City of London

Environmental Services

AUTOMATION AND CONTROL

VOLUME 2

STANDARDS

Version 4.1

INDEX

Version	Date	Description of Revisions
3.9	04/12/02	Preliminary release of consolidated requirements

All changes subsequent to V3.9 are highlighted in Red in the PDF version of this document. Additions are in regular text, while deletions show as ~~strike outs~~.

PART 1 INTRODUCTION

1.01 Common

(a) General

- The requirements set forth within this document, and related documents, define the minimum requirements acceptable to the City of London.
- These standards supersede all previous City of London Standards related to Environmental Service Facility Control and Automation.
- The current version of this document at time of Tender Close will take precedence over all other documents and drawings that form part of the tender package.
- Any project specific deviations shall be specifically and categorically stated on a separate page specifically listing these deviations and will be provided by the City as part of the tender package (or request for proposal).
- The terms “installed” and “supplied” are used interchangeably within this standard and both terms include the supply, installation and commissioning of the stated item.
- Note that P&ID and “for construction” wiring drawings will not entirely correspond to field wiring requirements as multiple signals shown on drawings may share a common digital communication link. The drawings only show connections on a conceptual basis and do not necessarily differentiate between analog / discrete I/O and information provided by digital serial communication links. If some signals are differentiated, do not assume that this will be uniformly the case. The requirements set forth in this document will take precedence.
- It is the responsibility of the contractor to ensure that they obtain, review and fully understand all implications on the scope of work resulting from provisions in these standards.
- It is the responsibility of the contractor to request clarification before tender submission if it is not clear how the various component parts of the tender package interrelate.
- If there appears to be any contradiction between specific clauses within these standards, it is the responsibility of the contractor to obtain clarification from the City with regards to which clause applies. Otherwise the contractor shall be responsible for any costs incurred as the result of changes required in conform to the clause determined by the City to take precedence.

(b) RPU & SCADA Programming

- Note that on projects that include a programming component that the contractor must ensure that they obtain “Automation & Control - Volume 3 Programming” as this document defines the requirements which must be provided for this scope of work.
- In general, all SCADA programming and integration will be performed by City of London staff unless otherwise stated.

1.02 Related Documents

(a) General

- The following City of London documents contain additional requirements which must be followed.
  - City of London Automation & Control – Volume 1 Design Requirements
  - City of London Automation & Control – Volume 2 Standards (this document)
  - City of London Automation & Control – Volume 3 Programming Requirements
  - City of London SCADA Procedures Manual
  - City of London Corporate Computer Policy
  - City of London Drafting Standard
- All work shall exceed applicable requirements set forth by the latest edition of the following codes.
  - Canadian Electric Code (CEC)
  - Ontario Electrical Safety Code (OESC)
  - National Fire Protection Association Fire Code (NFPA)
- The following industry standards apply in absence of specific requirements within these standards.
  - Electronic Industries Association (EIA)
    - *606, Design Guidelines for Administration of Telecommunications Infrastructure in Commercial Buildings (includes Ethernet Cabling Identification)*
    - *568A, Communication Cabling Identification*
    - *568A, Addendum No. 5, UTP Performance classification and support data transmission rates to 100 Mb/s*
    - *SP4195, Additional Transmission Performance Specifications for 4-Pair 100 Ohm Enhanced Category 5 Cabling*
  - American National Standards Institute (ANSI)
    - *ANSI C80.1*
    - *ANSI C80.5 Aluminium Rigid Conduit Fittings*
    - *EN50170-2-2:1996, Profibus Cabling Systems*
  - National Electrical Manufacturers Association (NEMA/EEMAC)
    - *PB 1, Panel Boards*
    - *1CS-6, Enclosures for Industrial Controls and Systems*
    - *RN1-1998 PVC Coated Galvanized Rigid Steel Conduit*
    - *TC-2 Rigid Non-Metallic Conduit*
    - *TC-2-1978 & ASTM D2564*
  - Factory Mutual (FM)
    - *IS, Approval for Explosion Proof and Intrinsic Safety*
  - Canadian Standards Association (CSA)
    - *C6, Approval for explosion proof and intrinsic safety*
    - *T528-92, Design Guidelines for Administration of Telecommunications Infrastructure in Commercial Buildings*
    - *T529-M90, Commercial Building Standard for Telecommunications Pathways and Spaces*
    - *C22.2#45 Aluminium Rigid Conduit Fittings*
    - *Device Registration Plate Requirements*

- International Society for Measurement and Control (Formerly ISA)
  - *S5.1-1984, "Instrumentation Symbols and Identification."*
  - *RP60.6-1984 "Recommended Practice for Nameplates, Labels, and Tags for Control Centres"*
  - *S50.1, Electronic Industrial Process Instruments Analog Signal Compatibility*
- Underwriters Laboratories (UL)
  - *67, Panel Boards*
  - *50, Cabinets and Boxes*
  - *489, Moulded Case Circuit Breakers*
  - *508, Standards for Industrial Control Equipment*
  - *943, GFCI*
  - *1449, Safety Transient Voltage Surge Suppressors*
  - *6, 467, 514, & 1242, Fittings in Non-Hazardous & Non-Corrosive Locations*
  - *360 Liquid-Tight Flexible Steel Conduit*
  - *514, & 886, Listed for use in Class I, Groups C & D locations*
  - *651 Rigid Non-Metallic Conduit*
- Institute of Electrical and Electronic Engineers (IEEE)
  - *519-1992, VFD Performance Requirements & Commissioning Tests*

- In the absence of specifically referenced standards, all guidelines set forth by the following organizations shall apply.
  - Profibus International (PI)
  - Canadian Electrical Manufacturers Association (CEMA)
  - National Fire Protection Association (NFPA)
  - Canadian Standards Association (CSA)
  - Institute of Electrical and Electronic Engineers (IEEE)
  - Electronic Industries Association (EIA)
  - National Electrical Manufacturers Association (NEMA/EEMAC)
  - Factory Mutual (FM)
  - Canadian Standards Association (CSA)
  - International Society for Measurement and Control (Formerly ISA)
  - Underwriters Laboratories (UL)
  - Institute of Electrical and Electronic Engineers (IEEE)

PART 2 AUTOMATION GENERAL

2.01 Common

(a) General

- Unless parameters are specifically stated as derived within these standards, online instrumentation shall directly provide the specified information (e.g. where rate of flow is listed, a flow meter which conforms with City of London Standards for Flow Meters must be provided).

(b) Process Philosophy

- All process equipment shall be connected such that each and every device can be fully controlled and configured remotely over the City of London Control Network.
- Control systems for critical processes shall provide a level of redundancy such that the system adjusts for and maintains automatic control even following key equipment failures. It is the responsibility of the contractor to verify with the City whether a system is deemed critical.
- Control systems shall be designed such that in the event of a controller failure process equipment can be operated manually.
- Local Manual Control is not specifically discussed in these standards but is required for all equipment. Once a device is switched to local, control of the device shall be independent of (and unaffected by) the actions (or absence) of the controller.
- Local electronic touch screen operator interface data panels shall be provided for all PLC controlled panels. The use of mechanical switches and lamps shall be minimized.
- Dedicated integrated electronic motor protection relays shall provide all protective interlocks not integral to the motor including but not limited to temperature and/or vibration.

2.02 Sewage Treatment Facilities

(a) General

- The following monitoring shall be provided:
  - Influent and effluent for each process stream for flow rate, turbidity, temperature, pH, nitrate, nitrite, ammonia, phosphorus, and dissolved oxygen (DO).
  - Percent solids and mass density on each waste activated sludge and recirculation activated sludge line.
  - DO in each aerated vestibule (tanks, lagoons, etc.) near discharge.
  - Streaming current, sludge blanket level, density, and suspended solids where deemed appropriate by the City for process automation and/or optimization of chemical use.

- Bypass flow and volume at each possible bypass location (if it is possible for individual process trains and/or sections to bypass independently each shall flow shall be monitored separately).
- Air mass flow to each aerated vestibule.
- Comprehensive power monitoring of each supply source (hydro connection and generator) and current draw for each major device.
- Chemical storage tank volumes and chemical feed volumetric flow rates for each chemical injection point. Chemical, for purposes of this clause is defined as any additive used to enhance the treatment process.
- UV intensity and contact time.
- Cl2, SO2, CH4 and O2 levels in ppm in all locations where there exists the possibility of gas collection and/or oxygen depletion that are not classed as confined spaces.
- CO levels in ppm in workshops, garages, generator rooms, and all other locations where there exists the possibility of CO collection

2.03 Water Storage Facilities

(a) General

- The following monitoring shall be provided:
  - Storage volume.
  - Pre-chlorination chlorine residual if chorine is added at facility;
  - Post fluoridation fluorine residual if fluorine is added at facility.
  - Effluent chlorine residual.
  - Chemical storage tank volumes and chemical feed volumetric flow rates for each chemical and chemical feed line. Chemical, for purposes of this clause is defined as any additive used to enhance the treatment process.
  - Cl2, SO2, CH4 and O2 levels in ppm shall be provided in all locations where there exists the possibility of gas collection and/or oxygen depletion that are not classed as confined spaces.
  - CO levels in ppm in workshops, garages, generator rooms, and all other locations where there exists the possibility of CO collection

2.04 Water Pumping Stations

(a) General

- The following monitoring shall be provided:
  - Effluent Flow.
  - Pressures for each pump's inlet and discharge.
  - Effluent chlorine residual if chorine is added at facility.
  - Effluent fluorine residual if fluorine is added at facility.
  - Chemical storage tank volumes and chemical feed volumetric flow rates for each chemical and chemical feed line. Chemical, for purposes of this clause is defined as any additive used to enhance the treatment process.
  - Cl2, SO2, CH4 and O2 levels in ppm in all locations where there exists the possibility of gas collection and/or oxygen depletion that are not classed as confined spaces.

- CO levels in ppm in workshops, garages, generator rooms, and all other locations where there exists the possibility of CO collection

2.05 Water Distribution Chambers

(a) General

- The following monitoring shall be provided:
  - Effluent flow and pressure for each distribution line.
  - Effluent chlorine residual if chorine is added at facility.
  - Effluent fluorine residual if fluorine is added at facility.
  - Chemical storage tank volumes and chemical feed volumetric flow rates for each chemical and chemical feed line. Chemical, for purposes of this clause is defined as any additive used to enhance the treatment process.
  - Cl2, SO2, CH4 and O2 levels in ppm shall be provided in all locations where there exists the possibility of gas collection and/or oxygen depletion that are not classed as confined spaces.
  - CO levels in ppm shall be provided in workshops, garages, generator rooms, and all other locations where there exists the possibility of CO collection

2.06 Sewage Pumping Stations

(a) General

- The following monitoring shall be provided at all stations:
  - Analog
    - *Bypass Flow Rate*
    - *Chemical storage tank volumes and chemical feed volumetric flow rates for each chemical and chemical feed line. Chemical, for purposes of this clause is defined as any additive used to enhance the treatment process.*
    - *Cl2, SO2, CH4 and O2 levels in ppm in all locations where there exists the possibility of gas collection and/or oxygen depletion that are not classed as confined spaces.*
    - *CO levels in ppm in workshops, garages, generator rooms, and all other locations where there exists the possibility of CO collection*
  - Discrete
    - *Bypass Alarm*
    - *UPS General Alarm*
    - *Fire Alarm*
    - *Sump / dry well flood*
    - *Thermal fire detector*
    - *Intruder alarm*
    - *Local intruder defeat*
    - *Controller failure*
    - *Alarm Test*
  - Power Monitoring
    - *Total Station Power consumption (kWh) derived from KYZ pulse connection to revenue meter*
    - *Power Failure – Monitor shall be on grid side of transfer switch*
    - *Transfer Switch Position*

