accuracy, as compared to the actual process value, to be determined from the value read at the principal readout device including the recorder, totalizer or human machine interface device. The requirements for overall system accuracy will not preclude any requirements specified herein for individual devices.

.2 For systems whose primary measuring device, transmitter, and receiver are furnished under this Section, the accuracies to be within the following limits:

.1 Pressure: 1.0 percent of measured span.

.2 Flow: 2.0 percent of actual flow rate between 10 and 100 percent of scale.

.3 Temperature: 1.0 percent of measured span.

.4 Position: 2.0 percent maximum travel.

.5 Thermal dispersion flow metering: 1.0 percent of full scale between 10 and 100 percent of scale.

.6 Differential producing primary element type metering: 2.0 percent of full scale between 15 and 100 percent of scale.

.6 Appurtenances:

.1 Signal converters, signal boosters, amplifiers, special power supplies, special cable, and special grounding and isolation devices to be furnished and installed as required for proper performance of the equipment.

.2 All direct process connected instrumentation to be provided with a 3-way valve manifold for isolation and calibration.

.7 Programming Devices:

.1 All instrument interrogation/ configuration devices required to service instruments on Parcel A shall be provided to the city at Handover and these shall be in addition to all instrument interrogation /configuration devices required to service instruments on Parcel B, which shall also be provided complete and in like-new condition.

2.2 Configuration, Components and Features

.1 Mounting Hardware:

.1 All instrumentation and equipment furnished under this Section to be provided with all manufactured supplied mounting hardware to mount the device according to the mounting requirements indicated in the individual device specification or the instrument data sheet.

.2 Lightning/Surge Protection:

.1 General:

.1 Provide surge/transient protection system containing surge/transient protection devices (SPDs) on all services entering all PCS control panels, marshalling cabinets, automation equipment panels, servers, and workstations.

.2 Acceptable Manufacturers:

.1 Weidmuller.

.2 Joslyn Telematic.

.3 Phoenix Contact.

.4 Or approved equivalent.

.2 AC Power SPDs:

.1 Provide SPD on AC power feed into the protected system, rated for normal operation current ±50%.

.2 SPD to provide duplicated and redundant protection networks based on MOVs with electronic monitoring and remote indication of service availability.

.3 SPDs to comply with CSA C22.2 No. 0, UL1449 and let through voltages as follows:

	Voltage (nom.)	Let through (L N G, N G, L L).
.1		
.2	120/208	400 V.
.3	220/380	700 V.
.4	600	1100 V.

.4 Internal line noise filters to be CSA approved.

.5 Panel board protectors to be Category C1/B3 as per IEEE C62.41 1991; 6 V/3 kA impulse rated.

.3 Data Communication SPDs:

.1 Manufacturers' confirmation of device suitability for application to be provided.

.2 Devices to provide full hybrid GDT plus secondary semiconductor) electronic protection devices.

.3 Hybrid SPDs to be rated for minimum 10 kA (8/20 micro-seconds) peak impulses.

.4 SPD leakage current on communication circuits to be 10 FA maximum at normal operating voltage.

.5 SPDs to be encapsulated or otherwise protected from casual interference, and all SPD components to be within one (1) housing per loop.

.6 Means to be provided for individual loop identification, which will positively identify that loop and be transferable to any replacement device. Adhesive labels will not be permitted.

.7 SPD common grounding to be provided automatically with mounting and is not to require additional grounding connections after mounting. Grounding can be via dedicated bulbar or via DIN rail, both to be insulated from chassis steelwork until connected at the dedicated system grounding point.

.4 Tubing and Fittings:

.1 All instruments take-offs and branch connections less than 50 mm to be Type 316 stainless steel.

.2 All instrument shut off valves and associated fittings to be supplied in accordance with the piping specifications and all instrument installation details. The materials for fittings and valves to be compatible with process fluids. Where metallic fittings and valves are compatible, wetted materials to be Type 316 stainless steel.

.3 The materials for instrument tubing to be compatible with process fluids. Where metallic tubing is compatible, tubing to be fully annealed ASTM A269 Seamless Type 316 grade free of scratches having the following dimensional characteristics as required to fit the specific installation:

.1 6 mm to 12 mm O.D. by 0.89 mm wall thickness.

.2 16 mm to 25 mm O.D. by 1.25 mm wall thickness.

.3 25 mm O.D. by 1.65 mm wall thickness.

.4 32 mm O.D. by 1.65 mm wall thickness.

.5 38 mm O.D. by 2.11 mm wall thickness.

.6 51 mm O.D. by 2.41 mm wall thickness.

2.3 Finishes

.1 Equipment Finish:

.1 Provide materials and equipment with manufacturer's standard finish system. Provide manufacturer's standard finish colour, except where specific colour is indicated. If manufacturer has no standard colour, finish equipment with ANSI 61-gray colour.

.2 Touch-up Painting:

.1 Touch-up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, colour, consistency, and type of surface of the original finish.

2.4 Identification

.1 Each instrument and controlled device provided to be identified on instrument data sheet and each instrument to be provided with a permanent identification tag in accordance with the City's Standards. Where primary elements and transmitters are physically separated, an identification tag for both devices to be provided. All field-mounted elements and transmitters will have engraved lamacoid identification tags. Panel, sub-panel, and rack-mounted devices will have engraved lamacoid identification tags securely fastened to the device.

.2 Identification tags will contain tag numbers in accordance with the Final Design.

.3 Provide tags for all instruments.

2.5 Spare Parts:

.1 Provide a list of recommended spares and expendable items in sufficient quantities and pricing to sustain the Instrumentation and Control System for a period of two (2) years after completion.

.2 Provide a component part list. The component part list to include a complete parts list for the entire Instrumentation and Control System, and will have the following features:

.1 All components to be grouped by component type, with the component types identified in a similar manner to the component identification code used in Appendix 18A, in accordance with Appendix 18D. .

.2 All components to be listed with their exact and complete manufacturer's part number, including all options or accessories.

.3 All components to be identified with their complete tag number indicated in the Final Design.

.4 All components without tag numbers to be grouped within component types by manufacturer's part number. Exact quantities to be listed for each part number.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

.3 Provide factory acceptance test and shop test results prior delivery to the site. Factory acceptance test and shop test procedures to satisfy the following minimum requirements:

.1 Visual inspection of equipment, instruments, control panels, and graphic displays.

.2 Validation of each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs. Validation to include:

.1 Monitoring state changes on operator interface screens based on the inputs state change.

.2 Observation of the automation system programming application software with the associated processor outputs state change.

.3 Outputs triggered by operator interface software devices (pushbuttons, sliders, and manually-entered values).

.4 Calibration and operation of instruments on or in the control panels.

.5 Repair of loops which do not pass validation and re-test the system.

.3 Calibration:

.1 Instruments are to be factory pre-calibrated. Provide a printed record of the factory calibration parameters for "smart" devices.

.2 Prior to calibration completely program "smart" transmitters including entries of the appropriate range and tag number.

.3 Instruments are to be calibrated by manufacturer approved instrument technician.

.4 Calibrate instruments to an accuracy of 0.5 percent of full range, or to the manufacturer's stated accuracy of the instrument whenever an accuracy of 0.5 percent is not achievable.

.5 Perform the following applicable calibration for each instrument and its associated signal conditioning equipment:

.1 Calibrate in line flow meters by a draw-down test.

.2 Calibrate vacuum and pressure instruments by manometer or accurate test instrument and hand test pump.

.3 Calibrate gas detectors using standard gas sample.

.4 Calibrate temperature instruments against a standard lab constant-temperature bath.

.5 Calibrate all other instruments (including pH and DO) according to manufacturer’s recommended procedure.

.6 Test equipment for calibration to be certified and valid at time of calibration.

.7 Provide a printed calibration record for each instrument.

.8 Provide manufacturer specific hardware, adapters, or tools, required for the calibration of the instrument.

.4 The instrumentation equipment provided to be installed in accordance with the manufacturer's instructions, the applicable Standard Details, and any related requirements of the Final Design.

.5 Instrumentation provided to be calibrated and tested by a qualified professional. The calibration is to be recorded in a report and submitted to the Engineer of Record for review and incorporation in the instrument checkout tag.

.6 Complete equipment checkout, functional and operational testing activities for Instrumentation and Controls equipment in accordance to Section 17907.

END OF SECTION

POWER SUPPLIES AND CONDITIONING EQUIPMENT

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of instrumentation and control power supplies and conditioning equipment for the Work.

1.2 Standards

.1 CSA C22.2 No. 107.1 – General Use Power Supplies.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Power Supplies:

.1 Hammond.

.2 Or approved equivalent.

.2 Automation System Power Supplies:

.1 Weidmuller.

.2 Sola.

.3 Or approved equivalent

.3 Conditioning Equipment:

.1 Sola.

.2 Or approved equivalent.

.4 Hybrid Filters:

.1 Control Concepts Corp. (subsidiary of Liebert Corp.) Islatrol IC+107 series "Active Tracking" filters.

.2 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Power Supplies:

.1 Provide all DC power supplies as required for all instrument circuits. Power supplies to be regulated, purposed built for PLCs, and be complete with an overvoltage protection module.

.2 Provide redundant configurations for power supply equipment serving more than one (1) instrument loop, so that failure of a single unit will not disable all or any shared part of the instrumentation and communication system. Provide diode isolation for redundant direct current supply units and ground the negative terminal of the power supply.

.3 Power supplies and transmitters feeding circuits that run in non-armoured cable in cable tray to meet the requirements for Class 2 circuits as defined by the CEC.

.4 Provide all DC power supplies to be rated 28 VDC, adjustable plus or minus 5 percent, and set to provide 26.4 V on the panel direct current bus. Minimum size is 10 A.

.2 Automation System Power Supplies:

.1 Power supply to be 24 VDC with minimum 5.5 A at 60°C with 120 VAC input, LED power indicator and CSA Class 2 listed.

.2 Provide redundant configurations for power supply equipment serving an Ethernet/IP network, so that failure of a single unit will not disable all or any part of the communication network.

.3 Conditioning Equipment:

.1 Isolation Transformers:

.1 Provide triple shielded isolation transformers for AC powered instrumentation loads containing solid state circuitry.

.2 Hybrid Filters:

.1 Provide series powerline filters for AC powered instrumentation loads containing solid state circuitry or microprocessors.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specified the testing and commissioning requirements for the Instrumentation and Control Systems.

1.2 Standards

.1 ANSI/IEEE Std. 100 - The Authoritative Dictionary of IEEE Standards Terms.

.2 TIA/EIA-TSB140 - Additional guidelines for field testing of Optical Fibre Cabling Systems.

.3 ISA S51.1 - Process Instrumentation Terminology.

.4 NEMA ICS 1 - Instrumentation Control and Systems General Requirements.

1.3 Definitions

.1 Terminology used in this Section conforms to the following definitions:

.2 Interpret specialized terms not explicitly defined herein as specified in ISA S51.1, NEMA ICS 1, ANSI/IEEE Std 100, and The Communications Standard Dictionary, by Martin H. Weik.

.3 Loop Testing:

.1 Testing, checking, and correcting deficiencies of instrumentation and control signal generation, transmission, reception, and response. Testing activities to be iterative due to failsafe switch interrogation.

.2 Sequential testing of all I/O between field devices and automation system by using the actual process variable or injection of the appropriate range of field signals in the I/O from a calibrated testing instrument.

.3 Verification of automation system loop output associated with each I/O on automation system HMI in response to each value of field signals injected by calibrated testing instrument.

.4 Using appropriate calibrated testing instrument, measurement and verification of automation system output signal sent back to associated field device in response to associated field signal injection.

.4 The following terms are used for the purpose of describing quality assurance and testing requirements:

.1 Factory Acceptance Tests: operation, programming, configuration, and testing of assembled system that may be witnessed by City's Representative and performed at the manufacturer's factory prior to shipping equipment to site. Complete factory acceptance tests prior to commencing Equipment Checkout.

.2 Shop Tests: testing of assembled system prior to it shipping to site. Complete shop test prior to commencing Equipment Checkout.

.3 Site Acceptance Tests: testing of installed system prior to or as part of Equipment Checkout.

1.4 Administrative Requirements

.1 Provide procedures in accordance with Sections 17905.

.2 Notify designer and City a minimum of ten (10) Business Days prior to commencing loop tests to demonstrate continuity and correct operation.

.3 Notify designer and City a minimum of ten (10) Business Days prior to commencing site acceptance tests testing.

.4 Provide all components, commodities, services, and personnel required to conduct tests for the Project.

1.5 Submittals

.1 Provide submittals according to Sections 01300, 16010 and 17800.

.2 Submit testing and commissioning schedule outlining all activities and tests.