- *Site Power Quality Monitoring*

- The following additional monitoring shall be provided at locations controlled by PLC:
  - UPS battery low
  - UPS online
  - UPS supply power failure (mains failure)
  - Building Temperature (Analog)
  - Power Consumption (kWh) for each pump
  - Current draw for each pump

(b) Basic Pump Stations

- General
  - Unless the pump station meets the following criteria the station must conform to the requirements set forth for VFD pump stations.
  - *Single wet well*
  - *Three or fewer pumps*
  - *Manual valves (i.e. no automated actuators)*
  - *No chemical addition*
  - *All motors are less than 50 peak hp.*
  - All local instrumentation not specifically defined within these standards as connected to the RPU shall directly support, and shall be connected to, an RS-485 Modbus or Profibus RTU network which is bridged to the City of London Real Time Control WAN. As a minimum, devices which are connected in this fashion shall include:
  - *Discharge Flow Meter*
  - *Power Monitor*
  - *Level Controller*
  - *Softstarts*
  - *Gas Monitor*
  - *Grinder*
  - *Genset*
  - Control shall be provided by Milltronics Enviroranger.
- Standard IO Requirements
  - If the overflow/bypass is located above the level monitored by the transducers used for control, an additional transducer will be provided to monitor the overflow/bypass level.
  - A magnetic flow meter shall be installed on the discharge line to monitor flow rates. The flow meter shall be directly connected by RS-485 connection to allow the SCADA system to directly interrogate the instrument over the same T4S4 data circuit used to monitor the ultrasonic based pump controller.
  - A velocity sensor shall be installed to monitor bypass flows. This requirement is irrespective as to whether the bypass will occur locally at the station or at a remote chamber – if the bypass occurs at a remote chamber; the scope of work includes interfacing the meter in the remote chamber with the controller in the pump station.
  - A local UPS shall provide power to the controller and flow measurement devices for a period of not less than 2 hours such as to keep the controller online for this entire period logging all flow information.
  - All pumps shall be controlled by soft starts which shall be provided.
  - A low-level stop and high-level start float shall be provided.

- The following list defines the operator interface requirements for the local hard wired operator interface.
  - Bypass Level / Bypass Flow Detected Lamp
  - Backup Circuit High-level Start Lamp
  - Backup Circuit Low-level Stop Lamp
  - RPU Fail Lamp
  - Hardwired Interlock Status Lamp
  - Normal/Test Switch, spring return with latch to hold switch in either position.
- The following list defines the IO Assignment.
  - D1 Pump 1 Run
  - D2 Pump 1 Local / Remote
  - D3 Pump 2 Run
  - D4 Pump 2 Local / Remote
  - D5 Pump 3 Run
  - D6 Pump 3 Local / Remote
  - D7 Pump Field Fault (Overload, Moisture Detected, Other)
  - D8 Overflow / Bypass Hi Level / Bypass Flow Detected
  - D9 Mains Power Failure
  - D10 UPS Fault
  - D11 Fire Stat
  - D12 Dry Well Flood
  - D13 Illegal Entry
  - D14 Illegal Entry Defeat
  - D15 Alarm Test / Normal
  - D16 kWh Pulse from Revenue Power Meter
  - Q1 Pump 1 Run
  - Q2 Pump 2 Run
  - Q3 Pump 3 Run
  - Q4 Alarm System Rearm
  - Q5 Fault (Loss of Echo)
  - A1 Bypass Flow Velocity

(c) VFD Pump Stations

- General
  - All Pump Stations which do not meet the requirements set forth for "Basic Pump Stations" shall meet the requirement set forth within this section.
  - Control shall be by PLC and all pumps shall have variable frequency drives (VFD).
- Standard IO Requirements
  - Separate ultrasonic level monitor with separate transceivers shall be installed in each wet well. If the location only has a single wet well, two ultrasonic level monitors shall be installed in the wet well.
  - Individual magnetic flow meters will be provided for each pump.
  - A secondary flow meter shall be installed to monitor bypass flows. This requirement is irrespective as to whether the bypass will occur locally at the station or at a remote chamber – if the bypass occurs at a remote chamber; the scope of work includes interfacing the meter in the remote chamber with the controller in the pump station.

- A local UPS shall provide power to the controller and flow measurement devices for a period of not less than 2 hours such as to keep the controller online for this entire period logging all flow information. Including but not limited to station bypass volumes.
- A bypass/overflow float will be provided as a backup to the ultrasonic based level monitoring system.

- The following list defines the operator interface requirements for the local hard wired operator interface.
  - Bypass Level / Bypass Flow Detected Lamp
  - Backup Circuit High-level Start Lamp
  - Backup Circuit Low-level Stop Lamp
  - Hardwired Interlock Status Lamp
  - Normal/Test Switch, spring return with latch to hold switch in either position.
- The following list defines the minimum IO that shall be connected to the PLC relating to pump control. This list is in addition to the IO listed elsewhere in the tender documents.
  - Discrete
    - *Pump running status (for each pump)*
    - *Loss of echo (for each ultrasonic)*
    - *Overflow/bypass float (for each wet well)*
    - *High wet well level float (for locations with only one ultrasonic)*
    - *Low wet well level float (for locations with only one ultrasonic)*
    - *All site specific interlocks (e.g. emergency stop, interconnection gate closed status)*
    - *General pump fail (for each pump)*
    - *Moisture detection (for each submerged pump)*
    - *High Casing Temperature (for each pump)*
    - *Excessive Vibration (for each pump)*
    - *High Bearing Temperature (inboard and outboard)*
    - *High Stator Temperature (for each pump)*
    - *Motor Overload (for each pump)*
  - Analog
    - *Wet well level (for each ultrasonic)*
    - *PID Tuning Parameters for each PID loop*
    - *Pump flows (for each pump)*
    - *Bypass flow*
    - *Pump Discharge Header Pressure (only applies to force mains)*
    - *Chemical storage tank volumes and chemical feed volumetric flow rates for each chemical and chemical feed line. Chemical, for purposes of this clause is defined as any additive used to enhance the treatment process.*
    - *Speed for each pump*
    - *MES - Minimum Efficient Speed for each pump*
    - *MaxS – Maximum control speed for each pump*

(d) Grinders

- General
  - The detailed control strategy shall be developed by the manufacturer of the grinder.

- Control Interface
  - Status monitoring shall be provided by RS-485 Modbus or Profibus Connection to the PLC at VFD Pump Stations, and direct connection to the pump station RS-485 network at basic pump stations.
  - The following IO shall be provided:
    - *Remote stop interlock*
    - *Hand/Reset switch position status*
    - *Run Status*
    - *Grinder Overload Alarm*
    - *Motor Overload Alarm*
    - *Oil High Temp Alarm*
    - *Low Oil Level Alarm*
  - For inline grinders, the following hard wired monitoring shall be provided.
    - *Run Status*
    - *Grinder Fault*

(e) Standby GENERATOR

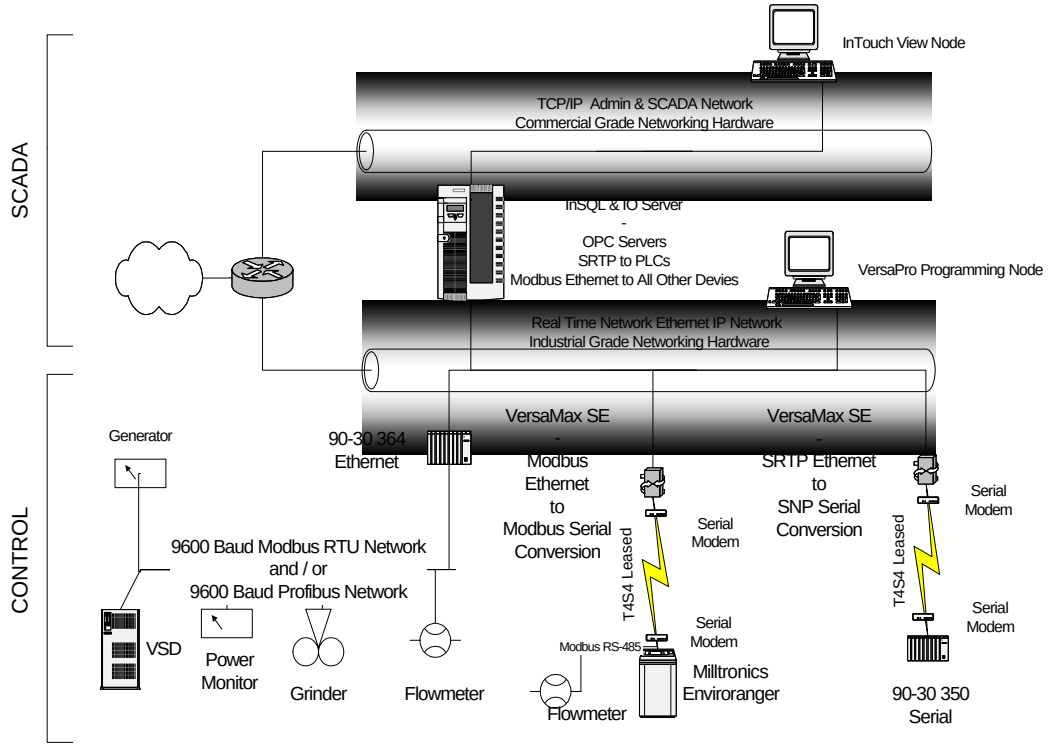
- Process Control Strategy
  - The control system for standby generation and transfer switch shall be provided by a single supplier as a complete package. The detailed control strategy shall be developed by the manufacturer of the generator.
  - See "Generator Control Module" section for details regarding IO requirements and controller functionality.

2.07 Communication Topology

(a) General

- All instrumentation to communicate on Profibus DP
- All MCC/VFD's to communicate on Devicenet
- All Fieldbus networks to be equipped with Ethernet gateway devices

- The following configuration drawing is a conceptual representation of the City of London's overall control architecture. This drawing does not show all the networking components, but defines the basic architecture.



- All PLC's at a given facility are to communicate using the same IP based protocol and shall communicate without need for any form of protocol converter (i.e. the protocol shall be supported as a native protocol by the programmable controller).
- All interconnections (except as otherwise stated within this document) between a PLC and field devices, including but not limited to all instrumentation, shall use GEFanuc EGD, Modbus TCP/IP, DeviceNet, Profibus DP and/or RS485 Modbus RTU.
  - Devices shall fully support all functionality defined within the current revision of the standard for the communication protocol selected.
  - Where the protocol standards specify a special functional subset for a given class of devices then this subset shall be supported.
  - In the case of Modbus Devices, as a minimum the following functionality shall be supported.
    1) Function Code 08 (Loopback Test) as defined in the standard
    2) Variable length data block reads (i.e. the ability with a single read function to request and receive a variable number of registers with the minimum range being any value between 1 and 255) as defined in the standard
    3) Module shall allow user configuration of the Modbus address to any value within the range of 1 to 255.
    4) Full support of all error response messages defined under the standard.
  - All devices supporting serial communication shall allow the end user to configure the device to perform a specified action or go to a specified state following an adjustable time out (e.g. in the case of Modbus, the device will perform this action if not successfully polled by the Master within this period).
  - Motor control centers and related electrical equipment shall communicate by DeviceNet.

- All Power Monitors & Programmable devices (e.g. VSD, PLC, Enviroranger, etc.) shall be directly connected to the City of London's "Real-Time" Ethernet control network and support remote program examination and modification over this network.
- Where standards governing bodies for a given protocol have a certification/verification program for devices, all devices provided shall have successfully passed through this process.

- If from a control perspective it is possible to subdivide the process into parallel process streams, the devices shall be distributed over separate communication buses such that the loss of a single bus will not result in the loss of more than one process stream.
- Devices that are required for the control of multiple process streams shall support multiple communication ports and shall be connected to each process streams bus.
- All Ethernet network components shall be manageable over the network using SNMP management tools.
- Switches shall be used in place of Hubs except where specifically approved by the City of London's Technical Services Division.

(b) Modem Connected Remote Location Communication

- The Contractor shall be responsible for communications with the remote location up to and including the serial protocol converter connecting the location to the City of London WAN.
- The scope of work includes, but is not restricted to, all works within the station, coordinating with Bell Canada the provision of the Type 4 Schedule 4 connection to the plant or main pumping station feed by the pumping station, and all works necessary to connect the pumping station to the City of London Control Network.
- PLCs shall communicate over phone lines by SNP (GEFanuc Series Ninety Protocol). At the point of connection to the City of London Control Network, the protocol shall be converted to SRTP (GEFanuc Service Request Transfer Protocol).
- All equipment at locations without PLCs will be interconnected by RS485 Modbus RTU connections such that all devices at the location are directly accessible from the City of London Control Network. The Ethernet converter in this case shall convert Modbus RTU to Modbus Ethernet.
- Cellular modem use will be reviewed on project basis.

(c) Division of Responsibility

- It is the contractor's responsibility to ensure that all information from all devices is directly accessible over the City of London Real-Time control network. This includes insuring full compatibility of all connected devices, including the installation and configuration of all necessary interconnection devices including but not limited to protocol converters, modems, and line extenders. It is the contractor's responsibility to resolve any and all communication problems which may arise.

- Routers will be supplied by Bell Canada as directed by the City of London's TSD group. All other communication equipment shall be provided by the Contractor.
- All equipment, including routers, shall be installed by the Contractor.
- The contractor is responsible for all works at the facility including all local interfaces. The contractor is not responsible for changes required to the Central monitoring system used to remotely monitor the facility.

2.08 Package Systems

(a) General

- Package system, and all component parts thereof, must conform to all requirements set forth within the City of London's Automation & Control Documents unless specifically exempted within this document.
- All modifications to package systems, which are required in order to ensure seamless integration with the City of London's centralized control system, shall be the responsibility of the contractor.
- PLC applications shall be provided unlocked (i.e. without passwords or encryption) such that City of London staff has full access to the programs to make modifications and confirm conformance with City of London programming standards.
- Except where specifically stated otherwise by the City of London, all package systems with self-contained controllers shall connect to the City of London control network by one of GE Fanuc's TCP/IP based protocols (EGD or SRTP).
- The contractor shall provide complete details (including passwords and documented source code) regarding how to remotely connect to and modify the configuration and programs of all devices which form part of the package system.

PART 3 IDENTIFICATION

3.01 Common

(a) General

This section applies to all Water and Wastewater works including all new works, reconstruction, expansions and modifications to facilities and facility control systems.

Standardized device identifiers conforming to the following shall be used for identification of all devices and related information.

- The core of all identification codes is the device identifier. The construction of this portion of the tag varies with the location and application as follows:
  - Non-process Equipment - All Locations

    LLLL.B##.EEE##

    LLLL - Location
    B## - Building Number
    EEE – Equipment or Panel
    First # = Floor level with the lowest level as 1
    Second # = Descriptor, with a number indicating less than 600 volt equipment or a letter indicating 600 volt and above equipment.

Note: devices installed prior to the version 4.0 release will utilize a dash (-) instead of a dot (.) in the name identifier eg LLLL-B##-EEE##. In most cases the separators (-) (.) (_) are considered equivalent.

  - Process Equipment

    Plants: LLLL.S#.PPP.EEE##A.SSS
    Pumping Stations: LLLL.EEE##A.SSS

    LLLL = Location
    S# = Section Number
    PPP = Process
    EEE = Equipment or Panel
    ##A = 2 numbers and 1 letter used for serialization (e.g. 03a)
    SSS = Attribute name
- The resulting SCADA tag name shall not exceed 29 characters.

3.02 Code Elements

(a) General

The coding system developed for the drawings, facilities and equipment is constructed under a location and function basis. It is comprised of four main elements, the location, section, process or building and equipment or panel elements.

All elements as defined for use for a given function shall be used and shall be separated with a dash.

Where the Contractor can not find an appropriate code in the following tables to describe a specific item, they are to bring this to the City's attention along with a proposed identifier based on ISA coding. This City will confirm acceptance or respond with the correct identifier to use within two (2) weeks.

(b) Location Element

The location element consists of four alphanumeric characters. Valid location identifiers for Water and Wastewater Facilities are as follows.

Pollution Control Plants

PCAD	Adelaide Pollution Control Plant	PCGW	Greenway Pollution Control Plant
PCOX	Oxford Pollution Control Plant	PCPB	Pottersburg Pollution Control Plant
PCSO	Southland Pollution Control Plant	PCVX	Vauxhall Pollution Control Plant
PCWE	Westminster Pollution Control Plant		

Sewage Pumping Stations

PSAD	Adelaide Sewage Pumping Station	PSBK	Berkshire Sewage Pumping Station
PSBD	Brookdale Sewage Pumping Station	PSBR	Broughdale Sewage Pumping Station
PSBW	Bostwick Sewage Pumping Station	PSBY	Byron Sewage Pumping Station
PSCG	Chelsea Green Sewage Pumping Station	PSCH	Chelsea Heights Sewage Pumping Station
PSCR	Clarke Road Sewage Pumping Station	PSCW	Crestwood Sewage Pumping Station
PSDC	Dingman Creek Sewage Pumping Station	PSEP	East Park Sewage Pumping Station
PSGR	Gore Road Sewage Pumping Station	PSHZ	Hazeldon Sewage Pumping Station
PSHC	Hunt Club Sewage Pumping Station	PSHP	Hyde Park Sewage Pumping Station
PSHR	Huron Sewage Pumping Station	PSMP	Manor Park Sewage Pumping Station
PSMD	Medway Park Sewage Pumping Station	PSNR	Northridge Sewage Pumping Station
PSPA	Paardeburg Sewage Pumping Station	PSPI	Pitcarnie Sewage Pumping Station
PSPM	Pond Mills Sewage Pumping Station	PSRB	River bend Sewage Pumping Station
PSSD	Sandford Sewage Pumping Station	PSSW	South Winds Sewage Pumping Station
PSSGE	Stonybook East Sewage Pumping Station	PSSGW	Storybook West Sewage Pumping Station
PSSC	Summercrest Sewage Pumping Station	PSSN	Sunninghill Sewage Pumping Station
PSTR	Trafalgar Sewage Pumping Station	PSTV	Talbot Village Sewage Pumping Station
PSWL	Wonderland Sewage Pumping Station	PSVC	Victoria Sewage Pumping Station
PSWS	Westmount Sewage Pumping Station		

Water Control Centre

WHR	Central Control Centre (Horton & Rideout)	WBA	Bathurst Works Yard (Bathurst & Adelaide)
WGW	Greenway Control Room – Water SCADA		

Water Treatment Plants

WLET	Lake Erie Water Treatment Plant	WLHT	Lake Huron Water Treatment Plant
WWOT	White Oaks Water Treatment Plant	WKOT	Komoka Water Treatment Plant
WLAT	Lambeth/Main Street Water Treatment Plant		

Water Pumping Stations

WARV	Arva Water Pumping Station	WAUS	Ausable Water Pumping Station
WEMPS	Elgin- Middlesex Boooster Pumping Station	WHPS	Hyde Park Water Pumping Station
WPON	Pond Mills Water Pumping Station	WSPS	Springbank Water Pumping Station
WUPL	Uplands Water Pumping Station	WWES	Westmount Water Pumping Station
WWIK	Wickerson Water Pumping Station		

Water Reservoirs

WEWS	Lake Erie Water Reservoir	WARR	Arva Water Reservoir
WSM4	Springbank Water Meter House 4	WSR1	Springbank Water Reservoirs 1,2
WSR3	Springbank Water Reservoir 3		

Water Works Control Chambers

WC01	Water Control Chamber 1 & 1A	WC02	Water Control Chamber 2
WC03	Water Control Chamber 3	WC04	Water Control Chamber 4
WC06	Water Control Chamber 6	WC07	Water Control Chamber 7
WC08	Water Control Chamber 8	WC09	Water Control Chamber 9 & 9A
WC10	Water Control Chamber 10	WC11	Water Control Chamber 11
WC12	Water Control Chamber 12	WC13	Water Control Chamber 13
WCS1	Springbank Water Control Chamber 1	WCS9	Springbank Water Control Chamber 9
WCCC	Clark/Commissioners Water Control Chamber	WCCH	Clarke/Huron Water Control Chamber
WCHM	Horton/Maitland Water Control Chamber	WCYM	York/Maitland Water Control Chamber

Water Works PRV Chambers

WPCJ	Commissioners/Jackson Water PRV Chamber	WPDC	Dingman/Castleton Water PRV Chamber

Water Works Wells

WBYN	Byron Well	WFW1	Fanshawe Well 1
WFW2	Fanshawe Well 2	WFW3	Fanshawe Well 3
WFW4	Fanshawe Well 4	WFW5	Fanshawe Well 5
WFW6	Fanshawe Well 6	WHW1	Highbury Well 1
WHW2	Highbury Well 2	WHP1	Hyde Park Well 1
WKW1	Komoka Well 1	WKW2	Komoka Well 2
WKW3	Komoka Well 3	WKW4	Komoka Well 4
WLA2	Lambeth Well 2	WLA3	Lambeth Well 3
WLA4	Lambeth Outer Drive Well #4	WWW4	White Oaks Well 4
WWW6	White Oaks Well 6		

Other Facilities

FHEU	Euston Fan House	FHSJ	St. Julien Fan House
FHGA	Gordon Ave Fan House	DMSB	Springbank Dam

(c) Section Element

Many facilities have been constructed in phases or sections. These section numbers denote a further element of location identification.

A single numeric character preceded by "S" represents the section element. Valid section identifiers for Water and Wastewater Facilities are as follows.

S0	Common to 2 or more Sections	S1	Section 1
S2	Section 2	S3	Section 3
S8	Section 8 (Sludge Thickening)	S9	Section 9 (Incineration and Sludge Removal)
SX	Non- Process (e.g. HVAC and Electrical Panels)		

(d) Process Element

The process element provides further location identification by indicating the relevant process that the equipment or instrumentation is associated with. This element consists of three alphanumeric characters. Valid process & building identifiers for Water and Wastewater Facilities are as follows.

Identifier	Description	Can Include
ILW	Inlet works	Chemical Injection, Grit Removal, RS Pumping, Screening
RSD	Raw Sewage Distribution	Chemical Injection
PCL	Primary Clarification	Chemical Injection, Raw Sludge Pumping
ABN	Aeration Basin / Activated Sludge	Chemical Injection
FCL	Final / Secondary Clarification	Chemical Injection, Sludge Return, Sludge Wasting
DIS	Disinfection	Chlorination, Ultraviolet
EFW	Effluent Water System	Flushing, Spray Water
SDW	Sludge Dewatering	Chemical Injection, Sludge Thickening
SLW	Sludge Wasting	(Greenway Only)
SLD	Sludge Disposal	Sludge Loading/Transfer, Sludge Storage / Unloading
INC	Incineration	(Greenway Only)
ODC	Odour Control	Chemical Injection

(e) Building Element

The building element provides an alternate method of description for section and process elements for use with non process equipment. This element consists of three alphanumeric characters. Valid process & building identifiers for Water and Wastewater Facilities are as follows.