.3 Submit a report with the completed tests and applicable testing forms.

.4 Submit details of all test procedures and instruments including I/O interface summary, together with technician's names responsible for carrying out the test.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

.3 Testing:

.1 Perform calibration in accordance with the following.

.1 Section 16020 and Section 17908.

.2 All supplied instruments to be factory pre-calibrated. Provide a printed record of the factory calibration parameters for all devices.

.3 Prior to on-site calibration completely program all "smart" transmitters including entries of the appropriate range and tag number.

.4 Instruments to be set up and calibrated by a qualified professional and working under the supervision of the instrument manufacturer.

.5 Calibrate all instruments to an accuracy of 0.5 percent of full range, or to the manufacturer's stated accuracy of the instrument whenever an accuracy of 0.5 percent is not achievable.

.2 Prior to instrument commissioning, perform the following applicable calibration for each instrument and its associated signal conditioning equipment:

.1 Calibrate all in-line flow meters by a weight-tank or volumetric test.

.2 Calibrate all vacuum and pressure instruments by manometer or accurate test instrument and hand test pump.

.3 Calibrate analytical instruments using the manufacturer’s recommended procedure and standardized samples.

.4 Calibrate temperature instruments against a standard lab constant temperature bath.

.3 Provide a printed calibration record for each instrument.

.4 Test equipment for calibration must have been certified and valid at time of calibration.

.5 After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops.

.6 Check the operation of all final control elements including solenoid valves, actuators, and the like by manual control before checking with automatic control.

.7 Check the electrical and pneumatic failsafe operations of all final control elements including solenoid valves and actuators.

.8 Test all tubing for leaks in compliance with ISA RP 7.1. Isolate all instruments when tubing is being tested to protect against over-pressure.

.9 Carry out all tests, sign and date all test reports.

.10 Provide two (2) weeks written notice to the designer and the City prior to energizing any system.

.11 Provide a qualified professional to remove covers for inspection and to perform tests as requested by the City Representative.

.12 Demonstrate to City proper calibration and correct operation of instruments and gauges.

.13 Ensure all instrument calibration and testing is complete and all appropriate testing forms have been completed and submitted.

.14 Provide the following:

.1 Verify signal levels and wiring connections to all instrumentation and control equipment.

.2 Verify and adjust under the Final Design service conditions the instruments and control equipment.

.3 Submit loop testing forms for each loop number (with wiring and calibration testing forms).

.4 Field Quality Control:

.1 Inspection:

.1 All panels, consoles and cabinets to be inspected by a Qualified Professional. Inspection will include, but not be limited to the following:

.1 Nameplates and tags.

.2 Wire sizes and color coding.

.3 Terminal block spare requirements.

.4 Proper wiring practices and grounding as per code requirements.

.5 Enclosure flatness, finish and colour.

.2 Submit documentation verifying that the inspections have been completed.

.2 Tests:

.1 All special testing materials and equipment to be provided. Where it is not practical to test with real process variables, provide suitable means of simulation. These simulation techniques to be subject to the approval of the City.

.2 The term calibration where used herein is understood to include the following: All continuous elements and systems will have multi- point calibrations performed and transmitter output verification at five (5) process points compared to a standard method acceptable. Factory calibration data sheets to be provided for instruments that are calibrated at the factory. Field calibration reports to be provided for instruments that require calibration using standards in the field. Field calibration will use the most rigorous method indicated in the specific manufacturer manual. All instruments to be field verified (checked) using five points as indicated herein. Field calibration report to be provided for instruments that are field verified for record purposes.

.3 Test Documentation:

.1 Documentation for testing of the Instrumentation and Control System to include:

.1 Check-off sheet(s) for each loop and an instrument calibration sheet for each active instrumentation element (except simple hand switches and lights).

Check-off and data sheets will form the basis for the tests and this documentation.

.2 Each loop check-off sheet will cite the following information and will provide spaces for sign-off on individual items and on the completed loop:

.1 Project name.

.2 Unit process.

.3 Loop number.

.4 Loop description.

.5 Installation check.

.6 Termination check.

.7 Calibration check.

.8 Adjustment check.

.9 Space for comments.

.10 Space for loop sign-off and date.

.2 For each element: tag number, description, manufacturer and model number, installation bulletin, and Specification sheet number;

.3 Each instrument calibration sheet will provide the following information and a space for sign-off on individual items and on the completed unit:

.1 Project name.

.2 Unit process.

.3 Loop number.

.4 Tag number.

.5 Manufacturer.

.6 Model number.

.7 Serial number.

.8 Calibration range.

.9 Calibration data: input, output, and error at 0 percent, 10 percent, 50 percent, 90 percent and 100 percent of span.

.10 Switch setting, contact action, and deadband for discrete elements.

.11 Space for comments.

.12 Space for sign-off and date.

.5 Progress Tracking of Loop Testing:

.1 Provide I/O interface summary (Microsoft Excel .xlsx format) for each system or sub-system in accordance with the City Standards. Spreadsheets to include the following for each I/O point:

.1 Signal number/tag.

.2 Annotation description.

.3 Complete physical I/O channel designation and addressing or communication I/O register designation.

.4 True/False status designations for digital I/O.

.5 Alarm thresholds and states.

.6 Process range; engineering units and any multipliers; and raw signal range count for analog I/O.

.7 Signals: Fixed point and scaled at the controller with minimum four (4) significant implied digits of scaling. E.g.: 0 to 1400 at controller for a pH range of 0 to 14 at operator interface.

.8 Provide operator interface scaling to display decimal digits required.

.2 Maintain a summary list of all completed tests and all outstanding tests and publish this summary at the end of each testing day.

.6 Instrumentation Loop Testing:

.1 Before commencing loop testing, ensure all instrumentation has been satisfactorily calibrated.

.2 Each instrument loop to be tested as an integrated system. Check operation from field instruments to transmitter to receiving components to the control panel or the facility control system operator interface station. Test signals to be injected at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

.3 After devices within a loop have been connected, check the loop for correct functioning and interaction with other loops.

.4 Check the operation of final control elements including solenoid valves and actuators by manual control before checking with automatic control.

.5 Check the electrical and failsafe operations of final control elements including solenoid valves, and actuators.

.6 Alarm functions, thresholds, and states.

.7 If the output control or monitoring device fails to indicate properly, complete corrections to the loop circuitry or device.

.8 Testing of loops with an interface to a programmable control system to include verification of processor input/output assignment and verification of operation of the input/output system and processor. Inspect the data table or register in the processor memory to verify proper operation.

.9 Perform continuity testing of cables and leak testing of tubing and record results in a form.

.10 The Engineer of Record and City's Representative will select up to 5 percent of the cables to be re-tested in their presence. Submit re-test results as specified in testing form. If any of the tests fail, complete repairs and re-test all cables as per above. Repeat continuity testing on 5 percent of a new set of randomly selected cables in the presence of the Engineer of Record and City's Representative.

.11 Correct loop circuitry and repeat the test until the instruments operate properly. Make as many corrections, modifications or adjustments as required to ensure proper function.

.12 The tests to be repeated until devices and instruments operate.

.13 Perform tests and record results on testing forms. Develop additional and/or more detailed testing forms as necessary to suit more complex instrumentation.

.14 Sign and date test reports.

.7 Checkout Tags:

.1 Instrument checkout tag size to be 90 mm x 215 mm, orange-coloured tag stock and include metal reinforced eye. A sample tag detail is listed in Standard Details.

.2 Upon receipt affix an instrument checkout tag to each instrument. The tag must remain with the instrument.

.3 Maintain the tag by signing and dating each section of the tag as the instrument is received, calibrated, installed, and checked out. Perform tests and record test results or make cross-reference to the appropriate testing form in the "Remark" section.

.8 Field Device Checklist:

.1 The following is a minimum checklist for all field-mounted devices:

.1 Cables and the individual conductors are tagged and identified.

.2 Cables are terminated on approved termination blocks.

.3 Conductors are terminated in an approved manner on termination blocks and at connection points on the device.

.4 Provide plug and receptacles for connect field devices.

.5 Termination boxes and junction boxes are identified and tagged.

.6 Cables are supported and strapped.

.7 Field Instruments (including flow meter and level transmitter) are tagged and identified.

.8 Instruments are bonded to ground, and signal shield is not bonded to ground except at the host controller. (Signal shield is continuous and not bonded to any other signal shields in the field or field JB).

.9 Instruments are adequately supported.

.10 Instruments are located free of mechanical damage.

.11 Instruments are new.

.12 Instruments are free of dents, scratches, cracks, breaks, defects and damage.

.13 Instruments are rated for the environment in which they are placed (indoor, corrosive, hazardous and outdoor).

.14 Flexible connections or fittings are used to connect to the instruments.

.15 Fittings for connections are water tight and secure.

.16 Instrument control wiring is separated from power wiring.

.17 Instrument control cable is shielded, twisted or configured in an approved manner to minimize electromagnetic and electrostatic interference.

.18 Instruments are tested, calibrated and adjusted to operate within prescribed parameters.

.19 ‘Loop check sheets’ and ‘instrument calibration sheets’ have been completed for each device.

.20 Exact Instrument location has been signed off with the Engineer of Record.

.21 Wiring at different voltage levels within the same junction box or termination box are segregated by an effective barrier.

.22 A minimum clearance of 30 mm is provided between the wireway and any point of wire termination.

3.2 Functional Testing

.1 Loop Tests:

.1 Prepare, complete and submit two (2) types of testing forms as follows:

.1 For those functions that can be demonstrated on a loop-by-loop basis, the form will include:

.1 Project name.

.2 Unit process.

.3 Loop number.

.4 Loop description.

.5 For each loop component: tag number, description, manufacturer, and data sheet number.

.6 Space for sign-off and date for the qualified professional and the Engineer of Record.

.2 For those functions that cannot be demonstrated on a loop-by-loop basis, the testing form will indicate a listing of the specific tests to be conducted. With each test description the following information to be included:

.1 Specification page and paragraph of function demonstrated.

.2 Description of function.

.3 Space for sign-off and date for the qualified professional and the Engineer of Record.

.2 Testing Forms:

.1 Review and complete all Instrumentation and Controls System testing forms in accordance with Sections 17905.

.3 Site Acceptance Testing:

.1 Testing must not commence until the instrumentation loop testing has been completed and documented.

.2 Testing consists of installing and debugging the automation system control logic program, verifying the interface points between the automation system and field devices and equipment, and exercising the automation system controls. Testing to be performed on one (1) automation system processor at a time.

.3 Provide qualified professional to immediately correct any deficiencies that may be encountered during testing.

.4 Verify and adjust under service conditions the instruments and control equipment.

.5 Verify signal levels and wiring connections to instrumentation and control equipment.

.6 Submit loop testing form for each loop number (with wiring and piping testing form and calibration testing forms).

.4 Closed Loop Testing:

.1 Tests to demonstrate stable operation of each loop under operating conditions. Testing activities to include adjustment of loop tuning parameters.

.2 Tuning parameters: gain (or proportional band), integral time constant, and derivative time constant for each control loop, adjusted to provide 1/4-amplitude damping.

.3 The loop response to a step disturbance to be provided for each loop. Two (2) graphs to be made for cascaded control loops; one showing the secondary loop response with its set point in manual, and the second showing overall loop response.

.4 Control loops with "batch" features to be adjusted to provide optimum response following start-up from an integral action saturation condition.

.5 Graph recording to be provided showing the response and made at sufficient speed and amplitude to show 1/4 amplitude damping. Label to show loop number and title, and settings of parameters and set point.

.6 Where a loop is controlled under the direction of an automation system processor, perform the necessary adjustment of loop tuning parameters and set points. Record the loop response, adjusting final elements, and assuring total integrated loop performance as specified.

3.3 Operational Testing

.1 Prior to Operational Testing, ensure that instrument calibration and Functional Testing are complete and the appropriate testing forms have been completed and submitted.

.2 Re-verify all function check and adjust under operational conditions the instruments and control equipment.

.3 Re-verify all loop-loop and closed loop tests performed under the functional test phase of the Instrumentation and Controls System requirements.

.4 Adjust, modify and re-calibrate all instruments to meet the requirements of the Technical Requirements.

END OF SECTION

AUTOMATION SYSTEM TESTING

1. GENERAL

1.1 Summary

.1 This Section covers the testing and commissioning requirements for the automation system for the Work.

.2 Conduct and document all testing identified herein.

1.2 Submittals

.1 Provide submittals according to Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Configuration, Components and Features

.1 Tools:

.1 Provide any specialized tools and services including fiber optic and wired network analysis and testing equipment, Provide process simulation software to facilitate factory testing of the application programs..

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

3.2 Factory Acceptance Tests

.1 In advance of factory acceptance tests, inspect and test automation system components to ensure they are fully functional and ready for factory acceptance tests.

.2 All cabinets, panels, and assemblies, which will form part of the automation system, to be inspected and Shop Tests to verify that they are in conformance with Appendix 18A.

.3 All tests to be itemized and the results documented. Documentation to be submitted to the Engineer of Record for review and certification.

3.3 Equipment Checkout

.1 Integrated Systems Tests:

.1 Conduct hardware verification tests for functionality of the backbone communication cabling infrastructure associated with the automation system.

.2 Conduct end-to-end hardware data communication system tests for all equipment that interface with the automation system and the automation system network. Verification and interface tests with the automation system hardware will include:

.1 Electrical equipment including metering.

.2 Automation equipment.

.3 Stand-alone vendor package control panels that communicate with automation system.

.4 PCS equipment.

.5 Building systems including Fire Alarm System, Security Access Control, CCTV, Radio system.

.6 All other stand-alone control systems.

.3 Conduct end-to-end automation system software tests using the automation system software to verify the correct operation of all communication points, I/O points and associated indications, HMI Views and workstation displays. Verification and interface tests with the automation system software will include:

.1 Electrical equipment including metering.

.2 Automation equipment.

.3 Vendor package control panels that communicate with automation system.

.4 PCS equipment including;.

.1 Server redundancy tests

.2 Power failure and recovery

.3 Network security

.4 Network latency.

.5 Wifi coverage in all plant areas

.6 Graphic display latency

.7 Alarm management

.8 System user credentials

.9 Histroian functionality

.10 Reporting functions and trend displays

.5 Miscellaneous Systems

.6 Building systems including Fire Alarm System, Security Access Control, CCTV, Radio system.

.7 Interface and functionality of enterprise systems including the computerized work management system, and the lab information management system.

.8 All other stand-alone control systems.

.2 PLC (Control Logic) Verification Testing:

.1 General:

.1 Conduct control logic verification testing in accordance with the Commissioning Plan and to meet the requirements of the Final Design. Coordinate the integrated system verification tests with the automation system software configuration developed by the automation system integrator. The control logic verification testing will include testing of the interfaces from the automation system to all systems and sub-systems within the Facility.

.2 Record all final control descriptions in As-Built Documents.

.2 Component/Equipment Verification and Testing:

.1 Level 1 – Equipment Verification Forms:

.1 Provide component verification forms.

.2 Perform all tests and measurements and recording results on the component verification forms.

.3 For proof of control logic utilize a simulator as part of the factory acceptance testing.

.2 Level 2 – Point Verifications:

.1 Prove all wiring and loops between the various components.

.2 Confirm that the loop test has been completed and record on the verification forms.

.3 Level 3 – Subsystem Verifications:

.1 All subsystem verification and testing to be performed.

.2 All related components verification to be completed prior to executing subsystem verifications.

.3 Subsystem verifications to be detailed on verification forms.

.4 The verification tests are intended to prove the integrity of the hardware and software for each individual subsystem. Tests will include but not be limited to the following:

.1 Operation of system in “Local” mode (Operator Initiated).

.2 Operation of system in “Remote” mode (by the automation system).

.3 Emergency Manual Mode (automation system failed).

.4 Safe operation or shutdown in response to a power failure.

.5 Maintain process control performance as set out in Appendix 18A and the Final Design.

.3 Panel Device Checklist:

.1 The following is a minimum checklist for all field-mounted devices:

.1 Cables and the individual conductors are tagged and identified.

.2 Cables are terminated on approved termination blocks.

.3 Conductors are terminated in an approved manner on termination blocks and at connection points on the device.

.4 All Instrumentation Field Devices and wiring are tested and checked.

.5 Wiring at different voltage levels within the same controls panel are segregated by an effective barrier.

.6 A minimum clearance of 30 mm is provided between the wireway and any point of wire termination.

.4 Functional Readiness Tests:

.1 Prior to Functional Testing, ensure that the requirements of Section 17907 are completed. Coordinate all testing activities with the automation system integrator.

.2 Prior to Functional Testing, the entire installed automation system is to be certified by the Engineer of Record that it is ready to be put into service.

.3 Prior to functional testing, ensure that all electrical, instrumentation and automation system checkout testing, adjustment and calibration are complete.

3.4 Functional Testing

.1 Perform testing of each of the field devices, Fieldbus network segments and Ethernet network segments. These tests will include, but not be limited to functional tests, resistance checks, capacitance checks, DC voltage checks and AC measurement (waveform) checks.

.2 Site Acceptance Tests:

.1 Include the following:

.1 Verify and test of each of the field devices, Fieldbus network segments and Ethernet network segments. These tests will include, but not be limited to functional tests, resistance checks, capacitance checks, DC voltage checks and AC measurement (waveform) checks. Check test results against expected design values recommended by the manufacturer and approved by the Engineer of Record.

.2 Carry out field testing to confirm the automation system configuration and HMI graphics are in accordance with the Final Design including but not limited to process control descriptions.

.3 Verify all electrical, instrumentation and automation system component calibration and provide adjustments necessary to meet the requirements of the Final Design.

.4 Designer to provide forms for documentation.

.3 All tests to be itemized and the results documented. Documentation to be submitted to the Engineer of Record for review and certification.

3.5 Operational Testing

.1 Include the following:

.1 Testing under nominal and peak hydraulic and contaminant loading conditions to verify performance of the automation system and provide adjustments necessary to meet the requirements of the Final Design.

.2 Re-test and tune automation system configuration and HMI graphics to be in accordance with the Final Design.

.3 Verify all electrical, instrumentation and automation system component calibration and provide adjustments necessary to meet the requirements of the Final Design.

.2 All tests to be itemized and the results documented. Documentation to be submitted to the Engineer of Record for review and certification.

END OF SECTION

CONTROL PANELS

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of control panels and enclosures for the Work.

.2 Additional control panel requirements are specified in the Standard Details.

1.2 Standards

.1 CSA C22.2 No. 14 - Industrial Control Equipment.

.2 CSA C22.2 No. 286 - Industrial control panels and assemblies.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Performance Criteria

.1 Provide outside finishes on all enclosures in ANSI 61 Grey.

.2 The enclosures shall be suitable for carrying the weight of the equipment mounted within the panel and on the doors without any warping.

.3 Provide NEMA type 12 gasketted enclosures in electrical rooms and control rooms.

.4 All enclosures for mounting outside of electrical rooms and control rooms shall be NEMA Type 4X, Type 316 stainless steel, corrosion resistant except where otherwise specified.

.5 All enclosures for mounting in electrically hazardous areas shall be suitably rated for the defined electrical hazard level in the area.

.6 Design enclosures for equipment in and around classified areas including sumps and odour control room according to Section 01450.

.7 Where possible, locate panels away from areas with the potential for dripping, splashing, spray, excessive heat, excessive cold, or flooding.

.8 Provide auxiliary heating or cooling systems for panels where ambient conditions will cause panel internal temperatures to exceed published limits for the equipment contained with the panel.

.9 Provide and install circuit breakers, fuses, terminal blocks, and relays as required in the Final Design.

.10 Provide RF shielding to cabinetry sufficient to ensure unaffected operation of the electronic devices housed within the cabinet upon the operation of a 5 watt 850 to 900 MHz handheld

radio placed at a distance of 500 mm from the cabinet with the cabinet doors closed and locked.

.11 Panels and junction boxes shall be the same or of superior quality and construction to the enclosures specified in this Section and shown in the DBA Drawings. Acceptable Products: Hammond, Hoffman.

.12 Provide a duplex receptacle in each control panel powered from the UPS.

2.2 Configuration, Components and Features

.1 Operator Device Enclosures:

.1 Operator device enclosures for mounting of pushbuttons, pilot lights or selector switches in electrical rooms, control rooms.

.1 Acceptable Product:

.1 Allen Bradley 800T series.

.2 Or approved equivalent.

.2 Operator device enclosures for mounting of pushbuttons, pilot lights or selector switches outside of electrical rooms and control rooms.

.3 Acceptable Product:

.1 Allen Bradley 800H series.

.2 Or approved equivalent.

.2 Control Panel Enclosures:

.1 Enclosure shall be fabricated from minimum 14 gauge steel panels complete with necessary stiffening to form a rigid free-standing lineup, or as specified otherwise. The structures shall be suitable for carrying the weight of the equipment mounted inside the panel and on the doors, and withstand seismic forces.

.2 Enclosure will come complete with inner panel for mounting equipment. Inner panel be made from minimum 14 gauge steel panel and shall be capable of carrying the weight of equipment mounted on it.

.3 Provide front access only. Doors shall be key-lockable and fitted with 3-point heavy-duty latching assemblies. Provide a continuous piano hinge. Each door shall be capable of opening minimum 120 degrees from closed position. NEMA 4X panel will have padlockable door latch.

.4 Finish the interior of the enclosure with white paint.

.3 Terminal Blocks:

.1 Terminal blocks shall be complete with mounting rail, end blocks, and label carriers.

.2 Acceptable Products:

.1 Rail: Weidmuller TS35.

.2 Ground Block:Weidmuller WPE4.

.3 Terminal Block: Weidmuller WDU4.

.4 Fused Terminal Block: Weidmuller WSI 6/2 c/w LED indicator.

.5 Label Carrier: WeidmullerSchT 14/6.

.6 Bus Jumper: WQV.

.7 Or approved equivalent.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

.3 Panel Wiring:

.1 Provide wiring inside the panels according to the following:

.1 Wiring for power distribution shall be a minimum of #12 AWG tinned stranded copper; insulation rated TEW (105°), 600 V.

.2 Control wiring shall be a minimum of #16 AWG tinned stranded copper; insulation rated TEW (105°), 600 V.

.3 Wiring for DC analog signals shall be a minimum of #18 AWG tinned stranded copper; insulation rated at 600 V, shielded pairs..

.2 Tag each wire at both ends with a heat shrink sleeve that is machine printed in accordance with Section 16010.

.3 Wiring systems with different voltage levels or types shall be suitably segregated within the panel, according to the CEC.

.4 Run all wiring in enclosed plastic wireways. Acceptable Manufacturer: Panduit. Size all wireways so that the total cross sectional area of the insulated wire and cable does not exceed 40 percent of the cross sectional area of the wireway.

.5 Provide a minimum clearance of 40 mm between wireways and any point of wire termination.

.6 Terminate all wiring, incoming and outgoing, at terminal strips mounted inside the panels. Identify each terminal strip with a terminal strip number.

.7 Label instrumentation and control conductors as follows:

.1 Label instrumentation and control conductors with the information provided on the instrument loop drawings, motor control schematics and schematic and wiring diagrams.

.2 Identify spare conductors using the destination identifier; i.e. the panel location and terminal identifier of the opposite end of the conductor are combined to form the conductor tag.

.8 Field wiring should enter panels from the bottom or side in all process areas and from the bottom only in or potentially wet process areas, and wherever process or HVAC pipes or vessels are located above. Top entry of wiring to panels will be allowed only in dry areas, electrical rooms, control rooms, automation rooms and server rooms.

.9 Armoured cables to terminate into enclosures through a Teck connector rated for the environmental conditions of the respective process area where the panel is located. Within the enclosure, each armoured cable's inner jacket shall be maintained to group the cable's conductors together to a point within 100 mm of the first conductor's termination.

.10 Un-armoured cables shall terminate into enclosures through a strain relief connector rated for the environmental conditions of the respective process area where the panel is located. Within the enclosure, each cable's outer jacket shall be maintained to group the cable's conductors together to a point within 100 mm of the first conductor's termination.

.4 Panel Grounding:

.1 Provide a ground system for the instrumentation circuits, isolated from the main power system ground to each marshalling panel.

.2 Provide grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor.

.3 Provide in each marshalling panel an isolated grounding bus bar 6 x 25 x 600 mm, equipped with necessary lugs for accepting two #2 AWG external grounding conductors.

.4 Firmly bond all panel mounted devices on or within the panels to ground. Provide supplementary bonding conductors for backpanels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for devices as case mounted instruments and meters.

END OF SECTION

PRESSURE AND TEMPERATURE GAUGES

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of pressure and temperature gauges for the Work.

1.2 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Pressure gauges:

.1 Ashcroft (Drexel Western).

.2 U.S. Gauge.

.3 WIKA (Guillevin International Inc.).

.4 Or approved equivalent.

.2 Temperature gauges:

.1 Ashcroft (Drexel Western).

.2 U.S. Gauge.

.3 WIKA (Guillevin International Inc.)

.4 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Equipment Components:

.1 All devices supplied under this Section to be the product of a single manufacturer.