Adelaide PCP Buildings

B01	Administration and Blower Building	B02	Chlorine Building and Garage
B03	Sludge Loading Building Sec. 1	B04	Operations Building Sec.1
B05	Inlet Works Building	B06	Sludge Loading Building Sec.2
B07	Raw Sewage Pumps Building	B08	Electrical Sub-Station

Greenway PCP Buildings

B01	Administration Building	B02	Administration Annex
B03	Primary Sludge Pumping Station (PSPS)	B04	Access Building Sec. 3 (Secondary Sludge SSPS)
B05	Sludge Unloading Access Building	B06	Pulp Building
B07	Flotation Building	B08	Sludge Disposal Building Press Side
B09	Incineration Building	B10	Incineration Building Annex
B11	Maintenance Building	B12	Chlorine Building
B13	Access Building Sec.1 West (Secondary SSPS)	B14	Access Building Sec.2 (Secondary SSPS)
B15	Pipe Gallery	B16	UV Control Building
B17	Blowers Building Sec.3	B18	Store Shed
B19	Chemical Storage	B20	Main Transformer Sub-station
B21	Cove Gate House	B22	Household Hazardous Waste Building

Oxford PCP Buildings

B01	Administration Building	B02	Blower, Maintenance and Operations
B03	Access Building Sec. 2 (Secondary Sludge SSPS)	B04	Sludge Loading Building
B05	De-grit Building	B06	Electrical Sub-Station

Pottersburg PCP Buildings

B01	Administration and Control Building	B02	Filter Building
B03	Garage Building (Maintenance)	B04	Inlet Works Building
B05	1 Section PSPS	B06	Blower and 2 section Secondary Sludge SSPS
B07	Electrical Sub-Station		

Vauxhall PCP Buildings

B01	Administration Building	B02	GBT Building
B03	Chlorine Building and Garage	B04	PSPS Building Sec. 1
B05	Blower Building Sec. 1	B06	PSPS Building Sec. 2
B07	Blower Building Sec. 2	B08	Electrical Sub-Station

Westminster PCP Buildings

B01	Administration Building	B02	Chemical Feed Building

Southland Operations Building

B01	PCP Building

(f) Equipment Element

The equipment element describes the actual piece of equipment. Five alphanumeric characters are used. The first 3 are equipment descriptors while the remaining 2 alphanumeric characters are assigned by the City and are used to further identify the specific item by number. Valid equipment descriptors for Water and Wastewater facilities are as follows.

Electrical

ACR	AC Control Relay	AHO	Alarm Horn
ATS	Automatic Transfer Switch	BPF	Back-up Power Feeder
BRK	Breaker (600 Volts)	CAP	Capacitor
CBR	Circuit Breaker (120/208/240 Volts)	CTX	Control Transformer
DCR	DC Control Relay	FDS	Fused Disconnect
GEN	Generator	GSR	Generator Set Receptacle
IS_	Isolation Switch	KES	Key Switch
KEY	Security Key Pad	LB_	Load-break Switch

LBT	Load-break Tie Switch	LTX	Lighting Transformer
MJN	Motor Monitor	MTR	Motor (Non Specific)
MTS	Manual Transfer Switch	PFA	Power Factor
PMO	Power Monitor	REC	Receptacle (600 Volts)
RPU	Remote Programming Unit (PLC)	RTU	Remote Terminal Unit (Remote IO Rack)
SMD	Smoke Detector	SUB	Substation
T	Transformer	TBN	Test Button
TDR	Time Delay Relay	TXR	Transformer (Non Specific)
UPS	Uninterruptable Power Supply	VFD	Variable Frequency Drive

HVAC

ACD	Air conditioner	AHU	Air Handling Unit
BOL	Boiler	CHR	Chillers
DHM	Dehumidifier	DHR	Duct Heater
EAC	Electronic Air Cleaner	FAN	Fan
FCU	Fan Coil Unit	FTR	Filter
UHR	Unit Heater		

Maintenance Equipment

BSR	Belt Sander	DPR	Drill Press
ECF	Electric Chain Fall	GDR	Grinder
HBS	Horizontal Band Saw	HST	Hoist
KSR	Key Sweater	LTH	Lathe
MIL	Milling Machine	MRC	Monorail Crane
OHC	Overhead Crane	SHR	Shear

Mechanical – Blowers, Fans & Compressors

ABB	Aeration Basin Blower	CAF	Carbon Absorption Fan
CBB	Channel Basin Blower	EFN	Exhaust Fan
FAB	Foul Air Blower	FBB	Fluid Bed Blower
GBB	Grit Basin Blower	IAC	Instrument Air Compressor
IAD	Instrument Air Dryer	SAC	Sand Conveyor Air Compressor
SBB	Storage Bin Blower	SFN	Supply Fan
SSB	Sludge Storage Blower	STF	Sludge Storage Tank Vent Fan

Mechanical – Gates, Weirs & Valves

ANV	Angle Valve	APV	Ash Pump Discharge Valve
ARV	Air Release Valve	BCV	Bypass Control Valve
BFV	Butterfly Valve	BLV	Ball Valve
BPW	Bypass Weir	CHV	Check Valve
FCV	Flow Control Valve	GCV	Gas Control Valve
GLV	Globe Valve	GSV	Gas Valve
GTV	Gate Valve	KNV	Knife Valve
MCV	M.O.E. Control Valve (Arva)	MDV	Mud Valve
PAV	Power Actuated Valve	PCV	Pressure Control Valve
PDV	Pressure Reducing Valve	PLV	Plug Valve
PRV	Pressure Relief Valve	PSV	Pressure Sustaining Valve
SCG	Sluice Gate	SLG	Slide Gate
SOV	Solenoid Valve	STG	Stop Gate
ULV	Unloading Valve	WRG	Weir Gate
WSV	Waste Sludge Diversion Valve		

Mechanical – Pumps

ASP	Ash Slurry Pump	BRP	Boiler Water Recirculation Pump
CBP	Chemical Booster Pump	CMP	Chemical Metering Pump
CIP	Chemical Injection Pump	CFP	Chemical Feed Pump
CTP	Chemical Transfer Pump	CWP	Cooling Water Pump
DRP	Drain Pump (Supernatant Pump)	ESP	Effluent Sampling Pump
ETP	Effluent Transfer Pump (Westminster)	EWP	Effluent Water Pump (Spray &/or Flushing)
FAP	Flotation Aeration Pump	FRP	Flotation Recirculation Pump
FTP	Flotation Transfer Pump	GRP	Grit Removal Pump
ISP	Influent Sampling Pump	LRP	Lamella Boiler Water Recirculation Pump
PAP	Pressate Pump	PDP	Primary Dewatering Pump
PFP	Pulp Feed Pump	PRP	Pulp Recirculation Pump
PSP	Primary Sludge Pump	PTP	Pulp Transfer Pump
RCP	Recirculation Pump	RSP	Raw Sewage Pump
SAP	Sample Pump	SCP	Scum Pump
SFP	Sludge Feed Pump	SMP	Sump Pump
SRP	Scrubber Recirculation Pump	STP	Sludge Transfer Pump
SSP	Secondary Sludge Pump (Return Sludge Pump)	WSP	Waste (Activated) Sludge Pump

Note that "chemical" includes Polymer, Alum, Ferric Chloride, Chlorine, Bleach, Lime, Potassium, etc.

Mechanical Equipment – Miscellaneous

CPG	Coupling	DRC	Drive Chain
DSP	Drive Sprocket	ELR	Elevator
GRB	Gear Box	HLE	Human Lift Elevator
ISP	Idler Sprocket	MDO	Motorized Door Operator
PDA	Pump Drive Assembly	PMP	Pump (Non Specific)
PTN	Piston	SWE	Swivel Elbow
VAC	Vacuum	VLV	Valve (Non Specific)
WHR	Water Heater		

Process – Flow Meters

AFM	Air Flow Meter	ASM	Ash Slurry Flow Meter
BPM	Bypass Flow Meter	CFM	Chem Feed Flow Meter (Poly, Alum, Bleach, etc.)
EWM	Effluent Water Flow Meter	GFM	Natural Gas Feed Flow Meter
OFM	Fuel Oil Feed Flow Meter	PFM	Pulp Feed Flow Meter
PRF	Partial Flume	PSM	Primary Sludge Flow Meter
PWM	Potable Water Flow Meter	RSM	Raw Sewage Flow Meter
SSM	Secondary Sludge Flow Meter (Return Sludge)	SFM	Sludge Feed Flow Meter
STM	Sludge Transfer (Loading) Flow Meter	VNR	V Notch Weir
WSM	Waste Sludge Flow meter		

Process Equipment – Miscellaneous

ATD	Aeration Tank Diffuser	BFD	Belt Filter Press Drive
BFH	Belt Filter Press Hydraulics	BFM	Belt Filter Press Mixer (Sludge / Polymer)
BFP	Belt Filter Press	BFL	Silencing Baffle
BLW	Non Specific Blower	BRS	Bar Screen
CAU	Carbon Absorption Unit	CBM	Chemical Injection Basin Mixer
CCD	Cross Collector Drive	CEV	Chlorine Evaporator
CFC	Chain and Flight Collector	CGR	Channel Grinder
CLD	Clarifier Drive / Collector Drive	CLI	Chlorine Injector
CLR	Chlorinator	COM	Comminutor
CRS	Course Screen	CTM	Chemical Tank Mixer (Alum, Polymer, etc)

CTR	Collector Trough	CWU	Chemical Wetting Packaged Unit
DCF	Dry Chemical Feeder	DEM	Demister
DEV	Development / Configuration Station	ELS	Effluent Liquid Sampler
FLD	Fluoride System (Arva)	FLT	W.A.S. System
FLM	Flow Meter (Non Specific)	GBT	Gravity Belt Thickener
GCM	Grit Chamber Mixer	GCR	Gantry Crane
GRC	Grit Classifier	GTD	Aerated Grit Tank Diffuser
HPR	Hopper	ILS	Influent Liquid Sampler
INJ	Injector	LVC	Level Controller
MIX	Mixer	OPC	Operator Pump Control
OST	Operator Station	PTU	Prefabricated Sewage Treatment Unit
PUL	Pulper	SCA	Scum Agitator
SCH	Scum Heater	SCM	Scum Mazorator / Mixer
SDA	Sludge Decant Arm	SFB	Sand Filter Bed
SFC	Sludge Feed Conveyor	SIR	Silencer
SLM	Sludge Mixer	SSC	Sludge Screw Conveyor
SSF	Sludge Screw Feeder	STR	Strainer
SRV	Network Server	SWC	Sweep Arm Collector (Round Clarifier)
TE	Temperature Element	TRC	Traveling Collector (Vauxhall Primaries)
TSN	Traveling Screen	TNK	Tank (Non Specific)
UVD	Ultra Violet Disinfection Unit	UVT	Ultra Violet Disinfection Unit Transformer

Structural – Tanks / Channels / Chambers

AGT	Aerated Grit Tank	ART	Aeration Tank (Aeration Basin)
BPC	Bypass Channel	CAT	Chemical Aging Tank
CCC	Chlorine Contact Chamber	CDT	Chemical Day (Dosing) Tank
CIB	Chemical Injection Basin	CHT	Chemical Holding Tank
CLT	Clarifier Tank	CMT	Chemical Mixing Tank
CSS	Chemical Storage Silo	DWL	Dry Well
EDC	Effluent Distribution Chamber	EQT	Equalization Tank
FTT	Flotation Tank	GDT	Grit Dewatering Tank
GSB	Grit Storage Bin	IBC	Inlet Bypass Chamber
ICH	Inlet Channel	IDC	Influent Distribution Chamber
LLC	Low Level Channel	HLC	High Level Channel
HPR	Hopper	PDT	Pulp Day Tank
PHT	Pulp Holding Tank	SCC	Scum Concentrating Chamber
SCT	Scum Holding Tank	SHT	Sludge Holding Tank
SLC	Sludge Collection Chamber	SPT	Supernatant Tank
SST	Sludge Storage Tank	VGC	Vortex Grit Chamber
WWL	Wet Well		

(g) Panel Element

The panel element provides an alternate method of addressing for equipment identifier for non-process equipment.