.2 Pressure and Temperature Gauges:

.1 Provide pressure and temperature gauges. Provide all Instrument Specification Sheets (ISS) (refer to Section 17994) for each instrument.

.2 Where pressure gauges are specified with diaphragm seals or in-line pressure sensors, they to be sealed and calibrated by the manufacturer.

.3 Refer to the requirements of Section 17911 for isolation valves, gauge and transmitter manifolds, diaphragm seals and in-line pressure sensors.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Pressure and temperature gauges ranges shall be selected so that the nominal process variable readings are no more than 50% of the selected span. For a process variable that is expected to be fluctuating, select a range that provides readings no more than 2/3 of the selected span. In all applications, select a range that will accommodate the highest reading available from the respective process.

.3 Provide pressure gauges with stainless steel construction, brass or bronze bourdon tube, 75mm face, 6.35mm process connection, liquid filled, and 1% accuracy.

.4 Provide pressure gauges with diaphragm seals where aggressive chemicals are to be monitored, The diaphragm seal materials shall be selected for compatibility with the process fluids and the ambient environment.

.5 Provide temperature gauges with 50mm tiltable face stainless steel construction and stainless steel thermowell. Select the sensor and thermowell length such that the sensor tip will be inserted to at least 1/3 of the pipe diameter.

.6 Provide temperature gauges with thermowells where aggressive chemicals or slurries are to be monitored, The thermowell material shall be selected for compatibility with the process fluids.

.7 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

PROCESS TAPS AND PRIMARY ELEMENTS

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of process taps and primary elements for the Work.

1.2 Standards

.1 CSA C22.2 No. 14 – Industrial Control Equipment.

.2 CSA C22.2 No. 25 – Explosion-Proof Enclosures for Use in Class II Groups E, F, and G Hazardous Locations.

.3 CSA C22.2 No. 30 – Explosion-Proof Enclosures for Use in Class 1 Hazardous Locations.

.4 CSA C22.2 No. 157 – Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Diaphragm Seals:

.1 Ashcroft.

.2 Or approved equivalent.

.2 In-Line Pressure Sensors:

.1 Red Valve. (Meridian Specialties).

.2 Moyno RKL Series W.

.3 Or approved equivalent.

.3 Manifolds not associated with Pressure Transmitters:

.1 Anderson Greenwood.

.2 Century Valves.

.3 Or approved equivalent.

.4 Manifolds associated with Pressure Transmitters:

.1 Trans-West as per Appendix 18E – Standardized Goods.

2.2 Performance and Design Criteria

.1 All devices supplied under this Section to be the product of a single manufacturer, with the exception of Standardized Goods as per Appendix 18E - Standardized Goods.

2.3 Configuration, Components and Features

.1 Process Taps:

.1 Provide pressure gauge and transmitter, annubar flow element and thermowell tapping requirements in accordance with Division 15.

.2 Provide isolation, gauge and root valves, where specified in accordance with Division 15 and with Standard Details.

.2 Primary Elements:

.1 Provide all primary elements required. Provide all ISS (refer to Section 17994) for each instrument.

.2 When applicable, provide drip pots (pigtail siphon) installed below the pressure elements measuring gas. Provide seamless, stainless steel drip pots.

.3 Refer to Section 17912 when primary elements and indicators are combined.

.4 Provide thermowells with RTDs (Thermal element) when required and provide the ISS for each instrument. Size thermowell based on pipe diameter and install based on Division 15 standard installation details.

.5 In-line flow devices including magmeters, pressure sensors and annubar flow elements are installed as part of the electrical Work.

.6 Materials of primary pressure elements which are in contact with specified process fluid to be inert to the effects of the process fluid.

.7 Provide pressure elements with a process connection as specified on Instrument Specification Sheets.

.8 Temperature elements are to be platinum 100 Ω with an alpha of 0.00385.

.3 Diaphragm Seals:

.1 Diaphragm seals are required for all pressure measurements of dirty fluids and chemical lines.

.2 Provide all diaphragm seals required and provide the ISS (refer to Section 17994).

.3 When diaphragm seals are specified with a pressure gauge or a pressure switch provide the assembly filled with ethylene glycol and calibrated by the manufacturer. When capillary tubing is provided for remote diaphragm seals, cover the tubing with a stainless steel sheath and properly support the capillary tubing in a 4 inch instrument channel.

.4 In-line Pressure Sensors:

.1 Line sized, in-line pressure sensors are required for all pressure measurements of sludge lines and slurry lines.

.2 Provide all in-line pressure sensors required and provide the ISS (refer to Section 17994).

.3 Provide ethylene glycol filled assembly calibrated by the manufacturer when in-line pressure sensors are specified with a pressure gauge, pressure switch, transmitter or in combination. When capillary tubing is provided, cover the tubing with a stainless steel sheath and properly support the capillary tubing in a 4 inch instrument channel. In-line pressure sensors installed by Division 15.

.4 Provide line sized annular ring, flow through type pressure sensors, with stainless steel body, a sensing element compatible with the corrosive and abrasive nature of the fluid being measured.

.5 Acceptable Products:

.1 Red Valve Series 42

.2 Robbins and Myers RKL Series W.

.3 Or approved equivalent.

.6 Provide stainless steel nipples extending to a tee from the pressure sensor. Mount the gauge on one (1) leg of the tee. If a pressure indicator/transmitter/switch is shown on the Drawings, mount on the other side of the tee. Otherwise, plug the tee.

.7 Supply annular type pressure sensors and diaphragm isolators with their initial fill of fluid.

.5 Manifolds:

.1 Manifolds to be three-valve bar-stock type as specified. Machine manifold body from ASTM, Type 316 stainless bar stock. Design manifolds for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not permitted.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

TRANSMITTERS AND INDICATORS

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of transmitters and indicators for the Work.

1.2 Standards

.1 CSA C22.2 No. 14 – Industrial Control Equipment.

.2 CSA C22.2 No. 25 – Explosion-Proof Enclosures for Use in Class II Groups E, F, and G Hazardous Locations.

.3 CSA C22.2 No. 30 – explosion-proof enclosures for use in Class 1 Hazardous Locations.

.4 CSA C22.2 No. 157 – Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Temperature, Pressure (Gauge or Differential), Flow (DP Cell):

.1 Trans-West as per Appendix 18E – Standardized Goods.

.2 Level Ultrasonic Type:

.1 Trans-West as per Appendix 18E – Standardized Goods.

2.2 Configuration, Components and Features

.1 All devices supplied under this Section to be the product of a single manufacturer, with the exception of Standardized Goods as per Appendix 18E - Standardized Goods.

.2 Transmitters and Indicators:

.1 Provide all transmitters and indicators required and provide the ISS (refer to Section 17994).

.2 Transmitters will have adequate power output to drive all devices associated with that signal loop. Provide signal boosters as required to achieve adequate signal strength.

.3 All transmitters to have local indication scaled in engineering units and are to include a lamacoid label indicating the engineering units. The transmitter is to be mounted and correctly oriented and visible from the normal operating floor position.

.4 Provide microprocessor based transmitters as specified on the ISS. All pressure transmitter sensing cells will incorporate an isolating diaphragm in combination with a sensing diaphragm using silicone oil as a pressure transmission medium.

.5 Provide transmitters with integral isolated 4 to 20 mA output “two wire type” transmitters with operating power derived from the signal loop. Transmitters to support an external load of up to 600 Ω or greater with a loop power supply of 24 VDC.

.6 Transmitter’s 4 to 20 mA output to be galvanically isolated from the process and the transmitter case.

.7 Transmitter and/or primary element enclosures (or housings) to be, as a minimum, rated NEMA 4X; where located outdoors or in areas specified as corrosive, enclosures to meet NEMA Type 4X requirements.

.8 Transmitter flanges, adaptors and associated bolts and nuts to be fabricated from Type 316 stainless steel.

.9 All 4-wire transmitters to be supplied with 4-20 mA isolated outputs.

.10 Provide all mounting brackets, cables, connectors and hardware necessary to install primary elements. Provide any and all brackets and sundry hardware to mount the transmitter on standard 50 mm pipestands as required in the mounting details. Fabricate all brackets from aluminum or stainless steel and all sundry hardware from stainless steel. Primary elements and transmitters to be complete with all necessary liquid filling, identification, and configuration as necessary to make the unit ready for use.

.11 Provide a 3-valve manifold for each differential pressure transmitter.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

CONTROL VALVES AND ACTUATORS

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of control valves and actuators for the Work.

.2 Supply installation and testing of electrical and/or pneumatic powered actuators and accessories for controlled devices including various valves, weirs and various gates dampers. In the case of controlled valves, supply of actuator and accessories complete with the valve body to be in accordance with Divisions 11 and 15.

.3 Sizing and selection of modulating control valve components.

.4 Size and match powered actuators to controlled devices.

1.2 Standards

.1 Design Builder will comply with the standards set out in this Section.

1.3 Submittals

.1 Submit design drawings and product data in accordance with Sections 01300, 16010 and 17800.

.2 Complete assembly and installation drawings, wiring and schematic diagrams, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished. Drawings for each unit will include, but not be limited to, overall dimensions, materials, installation details, mounting or support requirements, factory calibration data (including printouts), and power and signal wiring requirements.

.3 Submit manufacturer's catalog data, operating literature, specifications, performance data, instrument data sheet, and calibration curves for each system.

.4 Provide installation, operation and maintenance data as specified in Appendix 18F.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Rotork as per Appendix 18E – Standardized Goods.

.2 Or approved equivalent only when the conditions in Appendix 18E – Standardized Goods do not apply.

.2 Provide in accordance with the WSTP electrical and automation standard.

2.2 Performance Criteria

.1 Provide actuators of NEMA 4X construction, suitable for use in an industrial environment.

.2 Provide device and actuator as a matched set from the same manufacturer.

.3 Tag the control devices, accessories and actuators to indicate operating characteristics. Tag the actuator inlet and outlet ports for electric or pneumatic services. Electric actuators to be CSA approved.

.4 Fill out all ISS for all actuators and the ancillary electrical & instrumentation for the selected supplier.

.5 Provide a remote hardwired hand switch for all motorized, pneumatic and solenoid valves with 3 position functionality 'R/O/C' where; 'R' position (Remote Mode) allows the Plant Control System control over the valve position, 'O' position (Manual Open) drives the valve to the Open position and 'C' position (Manual Close) drives the valve to the Closed position.

2.3 Configuration, Components and Features

.1 Pneumatic Diaphragm Actuators – General:

.1 Provide diaphragm quarter turn and linear actuators capable of continuous duty over the full operating range.

.2 Design Builder to include actuator fail positions for actuators. The actuators will fail to the closed position when the control function fails or when pressure is removed from the actuator diaphragm.

.3 Each actuator to be capable of operating in any horizontal or vertical orientation.

.4 When manual actuation is specified fit each actuator with a hand wheel and gear actuator which will enable manual override control of the valve.

.5 House all internal components in a cast iron enclosure, drip-proof and corrosion-proof.

.2 Pneumatic Diaphragm Quarter Turn Actuators, Modulating Type (PDQM):

.1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for modulating service.

.3 Pneumatic Diaphragm Linear Actuators, Modulating-Type (PDLM):

.1 Diaphragm operators to be suitable for mounting on sliding-stem valves and dampers requiring linear actuation intended for modulating service.

.4 Pneumatic Diaphragm Quarter Turn Actuators, Open/Close-Type (PDQO):

.1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for on/off service.

.2 Provide a solenoid valve, an airset and accessories for each actuator.

.3 Provide two (2) needle valves (snubbers) for each actuator. The needle valves to control instrument air flows such that the actuator travels a full stroke within a time range adjustable from one to thirty (1 to 30) seconds with separate adjustments for each direction of travel.

.5 Pneumatic Piston Actuators – General:

.1 Provide piston actuators of the type specified in Divisions 11 or 15. Two (2) types of quarter-turn pneumatic piston actuators are available: rack and pinion or linkage. Actuators to be capable of continuous duty over the full operating range.

.2 Unless specified otherwise the actuators will fail in the last position when the control function fails or when pressure is removed from the actuator diaphragm.

.3 When manual actuation is specified, fit each actuator with a hand wheel to enable manual override control of the valve. Where actuators are mounted 3 m above surrounding levels, include manual operation for the chain using a hand wheel.

.4 Each actuator to be capable of operating in any horizontal or vertical orientation.

.5 House internal components in a cast iron enclosure, drip-proof and corrosion proof.

.6 Where valves are intended to fail open or closed, provide spring loaded actuators. Where they are intended to fail to last operating position, provide double acting actuators.

.7 Provide an equalizing valve in the control lines of double acting actuators.

.6 Pneumatic Piston Quarter Turn Actuator, Modulating Type (PPQM):

.1 Piston actuators to be suitable for mounting on quarter turn valves or dampers intended for modulating service.

.7 Pneumatic Piston Quarter Turn Actuator, Open/Close Type (PPQO):

.1 Piston operators to be suitable for mounting on quarter turn valves or dampers intended for on/off service. Sector types are not permitted.

.2 Provide actuator accessories including limit switches and position switches.

.3 Provide two (2) needle valves (snubbers) for each actuator. The needle valves to control instrument air flows such that the actuator travels a full stroke within a time range of one to thirty (1 to 30) seconds with separate adjustments for each direction.

.8 Damper Actuators:

.1 Type: heavy duty, electric valve actuator suitable for high duty cycle operation. Acceptable Manufacturers: Auma, Bernard or Rotork.

.2 Operation: 90 degree Stroke, fully modulating.

.3 Minimum design operating torque: 75 Nm.

.4 Control Signals: 4-20 mA.

.5 Power: 120 V/1 ph/60 Hz.

.6 Features: mechanical position input control, position transmitter, open/close limit switches, position indicator, manual override feature complete with manual operator.

.9 Current to Pneumatic (I/P) Converters:

.1 Provide I/P converters as set out by the Final Design.

.2 Supply all required hardware for mounting the I/P converter on the controlled device.

.3 I/P converter to be of NEMA 4X construction or as specified in the Instrument Specification Sheet.

.4 I/P converter to operate with instrument quality, control air at an operating pressure range of 20 to 200 kPa and fitted with output gauges.

.10 Valve Positioners:

.1 Provide positioners pre-mounted to each actuator. Do not mount the positioner upside down.

.2 Each positioner to service the entire operating range of the actuator. The equipment position to be fed back to the positioner through a mechanical linkage.

.3 Positioner to operate with instrument quality, oil-free control air.

.4 Mount a pressure gauge on the positioner to measure air output.

.11 Electro-Mechanical Actuators, General

.1 Provide electric actuators of type specified on the Instrument Specification Sheets.

.2 Unless otherwise specified, design actuators to fail to the last position when the control function or power fails.

.3 Unless otherwise specified, all electric actuators are to be supplied with Profibus communications. Where a specified actuator is not available with Profibus, the actuator shall be supplied with the hardwired signals as specified at the end of this section.

.4 Unless otherwise specified, electric actuators to be 230 V,1 Phase, 60 Hz for service where required torque is less than 115 N.m and 600 V, 3 Phase, 60 Hz for service with torque above 115 N.m. Provide each actuator with a high torque, reversible motor which is capable of continuous duty over the full operating range.

.12 Electric Quarter Turn Actuators, Open/Close Type (EMQO) and Modulating Type (EMQM)

.1 Provide electric operators suitable for mounting on quarter turn valves or dampers intended for ON/OFF or modulating service as required.

.2 Provide each actuator with built-in motor overload protection.

.3 Fit each actuator with a hand wheel which will enable manual override control of the valve.

.4 Design actuators to be capable of operating in a horizontal or vertical orientation.

.5 Provide external mechanical indication of valve position. Provide an external visual position indicator.

.6 House all internal components in a NEMA 4X enclosure, moisture-resistant and corrosion-resistant. All internal components are to be permanently lubricated.

.7 Motors for open-close duty will be rated at 20% intermittent duty cycle or higher. Motors for modulating duty will be rated for continuous duty.

.8 For remote indication provide the actuator with two SPDT travel limit switches, 10A, 125 VAC, UL listed. The travel limit switches to be adjustable.

.9 Provide the actuator with two SPDT torque limit switches, 10A, 125 VAC. The torque limit switches to be factory preset and field adjustable.

.10 Provide adjustable mechanical limit stops to ensure over-turning of the valve does not occur.

.11 The actuator speed will be field adjustable.

.12 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve.

.13 Electric Linear Actuators, Open/Close Type (EMLO) and Modulating Type (EMLM)

.1 Electric actuators for gates to be comprised of an electric motor and one or two gear boxes, depending on the gate design.

.2 Provide a sufficiently sized motor to seat and unseat gates and, if necessary, for control to traverse from full open to full closed position in small increments, in response to control signals.

.3 The actuator will impart a travel speed of 2.5 m/hr to modulating gates and 18.0 m/h to open/close gates unless otherwise specified on the Instrument Specification Sheets. The actuator speed to be field adjustable.

.4 For actuated gates, select actuators that are fully compatible with the gate. Mount actuator at operating height on the frame.

.5 Design actuators to accept 3 Phase, 60 Hz power. Protect motors against reversed phase rotation.

.6 Actuators to accept a 4-20 mA control signal for remote proportional control of gate opening.

.7 The drive train to be rated for heavy duty, continuous service. Connect the actuator drive shaft to gear box shaft(s) through a removable flexible mechanical coupling. Where the actuator is fitted to two stems, ensure that the gearing in each gearbox allows both stems to move identically.

.8 House the internal components of actuators and related gear boxes in weather proof, corrosion proof metal enclosures. House all electrical components in NEMA 4X enclosures. All electrical and mechanical components shall be capable of continuous operation in an ambient temperature range of 15°C to plus 40°C.

.9 Fit actuators with a capstan hand wheel operator. Fit hand wheel assemblies with a clutching mechanism which prevents hand wheel operation during normal motor operation. Provide a 1:1 gearing ratio with respect to the main drive shaft for the hand wheel.

.10 Fit removable safety guards over all moving drive train components between the actuator and each gear box.

.11 Provide adjustable limit switches on each actuator to define the upper and low limit of the stroke.

.12 High torque switches will protect the equipment and the structure against excessive gate travel. Provide high torque protection at the lower and upper ends of the stroke.

.13 Provide a controller enclosure to contain a motor contactor complete with overload protection. Provide line, load, and external control terminal strips.

.14 Fit each actuator with an electronic positioner to control gate position in response to a continuous 4-20 mA DC input signal.

.15 Provide a local operating station with a Local-Off-Remote switch and an Open-Close-Auto switch

.14 Position Switches and Indicators:

.1 When specified, actuator position switches include two (2) form C 2 amp contacts in an NEMA 4X (minimum) rated enclosure.

.2 Cams to be fastened to a splined shaft and adjustable without set screws.

.3 Provide a visual indicator with beacon type display showing red when the controlled device is closed position and green in open.

.4 Supply all required hardware for mounting of position monitor in accordance with the specified valve/actuator orientation.

.5 Valves to have external position indication.

.6 Enclosures to be suitable for environment to which they are exposed.

.15 Minimum monitoring and control signal requirements:

.1 Profibus Communications.shall be provided for all actuators as specified.

.2 Open Close actuator siganls.

.1 Momentary Open Command (Remote dry contact).

.2 Momentary Close Command (Remote dry contact).

.3 Open Status (Dry contact for remote indication).

.4 Closed Status (Dry contact for remote indication).

.5 Computer Mode (Dry contact for remote indication).

.6 Remote dry contacts to be rated 5 A at 120 VAC minimum.

.3 Modulating actuator siganls.

.1 All status signals specified for Open-Close actuators and;

.2 Input signal: 4-20 mA signal (or 3-15 PSI).

.3 Output signal: 4-20 mA signal.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

INSTRUMENT AIR SYSTEMS

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of air and pneumatic signal transmission systems for the Work.

.2 Additional application requirements are detailed in the Instrument Installation Detail Drawings.

.3 Requirements for mechanical equipment and piping are specified in Division 15.

.4 Provide the system to conform to the requirements of Sections 01300, 16010 and 17800.

1.2 Standards

.1 ANSI Z21.80 / CSA-6.22 – Line Pressure Regulators.

1.3 Submittals

.1 Submit product data in accordance with Section 16010.

.2 Submit a mark-up of this Specification; the applicable drawings detailing any deviations or modifications proposed for installation of tubing and ancillary components.

2. PRODUCTS

2.1 Materials

.1 Pneumatic and Process Connections:

.1 Pipe, fittings, valves, tubing and tube fittings required under this Section to be Swagelok and rated for the service in which they are to be employed. Tubing and fittings to be made of Type 316 stainless steel. Plastic tubing is not to be used.

.2 Dimensions:

.1 Process connections: 12 mm O.D. (nominal) tubing.

.2 Output/signal: 10 mm O.D. (nominal) tubing.

.3 Air supply 12 mm pipe (nominal) to isolation valves and 10 mm O.D. tubing (nominal) from isolation valves to end devices (e.g. valves).

.4 Specifications for the air piping systems are detailed in Division 15 including pipe and isolation valves.

.3 Provide a continuous support channel or raceway for all tubing and conform to Section 16191.

2.2 Configuration, Components and Features

.1 Air Sets:

.1 Provide all pneumatic actuator assemblies with an air set.

.2 Air set to be complete with filter regulator and output gauge.

.3 Acceptable Product:

.1 Fisher 67AFR.

.2 Or approved equivalent.

.2 Solenoid Valves:

.1 Provide 2-way direct acting, 3-way direct acting/2 position, 4-way direct acting/2 position and 4-way pilot operated/2 position solenoid valves as needed and provide the ISS in Section 17994.

.2 Solenoid enclosures in hazardous locations is not allowed.

.3 Provide manual overrides on coils.

.4 Standard coil voltage: 120 VAC.

.5 Pipe size, body materials and operating pressure range.

.6 Maximum operating pressure: 850 kPa instrument air.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

.3 Provide all installation requirements for valve and instrument air supply.

.4 Group instruments logically together. Orient instrument air and process connection isolation valves to provide consistent handle indication of normal open/closed status.

.5 Complete final location of field instruments to provide sufficient clearance for access to all maintenance settings; to provide unobstructed viewing of instrument indicators and to permit instrument calibration and maintenance during normal operation of the Wastewater Treatment Plant.

.6 Slope tubing installations 20 mm per 2 m of run down to process connection.

.7 Support tubing in channel or raceway if exposed or in close proximity to rotating equipment or high traffic areas otherwise, do not exceed 1 m between tubing supports.

.8 Field bend all turns with a minimum bending radius of 50 mm.

.9 Avoid non-terminal connections in tubing runs.

.10 Use teflon tape on all threaded fittings. Do not apply tape on the first two threads.

.11 Terminate tubing at devices with fittings or 90° bends, to allow removal of tubing without disturbing the device mounting.

.12 Complete the final 300 mm (nominal) of air tubing to instruments or control valves installed in process equipment with flexible reinforced neoprene hose. Support the tubing at the hose connection. Locate the hose connection to facilitate unrestricted removal of the instrument or control valve and to minimize transmission of process equipment vibration into the tubing.

END OF SECTION

PROCESS FLUID ANALYZERS

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of process fluid analyzers for the Work.

1.2 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Dissolved Oxygen:

.1 Oxyguard.

.2 Royce.

.3 Or approved equivalent.

.2 TSS:

.1 Royce.

.2 BTG.

.3 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Equipment Components:

.1 All devices supplied under this Section to be the product of a single manufacturer.

.2 Analyzers Primary Elements:

.1 Provide all analyzers primary elements required and provide the ISS (refer to Section 17994).

.2 Instrument manufacturer to confirm the selection of materials of primary elements which are in contact with specified process fluid to be inert to the effects of the process fluid.

.3 Analyzers:

.1 Provide all microprocessor based analyzers required and provide the ISS (refer to Section 17994).

.2 Analyzers with Profibus communications shall be provided if available for the specified process measurement.

.3 Where a required analyzer is not available with Profibus communications, provide analyzers with integral 4 to 20 mA output "two-wire type" with operating power derived from the signal loop. Transmitter to support an external load of up to 600 Ω or greater with a loop power supply of 24 VDC. Analyzers to have adequate power output to drive all devices associated with signal loop. Provide signal boosters as required to achieve adequate signal strength.

.4 Analyzer's 4 to 20 mA output to be galvanically isolated from the process and the analyzer case.

.5 Analyzer and/or primary element enclosures or housings to be, as a minimum, rated NEMA Type 4; where located outdoors or in areas specified as corrosive, enclosures to meet NEMA Type 4X requirements.

.6 Provide transmitters with local indication scaled in engineering units and include a lamacoid label indicating the engineering units. Mount the transmitter such that the output indication is correctly oriented and visible from the normal operating floor position.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

PROCESS SWITCHES

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of process switches for the Work.

1.2 Standards

.1 CSA C22.2 No. 14 – Industrial Control Equipment.

.2 CSA C22.2 No. 25 – Explosion-Proof Enclosures for Use in Class II Groups E, F, and G Hazardous Locations.

.3 CSA C22.2 No. 30 – Explosion-Proof Enclosures for Use in Class 1 Hazardous Locations.