Five alphanumeric characters are used. The first 3 are panel descriptors while the remaining 2 alphanumeric characters are used to further identify the specific panel. Valid panel descriptors for Water and Wastewater Facilities are as follows.

ACP	Administration Control Panel	CPL	Control Panel
CPP	Control Power Panel	DCP	DC Voltage Panel

DPL	Distribution Panel	EPL	Environmental Control Panel
LPL	Lighting Panel	MCC	Motor Control Centre
VPL	Valve Control Panel	TBX	Terminal Box
RBX	Relay Interface Box	SBX	Splitter Box

Panel designations are constructed of two alphanumeric characters. The first digit lists the floor level and the second digit to represent the panel number on that floor. The floor number of the building, may not necessarily coincide with the building floor numbering system, the lowest level will be consider as floor 1 and the roof level will be indicated by R. The second digit shall conform to the following guidelines.

- The panel character for 120/240-volt distribution will consist of a number.
- The panel character for 600-volt distribution will consist of a letter.
- High voltage panel and distribution designations will consist of number and letter combinations consistent with industry standards.

3.03 Identifiers

(a) Equipment

All equipment shall be tagged at the device's location with the correct device identifier code.

(b) Instrumentation

The coding system developed for instruments and control devices is based on the tag name assigned with the device that the instrument or control device has a primary association with.

When there is more than one of the same instrument type or control device attached to the same process item then a modifier element is added at the end of the tag name to insure uniqueness.

Example of Instrumentation Tag Coding

PCGW-1-FCL-WSP01–PIT1

This tag indicates the first pressure-indicating transmitter on the waste (activated) sludge pump in the final clarifier process, Section 1, at Greenway Pollution Control Plant.

(c) Field Cabling

The first line for the coding system developed for cable identification shall be based on the tag name given to the process equipment that the instrument or control device has the primary association with.

The equipment tag name is followed by one of the following Action Modifiers.

Auto (Local)	AUT	Bypass	BP	Bypass Run	BPR
Close	CL	Closed	CLD	Control Variable	CV
Enable	EN	Enabled	END	Fault	FLT
General Alarm	GA	Lag	LG	Lead	LD
Local	LOC	Loss of Echo	LOE	Manual	MAN

On	ON	Open	OP	Opened	OPD
Operator Interface	OI	Overload	OL	Over / Override	OVR
Position Indicator	ZI	Position Control	ZC	Power Failure	PF
Process Variable	PV	Remote (RPU)	REM	Reset	RST
Run	RN	Set-point	SPT	Speed Feedback (In)	SPI
Speed Set-point (Out)	SPO	Standby	SB	Standby Power	SBP
Start	ST	Status	STS	Stop	SP
Slow	__A	Medium Slow	__B	Medium Fast	__C
Fast	__D				

The second line defines where the cable is connected at the panel and consists of three elements: panel device, intermediate terminal block and device contact.

- Device: The device identifier consists of a prefix of either RPU (Remote Programmable Unit) if the device is a logical control device or RTU (Remote Terminal Unit) if the device provides remote IO but is controlled by another RPU. The suffix is the network address id number for the module.
- Terminal Block: The terminal block number within the panel that the wire connects through.
- Contact: Device contact following the general format Rack/Slot/Contact. Numbering shall follow the format used by the RPU/RTU vendor.

Example of Cable Identification Code

1-FCL-WSP01-ST RPU5A-TB6-A01/09/03

This tag indicates stop contact for the waste (activated) sludge pump in the final clarifier process, in Section 1, connected through terminal block 6 in the RPU 5A panel to contact 1A, of the module in slot 9, in rack number 3.

For analog signal wiring, the shielded twisted pair cable will have one label. Individual wires (positive and negative legs) are identified by colour (see Colour Conventions).

(d) RPU Panels Wiring

Blocks are shall be arranged by I/O module type. Wiring between the I/O cards to the terminal strip will be tagged identifying the RPU/Rack/Slot/Point/Terminal.

	Discrete	Analog
Tag	2-1/5/B1/09	5-2/07/C3-/15
Description	RPU 2, Rack 1, Slot 5, Point B1, Terminal 9	RPU 5, Rack 2, Slot 7, Channel 3 Negative Leg, Terminal 15

The terminal strip for wiring to the field will be grouped following its I/O card association. A group tag will identify the RPU, Rack and Slot association of the terminal strip then the individual terminal blocks may be identified with just the point and card terminal numbers.

	Discrete	**Analog**
Group Tag	2R1S05	5R2S07
Individual Tag	2B1/09	5C3-/15

All discrete inputs terminal strips will be laid out inside the panel in a group followed by all the discrete outputs, then the analog inputs and then the analog outputs.

(e) Communication - Voice/Data Cabling

Labelling of cabling shall conform to the applicable industry standards. Cables and interiors of boxes shall be labelled using self-laminated labels.

3.04 Colour Conventions

(a) General

Along with shop drawing submissions, and before ordering of any equipment or materials, provide the City with colour chips for all colours to be used for confirmation as to acceptability. Along with colour chips, provide complete legend referencing applicable colour chips and application.

In some instances, the use of colours is defined by codes governing fire protection, boilers, generators, engines, electrical distribution, health and safety and similar topics. In case of conflict between this standard, and applicable codes, the code having jurisdiction will prevail. The contractor shall bring any contradictions to the attention of the City of London.

(b) Field Indicating Lights

Field status and alarm lights shall conform to the following colour convention.

DESCRIPTION	**COLOUR**
Running / burner on / valve open / breaker closed	Green
Valve / gate in transition (opening)	Flashing Green
Stopped / burner off / valve closed / breaker open	Red
Valve/gate in transition (closing)	Flashing Red
Remote (PLC Control)	White
Local (Hand Control)	Blue
Emergency Stop	Flashing Amber
Alarm / Overload / High / Fault / Fail	Amber

(c) Pushbuttons & Switch Positions

Pushbuttons shall conform to the following colour convention.

DESCRIPTION	COLOUR
Hand / start / open	Green
Off / stop / close	Red
Remote (PLC Control)	White
Local (Hand Control)	Blue

(d) Panel Block & Panel Wire

Wires within control panels are shall be colour coded as follows.

DESCRIPTION	COLOUR
Power Wiring	Black
120 VAC Control	Red
120 VAC Neutral (if grounded)	White
DC Control (positive)	Blue
DC Control (negative)	Grey
Analog Positive	White
Analog Negative	Black
Power from other source (i.e. no local disconnect)	Yellow
Earth Ground	Green
Isolated Ground	Green Stripe

(e) Field Wiring

Field wires shall be colour coded as follows.

DESCRIPTION	COLOUR
Instrumentation Cable Jacket	Orange
Supply Power (up to 240V)	Yellow
Supply Power (240V to 600V)	Yellow with Green Stripe
Telephone Cables	Green
Ethernet - Switch to Router	Purple
Ethernet - Admin WAN / SCADA	Green
Ethernet - Water Real Time Control Data	Blue
Ethernet - Wastewater Real Time Control Data	Yellow
Other Communication	Green with Blue Stripe

(f) Process Piping & Valves

Process piping and valves bodies shall conform to the following colour convention.

DESCRIPTION	COLOUR	RGB
Air – Circulating	Green	0, 236, 0
Air – Compressed	Dark Green	0,100, 0
Chemical – Alum, Ferric, Ferrous, Fluoride, Other	Orange	240,120, 20

Chemical – Chlorine (including hypo-chlorite)	Yellow	240,240, 0
Chemical – Lime	White / Orange Band	
Chemical – Polyelectrolyte	Silver	
Chemical – Potassium Permanganate	Violet	
Fuel – Digester Gas or Fuel Oil	Orange	
Fuel – Natural Gas, Propane	Red	
Miscellaneous – Grit, Screenings & Drainage	Black	0, 0, 0
Sewage – Activated Sludge (RAS & WAS)	Light Brown	188, 162, 92
Sewage – UV Treated Effluent	Light Blue	0, 255, 255
Sewage – Primary & Secondary Effluent	Light Grey / Black Band	168, 168, 168
Sewage – Raw	Tan	205, 200, 120
Sewage – Scum	Buff	232, 228, 191
Sewage – Sludge (Other)	Dark Brown	100, 50, 0
Water – Non-potable, Plant, Seal	Dark Blue	0, 0, 139
Water – Potable Hot Water	White / Black Band	
Water – Potable	Light Blue	0, 255, 255

(g) Identification Text (including labels, stencils & tags)

Confirm with the City of London's Project Manager appropriate classification for labels and tags. Colour intensity and shade shall be selected such as to ensure easily readable.

DESCRIPTION	TEXT COLOUR	BACKGROUND COLOUR
Hazardous	Black	Yellow
Inherently Low Hazard	White	Green
Fire Protection	White	Red
General Purpose	Black	White

3.05 Materials

(a) General

The following general guidelines shall be followed for all identification. See applicable subsections for details regarding identification of specific items.

Provide and install nameplates on all devices provided whether mounted inside an enclosure or field mounted.

Provide and install face-of-panel mounted nameplates to identify systems, equipment and control functions.

Provide and install all electrical identification including conduit tags, wire labels, and nameplates for panels, contactors, disconnects, junction boxes, pull boxes, starters, terminals and transformers.

Label all devices, ducts, cabling, wiring and conduit. In the case multi-conductor cables, each individual conductor shall be uniquely and individually identified.

Label all terminal blocks and RTU/RPU module contacts consistent with all project drawings.

All labels shall be printer generated, handwritten labelling is not acceptable.

The contractor shall submit samples and lists of proposed wording for review and approval by the City before engraving. The City retains the option to alter wording during this review process at no additional cost.

(b) Nameplates

Nameplates refer to device identification nameplates and control identification tags (e.g. Hand/Off/Auto text).

All nameplates shall conform to the following general requirements.

Each nameplate shall be complete with bevelled edges and engraved wording to completely identify the equipment with no abbreviations except where approved within this document.

Nameplates shall be laminated 2-ply coloured plastic plates, which are a minimum of 1.6mm thick and shall be engraved using Micarta lettering.

Information on nameplates shall be as prescribed by the City of London. Wording is generally to be as per the drawings or IO point listing, but must be reviewed prior to engraving by the City of London Project Manager. Submittal must show text, placement of text & size of text.

The following table provides size guidelines. Actual sizes shall be as instructed by the Col contract administrator following submission of text for nameplates.

Size #	Dimensions (mm x mm)	Letter Height (mm)	Size Selection Guide
1	10 x 25	6	Control Labelling (e.g. Off)
2	15 x 50	6	Damper motors & control valves
3	25 x 75	8, 10	Instrumentation & control equipment
4	20 x 100	8	Control panels & Terminal cabinets
5	35 x 200	20	Mechanical room equipment
6	40 x 40	8	Valve tags

All devices shall be tagged at the location of the device. Tags shall indicate device identification code, power feed source with circuit # and voltage, associated control panel, and control signals. The following examples show the information to be included on equipment tags and valve tags.