.4 CSA C22.2 No. 157 – Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 United Electric Controls.

.2 Kytola (Esko) for seal water flow switches.

.3 Or approved equivalent.

2.2 Configuration, Components and Features

.1 All devices supplied under this Section to be the product of a single manufacturer.

.2 Process Switches:

.1 Provide all process switches required and provide the ISS (refer to Section 17994) complying with the following requirements:

.1 Contacts monitored by solid state equipment including programmable controllers or annunciators to be hermetically sealed and designed for switching currents from 20 to 100 mA at 120 VAC.

.2 Contacts monitored by electro-magnetic devices including mechanical relays to be rated NEMA B300.

.3 Provide double barriers between switch elements and process fluids such that failure of one (1) barrier will not permit process fluids into electrical enclosures.

.4 Switch electrical enclosures to be rated NEMA, Type 4X minimum.

.5 Make all contacts in Class 1, Zone 1 and 2 areas safe by suitable intrinsic safety barriers.

.6 Normally closed contact outputs for alarm actuation open to initiate the alarm.

.7 Normally open contact outputs to control equipment. The contacts close to start the equipment.

.8 All contacts in Class 1, Zone 1 and 2 areas, as defined by Section 16010, monitored by solid-state circuits safe by suitable intrinsic safety barriers.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

MISCELLANEOUS INSTRUMENTATION

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of miscellaneous field instruments for the Work.

1.2 Standards

.1 CSA C22.2 No. 25 – Explosion-Proof Enclosures for Use in Class II Groups E, F, and G Hazardous Locations.

.2 CSA C22.2 No. 30 – Explosion-Proof Enclosures for Use in Class 1 Hazardous Locations.

.3 CSA C22.2 No. 157 – Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

.2 Covering materials used, parts, devices and other accessories forming a part of the equipment furnished. Drawings for each unit will include, but not be limited to, overall dimensions, materials, installation details, mounting or support requirements, factory calibration data (including printouts), and power and signal wiring requirements.

1.4 Shipment, Protection and Storage

.1 Equipment provided under this Section to be identified, shipped, protected, and stored in accordance with the requirements of Section 17905.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers for equipment that is not a Standardized Good:

.1 Allen Bradley.

.2 General Electric.

.3 Micro Switch.

.4 Toshiba

.5 Edwards

.6 Federal Signal

.7 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Each device to be a pre-assembled packaged unit. Upon delivery to the site, each device to be ready for installation with only final piping and electrical connections required.

.2 When the device has Foundation Fieldbus support, ensure power is from the segment (bus).

.3 The systems to be installed to measure the specified process at the ranges and conditions indicated on the Instrument Data Sheets provided in Section 17994 of Appendix 18A and the Final Design. The devices to be installed at the locations as set out by the Final Design.

.4 Instruments to be selected based on their application, mounting and electrical classification for the area.

.5 The system design to be based on the process ranges and service requirements listed in the Instrument Data Sheets, in accordance with Section 17994.

.6 For a transmitter, it to be factory calibrated to the calibration ranges indicated in the Instrument Data Sheets. Transmitters to be calibrated using NIST approved bench calibration procedures. Calibration data to be stored digitally in each transmitter. Each transmitter to be programmed with the City instrument tag designation indicated on the Instrument Data Sheet of the Final Design. Factory calibration data to be submitted as described elsewhere in this Specification.

.7 Metering Accuracy:

.1 System metering accuracy when specified, refers to the overall measuring system accuracy and shall be determined by comparing the actual process variable value to the process variable value displayed at the PCS. System requirements will not preclude any requirements specified herein for individual devices.

.2 For systems where the primary measuring element and transmitter are furnished under this Section, the accuracy is specified in the individual instrument specification or as indicated on the ISS, in accordance with Section 17994.

2.3 Configuration, Components and Features

.1 General:

.1 The following does not constitute a complete Specification, but merely outlines the general scope and special features of the instrumentation and equipment required.

.2 All instrumentation, control, and electrical devices provided under this Section to be CSA approved and will bear the CSA approvals seal as detailed in Section 17905.

.3 Certify ISO 9000/9001 compliance.

.4 Sensing units to be mounted so that interference to the sensing function is not caused by surrounding structures. The sensor will preferably be mounted on its own support; purpose built to manufactures recommendations, to facilitate maintenance and/or adjustment and located to provide optimal performance.

.5 Isolation valve to be installed.

.2 Alarm Beacons:

.1 Alarm beacons to be individual or stacked strobe type fixtures suitable for indoor, outdoor, or hazardous area use as required. Each beacon or group of beacons shall be provided with wall mounting hardware. Beacon lens color is indicated in the ISS or loop diagrams.

.2 Mounting and installation hardware to be Type 316 stainless steel.

.3 Emergency Stop Switches:

.1 Switches to be heavy-duty, oil tight type with mushroom type plunger operators. Switch legends to be engraved on the switch faceplate. Contact configuration will include at least one (1) N/O and one (1) N/C contact, rated 10 A at 120 VAC. Plunger operators to be red in color and to be maintained type, which require the switch to be physically pushed or pulled to change status.

.2 The receptacle to be a male connector with integral leads for each pole. Number of poles to be equal to the number of switch terminal connections for external wiring (to a maximum of ten (10) poles per connector). Each connector to be installed in a knockout or hub, with leads connected to the switch terminals. Receptacles to be as indicated in the Installation Standards.

.3 Each emergency stop switch to be provided with a NEMA Type 4X control enclosure and all required mounting hardware to securely mount the switch to the wall. Mounting and installation hardware to be Type 316 stainless steel. Each switch to be provided with a nameplate indicating the switch service.

.4 Door/Hatch Switches:

.1 Switches to be independent and separate from access control door hardware.

.2 Switches to be mechanical type with a flexible actuating arm. Switches to be provided with DPDT contacts rated 5 A at 120 VAC. All necessary mounting hardware to be provided to allow the switches to be installed at the locations indicated on the Drawings.

.3 Mounting and installation hardware to be Type 316 stainless steel.

.5 Instrument Shutoff Valves:

.1 Instrument shutoff valves to be provided and installed for instrumentation. Shutoff valves to be compatible with the measured process and to be selected in accordance with the Material Classification Data Sheets. Unused ports of multi-port gauge valves to be plugged. An instrument shutoff valve schedule to be submitted indicating the quantity, material, size, and associated instrument. Valves referenced in the SOP or SWP must be identified and tagged.

.6 Digital Panel Indicators:

.1 Digital indicators to be designed for semi flush mounting in a panel. The indicator to be easily read at a distance of 3 m in varying control room lighting environments. Accuracy to be plus or minus 0.1 percent. The indicator to be scaled in engineering units, with the units engraved on the display face or on the associated nameplate. The indicator will have a selectable decimal point and will provide over range indication.

.7 Edgewise Panel Indicators:

.1 Edgewise indicators, designed for panel mounting, will have nominal 5 by 15 cm face dimensions. Indicators will have nominal 11 cm scale length, and the indicator accuracy to be plus or minus 2.0 percent of full scale. Major scale divisions to be equally spaced and to be in whole integers. Scale ranges to be as set out in the Final Design. Scale units (L/sec and kPa) to be engraved on the scale face or on the indicator nameplate.

.8 Selector Switches:

.1 Selector switches to be heavy duty, oil tight type with gloved hand or wing lever operators. Position legends to be engraved on the switch faceplate. Switches for electric circuits will have silver butting or sliding contacts, rated 10 A continuous at 120 VAC.

.2 Contact configuration to be as set out in the Final Design. Switches used in electronic signal circuits will have contacts suitable for that duty.

.3 Wing lever operator switches approved manufacturers:

.1 Allen-Bradley.

.2 Square D.

.3 Or approved equivalent.

.4 All other selector switches approved manufacturers:

.1 Allen-Bradley.

.2 General Electric “CR”.

.3 Micro Switch “Type PT”.

.4 Or approved equivalent.

.9 Indicating Lights:

.1 Indicating lights to be LED, approximate dimensions of 3 cm diameter, with low voltage lamps easily replaceable from the front.

.2 Legends to be engraved on the lens of the light or on a legend faceplate.

.10 Push Buttons:

.1 Push buttons to be heavy-duty, oil tight, of flush type construction, with legends engraved on the faceplate. Contacts to be rated 10 A continuous at 120 VAC.

.11 Power Supplies:

.1 All regulated dc power supplies for instrument loops to be designed and arranged so that loss of one supply does not affect more than one (1) instrument loop or system. Power supplies to be provided with an input voltage variation of plus or minus 10 percent, and the supply output to be fused or protected against short circuiting. Output voltage regulation to be as required by the equipment supplied.

.2 Power supplies serving multiloops can be provided if a backup supply is so designed that either the primary or the backup supply can be removed, repaired, and returned to service without disrupting instrument system operation.

.3 Multiloop supplies to be selectively fused so that a fault in one (1) instrument loop to be isolated from the other loops in the same supply. Fuses to be clearly labeled and to be located for easy access.

.4 Multiloop supply systems to be oversized by 10 percent for future loads.

.5 Failure of a multiloop supply to be indicated on the respective instrument panel or enclosure and communicated to the PCS.

.12 Relays:

.1 The use of relays is generally to be avoided where possible in favor of direct control from the PCS. Relays are permitted where required for critical control and safety applications where direct PCS control is not practical.

.2 Where relays are required, they shall be plug in socket base type with dustproof plastic enclosures. Relays to be CSA recognized and will have at least double pole, double throw contacts. Control circuit relays will have silver cadmium oxide contacts rated 10 A at 120 VAC. Electronic switching relays will have gold plated or gold alloy contacts suitable for use with low level signals.

.3 Relays used for computer input, alarm input, or indicating light service will have contacts rated at least 3 A.

.4 Time delay relays will have dials or switch settings engraved in seconds and will have timing repeatability of plus or minus 2.0 percent of setting. Time delay relays shall only be used when using PLC timing is not reasonably practical or provide insufficient safety.

.5 Latching and special purpose relays to be as required for the specific application.

.6 All relays to be provided with an integral pilot light to indicate energized condition. All required mounting rails and sockets to be provided and installed with the relays.

.13 Electronic Signal Booster/Isolators:

.1 Electronic signal boosters and isolators will have all solid state circuitry and complete electrical isolation between the power supply and the input and output signals. Each booster and isolator will have zero and span adjustment.

.2 Accuracy to be plus or minus 0.15 percent of span.

.14 Power Transducers:

.1 Power transducers to be true RMS sensing, combination W/VAR transducers, which produce separate output signals for each respective parameter. Nominal input voltage to be 120 VAC, with nominal current input of 0-5 A. Output signals to be isolated 4-20 mA loop powered type. Power metering to be intelligent devices integrated with Schneider MCC Modbus Network.

.2 Transducers to be mounted in a local panel or electrical gear low voltage metering compartment.

.15 Fieldbus Components:

.1 Except where an instrument is deemed as critical service or is required for safety reasons, the DB shall provide instruments with Profibus communications capability and incorporate instruments into the Profibus network segments for the respective process areas.

.2 Profibus network segment design parameters are defined elsewhere in this document.

.16 Density Transmitters

.1 Where density transmitters are specified, the standard of acceptance shall be Toshiba LQ employing microwave measuring technology.

.2 Devices incorporating a nuclear source such as nuclear density gauges and nuclear density transmitters are not acceptable.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

MAGNETIC FLOWMETERS

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of magnetic flowmeters for the Work.

1.2 Standards

.1 CSA C22.2 No. 25 – Explosion-Proof Enclosures for Use in Class II Groups E, F, and G Hazardous Locations.

.2 CSA C22.2 No. 30 – Explosion-Proof Enclosures for Use in Class 1 Hazardous Locations.

.3 CSA C22.2 No. 157 – Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800 including:

.1 Complete assembly and installation drawings, wiring and schematic diagrams, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished, to be submitted in accordance with Section 16010.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Trans-West as per Appendix 18E – Standardized Goods.

2.2 Performance Criteria

.1 Power supply to the transmitters to be 120 VAC unless otherwise required in the Final Design. Primary elements will derive any required power from the transmitter.

.2 The transmitters to be installed to measure the specified process at the ranges and conditions indicated on the ISS, in accordance with Section 17994. The transmitters shall be installed at the locations indicated on the ISS, in accordance with Section 17994.

.3 Environmental, temperature and pressure requirements for the element and transmitter to be specified on the ISS, in accordance with Section 17994.

.4 The system design to be based on the process ranges and service requirements listed in the ISS, in accordance with Section 17994.