Typical Control Device Tag

120 VAC
B01-LPL14 #22
1-PCL–CDT01–LIT-A
B01-CPL12
AO 4-20 ma
Via B08-TBX21

1. Source power is 120 VAC fed from lighting panel B01 - LPL14 contactor #22 (loop powered devices would simply indicate “Loop Powered”)
2. The device is a level indicating transducer
3. Control output shall panel B01-CPL12
4. Control wiring passes through terminal box B08-TBX21 prior to the control panel

Typical Valve Tag

1-PCL–BLV01
200 mm
NORMALLY OPEN

1. The device is a ball valve
2. The size of the valve is 200 mm
3. The normal operating state for the valve is open

(c) Pipes - General

Identification shall be provided by lettered legend, classification by colours, and direction of flow by arrows (double headed where flow is reversible). Text and arrows shall be sized as follows:

Outside Diameter of Pipe or Insulation	Size of Letters	Size of Arrows
< 50 mm	12 mm	35 x 100 mm
< 75	20	50 x 100
< 150	30	50 x 150
< 250	60	50 x 150
> 250	90	75 x 150

Identification Material

- For pipes and tubing 20 mm and smaller
  - *Waterproof and heat resistant plastic marker tags.*
- For pipe 20mm to 150 mm diameter
  - *Plastic coated cloth material with protective over coating and waterproof contact adhesive undercoating*
  - *Suitable for 100% humidity and continuous operating temperature of 150°C*
  - *Length shall be sufficient to wrap completely around the pipe with ends overlapping one (1) pipe diameter.*
  - *Lettering and directional arrows shall be pre-printed before installation.*
- For pipes over 150 mm diameter
  - *10 mil thick 25/50 rated PVC sleeve of sufficient length to wrap completely around the pipe with a minimum 25 mm overlap*
  - *Label shall be minimum 300 mm long with directional arrow and 100 mm colour coded banding at each end*

(d) Ducts – General

Ducts shall be identified by custom made Mylar stencils with 50 mm high lettering which accurately describes the duct service, following naming convention standards described previously, complete with a directional arrow.

(e) Electrical Components – Conduit, Cabling, Wiring & Similar

All wiring shall be identified with self-laminating vinyl labels produced by industrial thermal transfer printer (slip on identifiers shall not be used). Label material shall be selected to provide maximum durability accounting for anticipated environmental exposure.

Cable jackets shall conform to the standards for colour coding. Otherwise, code with plastic tape designed specifically for this purpose with spacing and locations to match standard for piping.

For underground conduits, provide warning tape consistent with the following example.

- Legend:
  - *1st Line – CAUTION CAUTION CAUTION*
  - *2nd Line – BURIED ELECTRIC LINE*
- Letters: 40mm minimum
- Interval: Continuous

Warning signs shall be provided as required by the Electrical Safety Authority and the Engineer. All warning signs shall be porcelain enamel decals sized to be clearly visible and readable at three (3) m.

All wires shall be labelled on both ends with the only exception being jumpers less the 300 mm in length that do not enter conduit, panduit, ducts or cable bundles.

(f) Electrical – Panels, Boxes, Devices & Similar

The following table provides specific details regarding the minimum information that shall be provided on electrical component nameplates (nameplate to conform to same general requirements as Device Identification Tags).

- Contactors — Identifier Code, Load Controlled & Voltage
- Disconnects — Identifier Code, Load Controlled & Voltage
- Junction boxes — Identifier Code, System & Voltage
- Pull boxes — Identifier Code, System & Voltage
- Starters — Identifier Code, Load Controlled & Voltage
- Terminal cabinets — Identifier Code, System & Voltage
- Transformers — Identifier, Capacity, Primary & Secondary Voltage

3.06 Manufacturer's Nameplates

(a) General

All equipment and instrumentation shall ship from the manufacturer with a manufacturer's nameplate.

Nameplates to be mechanically fastened and consist of brass tags with 12 mm stamped lettering and numbers filled with black paint.

All nameplates to include the following information:

- Equipment model
- Manufacturer's name
- Year of Manufacturer
- Serial number

(b) Motors

As a minimum, manufacturer's nameplates for motors shall include the following additional nameplate information.

- Voltage
- Cycle
- Phase
- Rated Power

(c) Pumps

As a minimum, manufacturer's nameplates for valves shall include the following additional nameplate information.

- Impeller Diameter
- Rated Capacity

(d) Valves

As a minimum, manufacturer's nameplates for valves shall include the following additional nameplate information.

- Valve Size
- Valve Class
- Liner & Seal Material (where applicable)

3.07 Installation

(a) General

The following general guidelines shall be followed for all equipment.

- Mount all specified identification indicators in clear view and positioned such that the text can be easily read without need for the individual to stoop, bend or stretch.

- Do not obstruct visibility by wire bundles or other equipment.
- All identification nameplates are to be applied prior to installation.
- Where works completed under this project interfaces with existing equipment (e.g. reuses or supplements) and field devices, all existing identification shall be replaced with identification conforming to these standards where the coding used is out of compliance.

(b) Devices - General

- Generally nameplates shall be attached by epoxy glue directly to devices. Before application, surfaces shall be properly cleaned and prepared to ensure secure and permanent attachment.
- Where not practical to device mount, securely fasten to each device or to a conduit clamp located near the device with 16-gage stainless steel straps.

(c) Valves

- Valve tags to be attached with 3.2 mm diameter by 100 mm long stainless steel bead chain.

(d) Piping & Ducts

- Paint entire length with prime colour with bands painted 50mm wide every 1000mm.
- For pipes, prepare surfaces as per product manufacturer's recommendations before mounting of identification. Overlap adhesive and liquid weld to seal ends of sleeves.
- For ducts, stencil over final finish only.
- Locate identification as follows:
  - Place plane of legend at approximately right angles to the most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility caused by dirt and risk of physical damage such that text is easily and accurately readable from all operating areas;
  - Locate at beginning and end points of each run; at each piece of automated equipment in run (preferably upstream of device); adjacent to each change in direction; at least once in each small room through which piping passes; on both sides of any visual obstruction; where runs may otherwise be difficult to follow; and beside each door.
  - Locate not less than once every 15m of run.

(e) Electrical Components – Conduit, Cabling, Wiring & Similar

- Securely apply nameplates and tags to conduits, pull and junction boxes, and terminations.
- All wiring shall be identified with self-laminating labels produced by industrial thermal transfer printer. Slip on pre-manufactured identifiers shall not be used.
- All wires identified at both ends using vinyl labels (except jumpers less the 300 mm in length that do not enter duct, conduit or wire bundles).

- Place warning tape in trench directly over duct banks, direct-buried conduit, and direct-buried wire and cable.
  - 20cm below finished grade where conduit or duct bank is 40cm or more below finished grade.
  - 10cm below finished grade where conduit or duct bank is less than 20cm below finished grade.

(f) Electrical – Panels, Boxes, Devices & Similar

- Labels shall be installed on all panel components including but not limited to switches, circuit breakers, etc.
- Using suitable permanent wire markers and terminal block tags, number all terminal blocks as specified within this standard (and consistent with all project drawings).

(g) Drawings

- Drawing numbers shall be prefixed with the location, section, process and building descriptor previously set forth. In cases where more than one process or building, are indicated on the same construction drawing, this element may be deleted.
- This automation and control identification code shall be followed on a separate line by standard construction drawing indexing as identified within the City of London Drafting Standard.

PART 4 ELECTRICAL GENERAL

4.01 Common

(a) General

The control system consists of instruments, control devices, panels, and digital control system equipment located throughout the facility. This section summarizes general requirements for electrical work related to automation and control.

- Furnish labour, materials, equipment, and services to store, transport, install, calibrate, and make operational, the control system.
- Include wiring, conduits, fittings, and connections to link the individual components into an integrated control system.
- Remove all existing unused cabling, instrumentation, control devices and related equipment, not part of the spares allowance defined within this document
- Procure and pay for permits and certificates required by local and provincial ordinances and fire underwriter's certificate of inspection.
- Unless otherwise specified, use new materials of current production that conform to the applicable standards and regulatory requirements.
- Submit certified test reports and shop drawings that meet the requirements set by Ontario Hydro for inspection purposes as evidence of compliance.
- Use one manufacturer for all similar items and associated equipment. Components of an assembled unit shall be products of the same manufacturer.
- Do not interfere with continuous operation of City of London's equipment, unless otherwise approved by the City of London.
- Do not install instrumentation and control equipment without the services of an on-site field service Engineer from the Supplier.
- Route redundant data cables in separate conduits. Locate redundant cables in tunnels, galleries, and duct banks as far apart as space permits.
- The contractor shall revise all electrical works which are impacted by the changes performed such that the finished works meets all requirements set forth in the latest revision of the applicable codes and regulations as part of the scope of works.

(b) Site Storage

- The atmosphere of the site may be corrosive to electronic equipment and components. As such, the contractor shall take all necessary precautions assuming this to be the case to protect equipment from any possible resulting damage.
- Inspect the intended storage space at the site. Prepare the storage location accordingly to ensure equipment is secure during storage.
- Provide a written report on the adequacy of storage.

(c) Site Examination

- Verify equipment locations and delivery routes prior to installation to ensure the equipment will fit in the available space.
- Existing raceways that contain space to run wiring may be used as long as existing equipment is not damaged, existing wiring is not damaged, control signals are not interrupted, monitoring signals are note interrupted and power is not interrupted. Obtain prior approval from The City of London before pulling wires.
- Verify the proposed installation plan will conform to all applicable standards and vendor recommendations.

4.02 Grounding

(a) General

- As part of the scope of works, have a ground verification report completed by a firm which specializes in these type investigations and ensure adequate grounding is available.
- Ground panels and enclosures to building grounds.
- Ground instrument signal shields and communication cabling at one location only.
  - Ground at control panel unless specifically directed otherwise by the equipment manufacturer or within these standards.
  - For Ethernet cabling, ground at the network switch.
  - At the ungrounded end, trim back and insulate shield.
  - If a signal passes through a junction box or barrier strip, maintain shield continuity.
- Ground computer equipment in accordance with manufacturer's recommendations.
- Ensure the quality of all grounds exceed manufacturers recommendations.
  - If a separate ground rod is recommended, bond it to all other ground rods.

4.03 Pull and Junction Boxes

(a) General

- Pull and junction boxes shall conform to the following general requirements.
  - NEMA 12 for general use.
  - NEMA 4X in areas where the possibility of exposure to moisture (e.g. wetted areas) and/or corrosive vapours (e.g. sludge processing areas) exists.
  - NEMA 4X in all exterior areas.
- NEMA 12 construction shall conform to the following minimum requirements:
  - 14 GA galvanized steel with seams continuously welded, ground smooth, no knockouts;
  - Zinc-rich coating on all seams;
  - Stainless steel captivated cover screws threaded into sealed wells;
  - Flat door with oil resistant gasket;
  - UL or CSA listed NEMA 12 classification.
- NEMA 4X construction shall conform to the following minimum requirements:

- 14 GA steel with polyester powder coating inside and out over phosphatized surfaces or 14 GA stainless steel;
- Seams continuously welded, ground smooth, no knockouts;
- Stainless steel clamps on four sides;
- Stainless steel hinges;
- Flat cover with oil resistant gasket;
- UL or CSA listed NEMA 4X classification.

(b) Installation

- Install junction boxes and pull boxes plumb and square to building lines and as required due to number of bends, distance, or pulling conditions.
- Securely anchor junction boxes and pull boxes, and make readily accessible.
- Do not total more than 180 degrees, including entrance and exit to the boxes, for conduit bends between boxes.
- Install pull boxes or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
- Use locknut and bushing for boxes in non-classified areas.
- Use cast metal boxes with threaded conduit hubs in hazardous areas.
- Use Type FS and FD boxes in exterior and wet areas and where exposed rigid steel conduit is required.
- Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
- Use boxes sized to accommodate quantity of conductors enclosed.
- Use boxes sized to accommodate conduit tying into box.
- Ensure covers of boxes are accessible.
- Install boxes rated for the area classification.
- Install rigid conduit squarely into boxes that do not have hubs or are drilled and tapped.
- Install with locknut on the outside and bushing on inside.
- Install rigid conduit squarely into boxes that do not have hubs or are drilled and tapped.
- Install with locknut on the outside and bushing on inside.

4.04 Outlet boxes

(a) General

- Boxes for exposed wiring:
  - Cadmium plated, cast, ferrous metal, with threaded hubs.
  - Cast blank, steel device covers.
  - Gasketed in exterior and wet locations.
  - Stainless steel screws.
- Boxes for concealed wiring:
  - Code gage, hot-dip, galvanized steel.
  - Provide grounding screw.

(b) Installation

- Use locknut and bushing for boxes in non-classified areas.
- Use cast metal boxes with threaded conduit hubs in hazardous areas.
- Use Type FS and FD boxes in exterior and wet areas and where exposed rigid steel conduit is required.
- Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
- Use boxes sized to accommodate quantity of conductors enclosed.
- Use boxes sized to accommodate conduit tying into box.
- Make covers of boxes accessible.
- Install boxes rated for the area classification.
- Install rigid conduit squarely into boxes that do not have hubs or are drilled and tapped.
- Install with locknut on the outside and bushing on inside.

4.05 Panel Boards

(a) General

- Provide dead-front type, designed in accordance with NEMA classification requirements.
- Enclosures shall conform to the following requirements:
  - Steel reinforced.
  - Concealed or semi-concealed hinges.
  - Trim adjusting screws.
  - Directory card mounted inside front door.
  - Corrosion proof lock with retractable latch.
  - Surface or flush mounting to match installation location.
- Bus bars shall conform to the following requirements:
  - Sequenced phase.
  - Fully insulated.
  - Solid Non-Plated copper construction.
  - Drilled and tapped on circuit pole centres.
- Solid neutral bar with solderless mechanical type connectors.
- Main lugs shall conform to the following requirements:
  - Solderless type.
  - Approved for copper and aluminium UL listed wire.
- Non-insulated grounding strip including:
  - Main ground lug.
  - Individual grounding terminals for each circuit breaker and circuit breaker space.
- Maximum panel voltage:
  - 240 VAC for lighting panel boards.
  - 600 VAC for distribution panel boards.

- UL 50 listed, Gutter space per NEMA and UL requirements.
- 240mm nominal depth, constructed of 14 gauge galvanized steel.
- Furnish with knockouts in side, top, and bottom panels.

(b) Installation

- Install as per manufacturer's instructions and in accordance with the appropriate NEMA standard such that the designated NEMA rating is maintained following installation.
- Mount on inside of panel board door "as connected" directory listing all connected devices and design loads. Listing shall be electronically generated on self-adhesive oil and water resistive label. Handwriting is not acceptable.

PART 5 WIRING

5.01 Common

(a) General

This section describes requirements for wiring, both within panels and general field wiring. This includes field wiring that connects the field equipment (instruments, control stations, control panels, MCCs, etc.) to the Process Control, Operator Interface (including local) and SCADA Systems.

- Use only CSA approved and labelled cables and conductors.
- All wiring shall be neatly dressed and run in conduit with AC and DC conductors in separate conduits. Wiring conduits shall provide a minimum of 20 percent spare space or room for a minimum of 4 additional cables of the largest size installed under this contract, whichever is the greater.
- Use continuous plastic coil reusable wiring wraps to bundle wires outside of wiring conduits. Securely fasten the bundles to the structure at intervals not exceeding 300mm.
- Keep minimum 10mm clearance between all wiring-bundles.
- Keep control cables physically separate from both low and high voltage cables.
- Separation between all cabling shall be not less than the distances recommended by all device manufacturers and standards organizations.
- Pump run lamp selector panel shall be located both at the MCC and at the location of the pump. The selector shall be DeviceNet based and shall provide the following functions:
    a. Hand/Off/Remote Selection
    b. Forward/Reverse or High/Low as required
    c. Reset
    d. Communication Fault Indicator
    e. Main Disconnect On/Off/Tripped Indication
- Thermocouple extension circuits shall be solid conductors of the same material as the associated thermocouple. Thermocouple signal lines shall be continuous from the thermocouple connection head to the final termination point.
- Ultrasonic sensor cabling must be installed strictly in accordance with manufacturer's instructions.
- Communication and analogue signal conductor shields must be isolated and taped back at one end and terminated at a single ground point at the other as shown on the loop drawings. If the correct grounding information is unclear, confirm exact shield termination and isolation details with the equipment manufacturer and the Engineer.
- Each conduit shall be sized for spare conductors equal to 25% of the number required for present and defined future conditions, but in no case less than four spare wires or

two pair. Each cable shall have 10% spare conductors but not less than two conductors. Spare conductors shall be terminated on a marked terminal strip at each end.

- Wire at both ends of the cable shall be terminated with pre-insulated solderless spade, screw terminals, or ring lugs for maximum physical strength and electrical conduction. Wires shall not be terminated on adjacent terminal points if accidental short-circuiting could cause tripping or closing of a breaker.

(b) Utility Wiring Devices

- Switches shall be mounted with toggle in up position when switch is closed (power on).
- Multiple devices shall be mounted in common gang type outlet boxes where more than one device is in close proximity (defined as less than 1.5 m separation).
- Where switched outlets are provided, use divided outlets mounted vertically with only upper portion switched.
- All outlets shall be installed with full GFI protection for all sockets. GFI protectors shall be mounted in the panel board not at the outlet.

5.02 Power Feeds

(a) General

In addition to requirements set forth elsewhere in these standards, the following requirements apply:

- All feeders shall be run in continuous conduit between power supply point and the load with no splices.
- Provide for separate feeder circuit conduit entry.
- Connect through disconnect switch that isolates all conductors. Immediately follow disconnect switch with power surge suppression providing protection on all conductors.
- Provide a master circuit breaker and branch circuit breakers on each individual circuit distributed from the panel.
- Group the circuit breakers and mount on a single dedicated Din rail.
- Place sub panel so that there is a clear view of and access to the breakers when the door is open.
- Use branch circuit breakers rated at 120% of the attached design load.
- No more than 20 devices shall be installed on any branch circuit.
- Where multiple units perform parallel operations, group devices over not less than two separate circuits so the loss of one circuit does not result in the loss of the parallel operation.
- Ensure that no branch circuit combination of devices exceeds 10A total peak load.
- Use type THWN power wiring with insulation rated at 600 V.
- Use 12 AWG or larger for power wiring that supplies all non-control loads.

5.03 Control Panels (RPU panels, relay panels, selector panels, etc.)

(a) General

In addition to requirements set forth elsewhere in these standards, the following requirements apply:

- Supply power to all instrumentation monitored by a control panel from the same control panel as the RPU used to monitor the instrumentation. Instrumentation shall be powered by UPS.
- The PLC power supply shall not be used to supply power to field devices or panel lamps.
- All wiring shall consist of flexible stranded copper wiring run in continuous lengths from terminal to terminal. Splicing of wires is not acceptable.
- Provide main On-Off disconnect switch and individual DIN rail circuit breakers for each instrument powered from the panel sized appropriately for the attached load.
- Provide open and short circuit protection between RPU/RTU and all field devices.
- Provide a minimum of 10% spare wires (not less than 6) run to panel doors (except doors without operators or indicators).

(b) Grounding

- Supply two separate grounds, one for instrument grounding (i.e. 4-20 mA cable shields etc.) and one for control circuit grounding (i.e. case grounds, control circuits, etc.).
- Install grounding so as to keep two grounds isolated (separate).
- Ground conductors shall be #6 AWG.
- Provide grounding lugs for connection to the external grounding system.

5.04 Terminal Blocks

(a) General

In addition to requirements set forth elsewhere in these standards, the following requirements apply:

- Provide knife-switch field terminal blocks with test contacts on all analogue 4-20 mA loops to permit easy electrical isolation of loop and connection of ammeter into loop.
- Provide fused terminal blocks with neon “fuse blown” indicator on a knife switch with test contacts for all digital loops to electrically isolate the loop.
- Provide factory assembled terminal blocks on a mounting channel and bolt the channel to the inside of the panel. Space terminal block strips no closer than 6 inches centre to centre.
- All terminals shall be DIN rail mounted.
- Use anti-oxidant on terminals.

- All field and control wiring external connections shall be completed through easily accessible terminal blocks with minimum of 20% space for expansion.
- Terminate all I/O, irrespective as to whether IO is used, to terminal blocks.
- Supply terminal block partitions for separating instrument loop (4-20 mA, etc.) from 120V AC terminals.
- Arrange terminal strip so that terminal block barriers partition control wiring and instrument wiring and ground points.
- Grounding points shall always be located on separate rails. The same applies to field power supple terminal blocks.
- Common connection of wires at terminal blocks shall be by jumper bars by the same manufacturer as the terminal blocks and designed to work with the terminal blocks. Provide a continuous marking strip with the terminals to indicate common connections.
- Separate terminals shall be used for each wire.
- Reserve one side of each terminal strip for field incoming conductors. Do not make common connections and jumpers required for internal wiring on the field side of the terminal.
- Provide a minimum of 20% spare terminals.

5.05 Control Wiring

(a) General

In addition to requirements set forth elsewhere in these standards, the following requirements apply:

- Separate signal wiring from control power wiring, group functionally, and arrange neatly to facilitate tracing circuits. Separate analog signal wiring at least 150mm from power wiring.
- Use twisted unshielded wire for dc signals with a minimum of six twists every 300mm. Do not intermix within the same bundle or conduit with wire conducting ac signals.
- Organize I/O points in racks so that I/O from two or more pieces of equipment, with the same process function, is divided among at least two groups of I/O cards in a rack. Organize the I/O points so that if one I/O card fails, at least one piece of equipment from the group that has the same process function will remain fully operational.
- Discrete control wiring shall be installed such that signals conform to the following conventions.
  - Circuit powered from field device power unless field device powered through panel. Concept is that field devices should never be powered by more than one source.
  - DI status from “On/Off” selector – Energized = Device On
  - DI status from “Local/Remote” selector – Energized = Remote
  - DI status from Breaker – Energized = Breaker Closed
  - DI status from Device – Energized = Running
  - All control I/O shall be individually fused at the terminal block
- The following requirements apply for Discrete control wiring:

- AC digital signals are 120 VAC and less than 15 amperes, and received from contact outputs used for controlling 120 volt devices such as motor starters, push-buttons, pilot lights, and the like.
- Single Conductor: For single circuits use single conductor #14 AWG, 19 strand copper conductor with RW90 insulation and PVC jacket.
- Multi Conductor: For multiple circuits use multiple conductor #14 AWG, 19 strand copper conductor with RW90 insulation and PVC jacket.
- Unless specifically shown otherwise, wire all digital alarm contacts "normally closed", "open to trip".

- The following requirements apply for Analog control wiring:
  - Control signals shall be 4 to 20 mA, linear, isolated, and capable of driving a maximum load of 750 ohms. Existing equipment not conforming to this requirement shall be modified or replaced.
  - Single Pair: For individual instrument circuits use single pair, two inch lay, double-shielded twisted, foil-shielded cables with drain wire, #16 AWG, 600 volt, 19 strand copper conductors.
  - Multi Pair: For multiple instrument circuits use multi-pair double shielded cables made up of individual single pair, two inch lay, twisted, each pair individually foil shielded cables with drain wire, #16 AWG, 600 volt, 19 strand copper conductors.
  - Shields: Signal shields shall have one ground point located at the control panel unless otherwise recommended by the instrument/equipment manufacturer. Shields shall be continuous through cabinets, panels and junction boxes.
  - Separate analog signal wiring at least six inches from power wiring.
- Install optical signal isolators on all control loops with signal cabling running outside buildings, speed control signals into variable frequency drives, any other situation where potential EMF problems could develop and on all other high risk control wiring (high risk is defined as all I/O potentially exposed to surges, transients, capacitive ground effects, or ground potentials).