.5 Each transmitter to be factory calibrated to the calibration ranges indicated in the ISS. Transmitters to be calibrated using NIST approved bench calibration procedures. Calibration data to be stored digitally in each transmitter. Each transmitter to be programmed with the

automation system instrument tag designation indicated on the ISS. Factory calibration data to be submitted as described elsewhere in this Specification.

.6 Metering Accuracy:

.1 System metering accuracy, as compared to the actual process value, to be determined from the value read at the principal readout device including the recorder or man-machine interface device. System requirements will not preclude any requirements specified herein for individual devices.

.2 For systems where the primary measuring element and transmitter are furnished under this Section, the accuracy to be 0.25 percent.

2.3 Configuration, Components and Features

.1 General:

.1 The following does not constitute a complete specification, but merely outlines the general scope and special features of the instrumentation and equipment required.

.2 All instrumentation, control and electrical devices provided under this Section to be CSA approved and will bear the CSA approvals seal as detailed in Section 17905.

.2 Magnetic Flowmeters:

.1 Transmitter:

.1 Transmitters will have “smart” electronic circuitry and to be 120 VAC four-wire type. Wetted materials to be selected based on the indicated measured process medium for proper operation in the process. Transmitters will have self-diagnostics and electronically adjustable span, zero, and damping. Transmitter output to be 4-20 mA without the need for external load adjustment. Transmitters will also be provided with a Profibus DP communications card. Transmitters will not be damaged by reverse polarity. Transmitters to be capable of having an elevated or suppressed zero, as required by the application. Transmitters to be provided with a 3½ digit LCD display, calibrated in engineering units.

.2 Mounting Hardware:

.1 Each transmitter to be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the ISS in accordance with Section 17994.

.3 Interconnecting Cable:

.1 For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter to be provided by vender. Length of cable to be a minimum of 30 m or as indicated in the ISS.

2.4 Spare Parts

.1 Include in the Spare Parts list the following items:

.1 Any special tools required.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

SIGNAL CONDITIONING MODULES

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of signal conditioning modules for the Work. Signal conditioning modules shall not be used in place of PCS I/O modules designed and selected for the range of input and output signal types for this project. Signal conditioning modules should only be considered where unforeseen circumstances arise such as impedance matching, circuit loading, leakage currents, ground loop errors, etc.

1.2 Standards

.1 CSA C22.2 No. 205 – Signal Equipment.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Action Instruments – rail mounted.

.2 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Equipment Components:

.1 All devices supplied under this Section to be the product of a single manufacturer.

.2 Signal Conditioning Modules:

.1 Provide, when required, signal conditioning modules which comply with the following requirements:

.1 Analog signal inputs: 4 to 20 mA into 250 Ohms.

.2 Analog signal outputs: 4 to 20 mA into 600 or 1000 Ohms.

.2 Rate modules for continuous operation in an ambient temperature of 0 to 80°C. Ambient temperature effect not to exceed plus or minus 0.01 percent per °C within that range.

.3 Span and zero adjustments to be made by front accessible multi-turn potentiometers.

.4 Galvanically isolate signal and power supply terminals from the case.

.5 Isolator to provide galvanic isolation of milli-ampere transmission signals from transmitters with inadequately isolated output circuits.

.6 Isolator to derive its operating power from the signal input circuit.

.7 Input and output signals to be 4 to 20 mA, with an error not exceeding 0.1 percent of span. Input resistance will not exceed 550 ohms with an output load of 250 ohms.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

INTRINSICALLY SAFE BARRIERS

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of intrinsically safe barriers for the Work.

1.2 Standards

.1 CSA C22.2 No. 157 – Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Intrinsic Safety barriers:

.1 MTL Type MT3042.

.2 Pepper1 & Fuchs ZG series.

.3 Stahl 9005/01-252/100/00.

.4 Or approved equivalent.

.2 Intrinsic Safety Relays:

.1 Pepperl & Fuchs Model WE77/Ex-2.

.2 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Intrinsic Safety Barriers and Relays:

.1 Provide when required, intrinsic safety barriers for two-wire transmitters of the active, isolating, loop powered type.

.2 Provide dual type intrinsic safety relays for process switches.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of temperature and vibration monitoring systems for the Work.

.2 Description of the System:

.1 Temperature and vibration protection system are required where specified in other divisions to protect pump-shaft-motor assemblies.

.2 The temperature and vibration protection system continuously monitors various points on the pump-shaft-motor assembly, generates alarms and shuts downs the protected process equipment if temperature or vibration exceeds the adjustable upper limits.

.3 The temperature and vibration protection system continuously monitors all the temperature and vibration points and sends the real time data via an Ethernet/IP data communication link to automation system for further processing and trending.

.4 Refer to and coordinate with specification sections 16224 Medium Voltage Electric Motors and 16229 Medium Voltage Variable Frequency Drives for additional requirements.

.3 Scope:

.1 These Specifications cover the minimum requirement for the design, manufacturing, testing, supply and delivery of the temperature and vibration protection system for a pump-shaft-motor assembly including all the temperature and vibration sensors. All required components and necessary accessories for reliable continuous operation of the system to be provided even if not all details are expressively stated in Schedule 18 or Appendix 18A.

1.2 Standards

.1 All design, material, equipment required within the Final Design, manufacturing and testing to be in accordance with the latest IEC, DIN, VDE, ANSI, or equivalent. The equipment to be approved by CSA or an accredited and recognized agency.

.2 Design Builder will comply with the standards set out in this Section:

.1 Operating Temperature IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-14: -25 to 70˚C.

.2 Relative humidity: IEC 60068-2-30: up to 95 % (without condensation).

.3 Vibration: Per IEC 600068-2-6.

.4 Shock, operating, non-operating: IEC 60068-2-27.

.5 Electrostatic discharge immunity: IEC 61000-4-2.

.6 Radiated and Conducted RF immunity: IEC 61000-4-3, IEC 61000-4-6.

.7 API standard 670, (1) Machinery Protection Systems.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

1.4 Quality Assurance

.1 Perform all tests as recommended by the process equipment manufacturer.

.2 Tests to be performed by the manufacturer's representative of the Temperature and Vibration Monitoring System or a suitably qualified person and a written report to be submitted.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Rockwell Automation XM Series.

.2 Dynamix 1444 Series.

.3 Wilcoxon, IMI.

.4 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Temperature and Vibration Monitoring System description:

.1 The temperature and vibration protection system will consist of the following components:

.1 Temperature Monitoring System.

.2 Vibration Monitoring System.

.2 Each pump-shaft-motor assembly to be provided with a dedicated temperature and vibration protection and monitoring system panel, which is to be located on the floor next to each motor, on the upper floor.

.3 The panels to be NEMA 4X Type 316 stainless steel.

.4 Each temperature and vibration and protection monitoring panel to be 120 VAC powered from its respective VFD control power, and its power status to be monitored by the fail and trouble signals above.

.5 The temperature and vibration and protection monitoring will follow fail-safe wiring. Presence of control voltage will represent normal operating condition.

.6 Provide an Ethernet cable and connect monitoring system to automation system network.

.7 Temperature and vibration and protection monitoring system failure and trouble to be provided and to be communicated to automation system via Ethernet/IP.

.8 Provide all Drawings for the temperature and vibration monitoring system to City Standards (i.e. loop drawings required for each Temperature and Vibration Element signal (i.e. one (1) loop for TI and VI, one loop for TSH and Vibration Switch High (VSH), one (1) loop for TSHH and Vibration Switch High High (VSHH) for each axis indicated, as well as Control Wiring Schematics, Panel Fabrication Details, and Terminal Block Diagrams).

2.3 Configuration, Components and Features

.1 Temperature monitoring system:

.1 The temperature monitoring sensors to be 3 wire 100 ohm platinum type RTD, quick disconnect type except for motor winding.

.2 All motors to be provided with eight (8) platinum 3-wire RTDs, PT100, 6 in motor, (2 per phase winding) and two (2) for the bearings. All RTDs to be wired to a terminal block located in the RTDs and transducer's termination box.

.3 All pumps to be provided with two (2) platinum 3-wire RTDs, PT100, for the bearings. All RTDs to be wired to a terminal block located in the RTDs and transducer's termination box.

.4 Pump shaft to be provided with a platinum 3-wire RTD, PT100, for each bearing. All RTDs to be wired to a terminal block located in the RTDs and transducer's termination box.

.5 Coordinate with individual equipment suppliers the exact number of temperature monitoring points and follow their recommendation.

.6 An Alarm and Trip level to be configurable for each RTD input point to generate an alarm and trip if the corresponding temperature levels are exceeded.

.7 Ethernet/IP communications to be provided for all temperature monitoring points (RTDs) includes:

.1 TExxxA1 - motor winding RTD phase A.

.2 TExxxA2 - motor winding RTD phase A.

.3 TExxxA3 - motor winding RTD phase B.

.4 TExxxA4 - motor winding RTD phase B.

.5 TExxxA5 - motor winding RTD phase C.

.6 TExxxA6 - motor winding RTD phase C.

.7 TExxxA7 - motor Drive-End (DE) bearing RTD.

.8 TExxxA8 - motor Non-Drive-End (NDE) bearing RTD.

.9 TExxxA9 - shaft bearing(s) RTDs (the exact number to be confirmed).

.10 TExxxA10 - pump DE bearing RTD.

.11 TExxxA11 - pump NDE bearing RTD.

.8 A common hardwired signal to be provided for Pump Trip on High High Temperature. This Common TSHH to be triggered by High-High Temperature (TSHH) on any of the Temperature Elements. The trip to be accomplished by using a normally closed 120 VAC, 2 A rated dry contact Common TSHH signal, hardwired to the VFD as a "Pump Trip on High High Temperature".

.2 Vibration Monitoring System:

.1 Tri-axial sensors (vibration elements) for each pump-shaft-motor assembly to be supplied. The tri-axial sensors to be threaded type, installed into pre-threaded locations at the machine bearing locations.

.2 All cables between the machine assembly and the vibration panels to be supplied and installed.

.3 Technical information regarding the cables to be provided and to be included within the Operations and Maintenance Manual.

.4 All of the warning and alarm system set points shall be operator tunable from the plant control system. These signals to be communicated to the plant control system via Ethernet. The NDE 'z' axis VSH and VSHH for both Motor and Pump are not required. A common hardwired signal to be provided for Pump Trip on High High Vibration. This Common VSHH to be triggered by excessive vibration (VSHH) on any of the four 'X' axis bearing vibration elements. The trip to be accomplished by using a normally closed 120 VAC, 2 A rated dry contact Common VSHH signal, hardwired to the VFD as a "Pump Trip on High High Vibration".

.5 Ethernet/IP communications to be provided for all vibration monitoring points.

.1 Designation is as follows: Motor NDE X-axis Vibration Indication - VIxxxA1 (where xxx denote the specific motor tag number; i.e. VI100A1 indicates motor M100A.

.2 For motor-shaft-pump assembly provide all vibrational indicators and signal points required includes:

.1 Motor NDE Y-axis Vibration Indication - VIxxxA2.

.2 Motor DE X-axis Vibration Indication - VIxxxA3.

.3 Motor DE Y-axis Vibration Indication - VIxxxA4.

.4 Motor DE Z-axis Vibration Indication - VIxxxA5.

.5 Pump DE X-axis Vibration Indication - VIxxxA6.

.6 Pump DE Y-axis Vibration Indication - VIxxxA7.

.7 Pump DE Z-axis Vibration Indication - VIxxxA8.

.8 Pump NDE X-axis Vibration Indication - VIxxxA9.

.9 Pump NDE Y-axis Vibration Indication - VIxxxA10.

.10 Shaft X-axis Vibration Indication - VixxxA11.

.11 Shaft Y-axis Vibration Indication - VIxxxA12 .

.12 Motor NDE X-axis Vibration Switch High - VSHxxxA1.

.13 Motor NDE Y-axis Vibration Switch High - VSHxxxA2.

.14 Motor DE X-axis Vibration Switch High - VSHxxxA3.

.15 Motor DE Y-axis Vibration Switch High - VSHxxxA4.

.16 Motor DE Z-axis Vibration Switch High - VSHxxxA5.

.17 Pump DE X-axis Vibration Switch High - VSHxxxA6.

.18 Pump DE Y-axis Vibration Switch High - VSHxxxA7.

.19 Pump DE Z-axis Vibration Switch High - VSHxxxA8.

.20 Pump NDE X-axis Vibration Switch High - VSHxxxA9.

.21 Pump NDE Y-axis Vibration Switch High - VSHxxxA10.

.22 Shaft X-axis Vibration Switch High - VSHxxxA11.

.23 Shaft Y-axis Vibration Switch High - VSHxxxA12.

.24 Motor NDE X-axis Vibration Switch High High - VSHHxxxA1.

.25 Motor NDE Y-axis Vibration Switch High High - VSHHxxxA2.

.26 Motor DE X-axis Vibration Switch High High - VSHHxxxA3.

.27 Motor DE Y-axis Vibration Switch High High - VSHHxxxA4.

.28 Motor DE Z-axis Vibration Switch High High - VSHHxxxA5.

.29 Pump DE X-axis Vibration Switch High High - VSHHxxxA6.

.30 Pump DE Y-axis Vibration Switch High High - VSHHxxxA7.

.31 Pump DE Z-axis Vibration Switch High High - VSHHxxxA8.

.32 Pump NDE X-axis Vibration Switch High High - VSHHxxxA9.

.33 Pump NDE Y-axis Vibration Switch High High - VSHHxxxA10.

.34 Shaft X-axis Vibration Switch High High - VSHHxxxA11.

.35 Shaft Y-axis Vibration Switch High High - VSHHxxxA12.

.36 Vibration Panel Fail - XSFxxxA1.

.37 Vibration Panel Trouble - YSFxxxA1.

.3 Self-Diagnostics:

.1 Each component of the temperature vibration protection system to be continuously self-supervised.

.2 If any component temperature and vibration protection system of the system fails a normally close (NC) alarm contact to be activated and the display will indicate the self-supervision failure code and an LED for the internal fault.

2.4 Equipment and System Controls

.1 Temperature/Vibration Monitoring Software:

.1 Provide, install and configure all necessary software components to allow for the temperature/vibration system real time monitoring.

.2 Provide, install and configure all necessary software components to allow for the temperature/vibration system historical data collection and storage.

.3 Provide, install and configure all necessary software components to allow for the temperature/vibration system historical data retrieval and trending, including graphical screens.

.2 Temperature/Vibration System Configuration:

.1 Carry out complete temperature/vibration system configuration including but not limited to the following:

.1 All temperature and vibration points to monitor the actual temperature and vibration.

.2 All temperature and vibration points to generate an alarm and trip signal to be available on individual dry contacts for customer use.

.3 One common signal from all temperature/vibration trip signals to shut down the corresponding VFD.

.4 Ethernet communication configuration to transmit all the above points to the automation system.

.5 Historical data storage.

.6 Historical data retrieval and trending; provide all graphical screens for the data trending.

.7 Temperature/vibration 'System Failed' to be available on an individual dry contact for customer use.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

.3 The temperature vibration monitoring system to be installed near the motor-shaft-pump assembly.

.4 Provide and install all required monitoring software to provide a fully functioning temperature and vibration monitoring system for all pumps.

.5 Testing:

.1 Provide all testing and commissioning services to test, to configure and to verify operation of each temperature and vibration channel in the temperature and vibration monitoring system.

.2 Verify full operation of the monitoring software.

.3 Provide the test and configuration report.

END OF SECTION

GAS DETECTION SYSTEM

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of gas detection system for the Work.

1.2 Standards

.1 CSA C22.2 No. 152 - Combustible Gas Detection Instruments.

1.3 Submittals

.1 Submit product data in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Field Sensors and Transmitters:

.1 MSA as per Appendix 18E – Standardized Goods.

.2 Alarm Beacons and Horns:

.1 Edward, LED type Model AdaptaBeacon.

.2 Crouse-Hinds, LED type.

.3 Or approved equivalent.

2.2 Performance Criteria

.1 All devices supplied under this Section to be the product of a single manufacturer.

2.3 Configuration, Components and Features

.1 Field Sensors and Transmitters:

.1 Provide all gas detection equipment and accessories required and provide the ISS (refer to Section 17994).

.2 Provide monitoring points of the gas detection system to the automation system. Monitoring points shall include; gas concentration, warning, threshold, alarm threshold, and instrument fault.

.3 The gas detection system shall monitor concentrations of the following gasses to which workers may be exposed during the course of their duties. In accordance with Manitoba regulations, the Warning and Alarm values for gas concentrations shall be based on the threshold limit values (TLV) for each gas as recommended by the American Conference

of Governmental Industrial Hygeinists for time weighted average (TWA), STEL (short term exposure limit), and exposure ceiling © for each gas type:

.1 CH4.

.2 H2S.

.3 NO.

.4 CO.

.5 O2.

.2 Alarm Beacons and Horns:

.1 Alarm beacons and horns will operate on 120 VAC, 60 Hz controlled by the gas detection system.

.2 Provide rotating alarm beacon in hazardous locations.

.3 Alarm beacons and horns located in outdoor locations to be of corrosion resistant type NEMA 4X construction.

.4 Provide alarm/trouble signals of the gas detection system to the automation system.

.3 Calibration Equipment

.1 Each gas monitoring sensor shall be fitted with a calibration cap/fitting to facilitate calibration and bump testing using bottled zero reference and span gas.

.2 Where gas monitoring sensors are not readily accessible and/or are mounted at greater than 2m above finished floor, the sensor shall be fitted with calibration gas tubing from the sensor location to a calibration station located at 1.5m above finished floor and as close as practicable to the sensor.

.3 For each type of gas being monitored, provide a one year supply (from substantial completion) of zero reference and span gas based on average gas consumption required for monthly calibration of each gas monitoring sensor.

2.4 Spare Parts

.1 Include the following in the Spare Parts list:

.1 One (1) calibration kit for each type of gas sensor including a one (1) year supply of gases to calibrate sensor.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

INSTRUMENTATION CABLES

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of instrumentation cables.

1.2 Standards

.1 CSA CAN3 C21.1 - 600 V Control Cable +75°C to -40°C.

.2 CSA C22.2 No. 239 - Control and Instrumentation Cables.

.3 CSA C22.2 No. 3 - Wire and Cable.

.4 IEEE 383 - Standard for Qualifying Electrical Cables and Splices.

.5 ODVA Pub. 00148R0 - Ethernet/IP Media Planning and Installation Manual.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 16010 and 17800.

2. PRODUCTS

2.1 Performance and Design Criteria

.1 Analog Signals:

.1 Use TPSH or instrument Teck cable for all low level analog signals including 4-20 mA, 1-5 VDC, 0-10 VDC, pulse type circuits 24 VDC and under.

.2 Use RTD cable for connections between RTDs and transmitters or CDAC RTD inputs.

.2 Digital Signals:

.1 Use TPSH cable for all input and output signals 24 VDC and under and terminate in the Marshalling Panels.

.2 Use Teck cable or wire and conduit for power to instruments, for power to instruments with 120 V signals.

2.2 Configuration, Components and Features

.1 Twisted Pair Shielded Cables:

.1 TPSH cables constructed as follows:

.1 Two copper conductors, stranded, tinned, minimum #16 AWG, PVC insulated, twisted in nominal intervals of 50 mm.

.2 Insulated for 600 V, 90°C.

.3 100% coverage aluminum foil or tape shield and bare stranded, tinned copper drain wire, minimum #16 AWG for each pair.

.4 Overall shield and bare stranded tinned copper drain wire for multi-pair cables.

.5 Overall flame retardant PVC jacket rated to -40°C and meeting low gas emission and FT 4 flame test requirements set forth in CSA-C22.2 – No. 0.3 and IEEE 383 for all cables. PVC jacket shall be grey in colour.

.6 The entire cable assembly shall be suitable for pulling in conduit. Cables located in cable tray and/or otherwise run exposed to be armoured and jacketed-type.

.2 Continuously number code each pair of multi pair TPSH cables.

.3 Provide number of pairs as indicated in Design Builder's Design.

.2 RTD and Multi Conductor Shielded Cable:

.1 RTD cables constructed as follows:

.1 Three or more copper conductors, stranded, tinned minimum #16 AWG.

.2 PVC insulated for 600 V.

.3 100% coverage aluminum foil or tape shield.

.4 Separate bare stranded, tinned copper drain wire.

.5 Overall armoured and flame-retardant PVC jacket as specified for TPSH cables.

.2 Individually shield and continuously number code for each triad of multi triad cables. Provide an overall shield, a bare stranded tinned copper drain wire, and an overall flame retardant PVC jacket for the cable assembly.

.3 Provide number of triads as indicated in Design Builder's Design.

.3 Ethernet Shielded Cable:

.1 Provide shielded Ethernet cables as indicated in Design Builder's Design.

.4 Teck Cables:

.1 Provide Teck cables in accordance to Section 16122 with the exception that instrument Teck cables shall be identified by a grey outer jacket.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

3.2 Installation

.1 Install instrumentation cables in aluminum conduit systems or in cable trays (refer to Section 16114). Use a minimum of 300 mm length of liquid tight flexible conduit to connect the field sensors to conduit.

.2 Where instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.

.3 Where instrumentation cable is installed in conduit or duct, seal conduit ends with duct sealing compound.

.4 At each end of the run leave sufficient cable for termination.

.5 Cable splices in any of the instrumentation cable runs shall not be permitted.

.6 Where splices are made to coaxial cables, use standard coaxial cable connectors.

.7 Ground cable shields at one end only, unless otherwise specified by the equipment manufacturer.

.8 For the Ethernet cable maintain continuity for the shield and drain wire throughout the entire network. Ground the cabling at one end (point) only, for the rest of the network, insulate the shield and drain from ground in accordance with ODVA standards.

.9 Protect all conductors against moisture during and after installation.

.10 Terminate armour with connectors approved for use by the manufacturer.

.11 Surface installation for Teck cables:

.1 Install individual runs of Teck cable or multiple runs as specified herein.

.2 Fasten unistrut to the ceiling or wall as indicated in Design Builder's Design.

.3 Secure cables to unistrut with cable clamps.

.4 Provide corrosion resistant clamps, hot dip galvanized, stainless steel or PVC coated.

.5 Install unistrut supports with a maximum spacing of 1 m.

.6 One (1) or two (2) surface mounted cables shall be strapped using one hole straps and stand-off spacers. Fastening, strapping and support materials to be compatible with the area conditions.

.1 Acceptable Product:

.1 T&B 1275AL series

.2 Or approved equivalent.

.7 Three (3) or more cables shall be installed in cable tray or channel tray.

.12 Conductor Terminations:

.1 Provide all equipment with terminal blocks to accept conductor connections.

.2 Equip instrumentation conductors terminated at equipment terminals other than terminal blocks self-insulated, locking type terminators. Size as required to fit conductors and screw terminals.

.1 Acceptable Product:

.1 Burndy YAE-2.

.2 STA-KON.

.3 Or approved equivalent.

.13 Testing:

.1 Test all cables for isolation from ground and between conductors. Resistance shall not be less than those recommended by the cable manufacturer.

.14 Fire Barriers:

.1 Provide openings in fire rated walls and floors, where cables are to run through.

END OF SECTION

INSTRUMENT INDEX

1. GENERAL

1.1 Summary

.1 Provide equipment to conform to the requirements of Section 17905 and the Final Design.

.2 Install all instruments in accordance with the instrument index details associated with each tagged instrument provided within the Final Design.

.3 Refer to specification section listed for each instrument or equipment for additional information.

.4 Refer to instrument loop diagram drawings for wiring and control device requirements.

.5 Refer to the Standard Details for installation and other instructions pertinent to a particular device.

1.2 Definitions

.1 The following definitions relate to the “Supply Code” listed on the Instrument Index:

.1 ACC. – Instrument accessory supplied as an integral part of another device with no ISS reference.

.2 CON. – Contractor supplied instrument.

.3 CITY – City supplied instrument.

.4 PKG. – Instrument supplied as part of packaged equipment.

.5 EXIST. – Existing instrument requiring no purchase.

.6 REL. – Existing instrument requiring relocation.

1.3 Submittals

.1 Provide submittals for all instruments in accordance with the requirements specified in Sections 01300, 16010 and 17905.

2. PRODUCTS

2.1 Performance Criteria

.1 Provide all ISS (refer to Section 17994).

3. EXECUTION (NOT USED)

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION

INSTRUMENT SPECIFICATION SHEETS

1. GENERAL

1.1 Summary

.1 Provide the ISS details relevant data for the supply of devices.

1.2 Submittals

.1 Submit all ISS documents in accordance with the requirements specified in Sections 01300, 16010 and 17800.

.2 As-Built Documents:

.1 Update the ISS to reflect the latest data and manufacturer information.

.2 Provide ISS which contain actual data provided as part of a packaged equipment submittal. Any additional instruments to be included in the Instrument Index and be properly cross referenced.

2. PRODUCTS

2.1 Manufacturers and Products

.1 The ISS define Acceptable Manufacturers and Acceptable Products.

2.2 Performance Criteria

.1 Provide the ISS for all instrumentation devices and detail application requirements indicated in the Final Design.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the technical requirements.

END OF SECTION