5.06 Field Wiring

(a) General

In addition to requirements set forth elsewhere in these standards, the following requirements apply:

- The following defines the requirements for field control wiring for equipment.
- Devices (unless otherwise stated within this document) shall be provided with Hand/Off/Remote selector switches. The PLC shall monitor the Remote positions of the selector and shall alarm when a device is not in remote as this is an abnormal mode only intended for maintenance purposes.
- Where the ability to switch the devices between local and remote in a bumpless fashion is required, Start/Stop Pushbuttons with a separate Local/Remote Selector shall be provided. Aeration blowers are an example where this type control applies.

- Where the device shall default to the OFF state when running in local upon interruption of power, Start/Stop Pushbuttons with a separate Local/Remote Selector shall be provided.
- Sending the valve an analog set point for position shall control modulating valves. Upon loss of signal, the valve shall return to either a preset set point or will hold last position to correspond to a safe state.
- Open/Closed Valves shall be controlled by separate open & close signals. The open state requires open signal to be energized (not momentary pulse) and the closed state requires close signal to be energized (not momentary pulse). If both the open and close signal are the same (both energized or both denergized) then the valve shall revert to a predetermined state of either open, closed or hold last state.
- A single run contact shall control motors & similar devices. If the PLC fails, the device shall stop and the operational procedure shall be that in order to restart the device the selector must be switched off of Remote, unless stated otherwise, elsewhere in these standards.
- From a programming perspective, since Hand and Off are abnormal operating procedures, the SCADA should generate a low priority “Not Available to SCADA” alarm when left in these modes.
- Manual controls (e.g. local device start/stop or open/close selectors) will only function when the mode selector is in the Local position. Similarly, remote control will only function when the selector switch is in the remote position.
- All cables and wires shall be installed within conduit. Use field junction boxes suitable for the area classification to "marshal" groups of signals of the same type in an area and cable back to buildings and local control panel with multicore cables.
- Avoid running cables inside or under power cable trays. Where field wiring is in power cable trays, insulation must be equal to or greater than double the highest voltage in the cable tray.
- Where power or signal cables must cross, make them cross at an angle of 90 degrees.
- Cable runs from terminal block to terminal block shall be continuous lengths without splices.
- Where specific wiring types are not specified, provide types of wiring as recommended by the system component manufacturers and conforming to all applicable standards.
- Provide conduit for all system wiring, except for power cords with integral plugs, and except where conduit, tray or similar raceway is provided.
- Unless otherwise specified, install analogue signal cabling, including transducer cables and network cables in separate dedicated R.S. conduits away from AC power and other EMF sources.
- Provide adequate slack on cable harnesses to permit easy removal of devices, I/O, and other printed circuit cards and/or modules during service or repair.

5.07 Safety and Permissive Interlocks

(a) General

In addition to requirements set forth elsewhere in these standards, the following requirements apply:

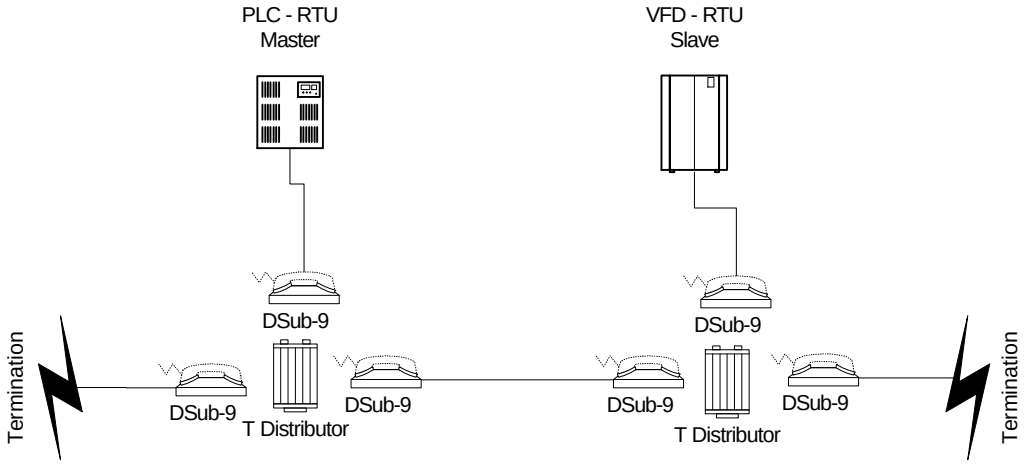
- Interlocks shall be used to prevent equipment from running under undesirable conditions (e.g. low pump well level locking a pump out).
- All interlocks, except those that are integral to the device (e.g. motor overload protection) and device disconnects, shall be handled programmatically in the PLC, unless specifically directed otherwise by the City of London. An exception is that motor protection for large motors (over 50 hp) shall be provided by dedicated motor protection relays.
- Each interlock condition shall be individually monitored and alarmed by the City of London's Wastewater SCADA system.
- Individual disconnect switches shall be provided for all equipment. Disconnects shall be located within 3 m of the equipment controlled in direct line of sight. The paths between disconnect and controlled device shall be unobstructed. When the disconnect switch is open, the switches auxiliary shall be wired such as to not permit the operation of the starter coil, or a starter contact. Disconnect switch position shall be monitored by the central control system.
- When the breaker at the starter panel is open, the status auxiliary contact shall be wired such as to not permit the operation of the starter coil, or a starter contact. As a minimum, each breaker shall be monitored by the SCADA for Open, Closed and Tripped states.

5.08 Serial Communication Cabling

(a) General

In addition to requirements set forth elsewhere in these standards, the following requirements apply:

- In order to ensure clear clean wire connections all RS-485 based serial field connections (including Profibus) will be made using screw contact style DSub-9 plug connectors and T-branch RS-485 distributors. The total bus loop distance shall not exceed 2200 m and branch line distance (tap to field device) shall not exceed 1.5m.
- The following diagram shows the basic cabling methodology for a simple two-drop network.



- A spare DB-9 port will be provided on the bus in order to provide a port for connection of a RS-485 diagnostic device.
- All cable runs shall be designed to support both Modbus RTU and Profibus Serial communication at speeds of not less than 19200 baud.
- The contractor shall resolve all communication interference problems including problems resulting from installation practices (e.g. locating signal cables too close to other cables), and line noise & electromagnetic radiation induced by VFD & other equipment installed at the location. If problems are encountered it is the sole responsibility of the contractor to isolate the source and resolve the communication problems.
- Separate communication analog signal wiring at least 150mm from power wiring.
- Use uniformly twisted shielded pairs not smaller that 20 AWG with a minimum of six twists every 300mm designed specifically for RS-485 industrial communications.
- Ensure all cabling is certified Profibus compliant.
- Provide individual T-branch signal drops for each connected device and necessary termination resistance
- Provide continuous foil shields with 100 percent coverage. Include a drain wire in continuous contact with the shield. Signal shield ground points shall be connected as per manufacturer recommendations
- Install optical isolators on all communication loops considered high risk (high risk is defined as all loops potentially exposed to surges, transients, capacitive ground effects, or ground potentials)
- Install optical isolators on all Modbus RTU Master Devices

5.09 Voice/Data Cabling

(a) General

In addition to requirements set forth elsewhere in these standards, the following requirements apply:

- City of London staff shall perform the physical interconnection between premise wiring and corporately owned equipment.
- A single subcontractor shall install the complete and fully operational cabling system as required to meet the design for the facility.
- Ethernet cabling systems shall comply with all applicable Ethernet and data communication standards for 10/100/1000 Mb/s transmission rates.
- Fibre Optic cabling shall be used in all locations where one or more of the following criteria are met.
  - The total cable run between switch and field device interfaced exceeds 90 meters.
  - Cable provides connectivity for more than one device (e.g. connects two switches).
  - Cable connects to a control panel.
  - Cable will run within 10m of medium voltage conductors.
  - Cable will run within 10m of high voltage conductors.
- Each room outlet, unless otherwise noted, shall be served by two communication ports. Separate cables shall service each port, and each cable shall be terminated on an 8-position, 8-conductor Universal jack conforming to the applicable colour coding.
- All cabling shall have appropriately coloured jacket.
- Individual conductors shall be FEP insulated.
- Cable shall meet the performance requirements set forth in the applicable standards for Frequency range testing, Attenuation, NEXT, PS NEXT, ELFEXT, PS ELFEXT, Return Loss, ACR and PS ACR.
- The entire cabling system shall conform to the applicable commercial and industrial standard for telecommunication pathways and spaces, and shall be tested. Test reports shall be certified by the cable supplier.
- LAN/Telco room rack cabinets shall be wall mounted, 19" wide, height to suit application c/w all necessary cable guides, and with integral 120 Volt receptacle strips with plug-set at bottom. Rack cabinets shall be sized to house all termination/patch panels, hubs and system equipment to be located at the site including both contractor and city provided equipment. Cabinets shall be lockable with replaceable lock tumbler assembly.
- Unless specifically for telephone company use only, patch cords shall be certified by the manufacturer to the applicable standards with terminations and anti snag covers factory installed.
- The horizontal twisted pair cabling shall be terminated onto rack-mounted 110 Connect/BIX patch panels. Patch panels shall be 3.5" high and provide 48 modular jack ports. The front each module shall accept a 9mm label.

- The 110 Connect/BIX patch panels and LAN electronics shall be rack mounted with horizontal cable troughs, cable management panels, and vertical management on the mounting rails of the rack.
- Forty-eight port Universal 110 Connect/BIX patch panels shall be provided to terminate the required number of communication drops. The patch panels shall be provided with cable support bars (located beneath each panel on the rear of the rack) to property dress, terminate and manage the installed cables.
- The jack shall be shall be either a BIX or 110 connect outlet in Grey. All communication (both data and voice) cabling shall be tested with scanner suitable for Ethernet Certification (1000 Mbps) which provides a printout of test results for all links for review. Any cable that does not achieve a passing rating shall be replaced.
- Submit test results on 3-1/2" diskette in addition to hard copy. Hard copy shall bear the printed name and signature of the testing professional. Test results shall include certificate of cabling system manufacturer recognition of test results, quality of installation, and performance warranty for entire system.
- Run cables neatly in conduits and provide sufficient slack cable in rack to run each cable down to the floor of the room to allow any cable to terminate at any location on the rack now or in the future.
- Where runs must be pulled, a tension meter shall be used. Pulling tension shall not to exceed 25 pounds.
- Bond all racks to ground in accordance with OHESE requirements using #6 AWG insulated ground wire.
- To provide for future expansion, a spare port shall be installed wherever a device is connected.
- For Ethernet Connected Panels, provide SNMP managed switch with minimum of three (3) 10/100Base-T Ethernet ports and Fibre port for connection to plant LAN. Connect RPU and UPS to switch by pre-assembled CAT6 cables.

PART 6 CONDUIT

6.01 Common

(a) General

- The following table defines the type of conduit that shall be installed.

TYPE	USAGE
Rigid Steel	Unless otherwise stated.
PVC Coated Rigid	Direct Buried applications including Instrumentation Direct Buried Power and Control – Entering or leaving buildings and runs with bends
Rigid Aluminium	Sludge Processing and Incineration Wet areas Indoors, outdoors where exposed to elements
Flexible	Equipment connections

- Rigid, Non-Metallic Conduit and Fittings shall not be stored exposed to sunlight or other UV rays.

6.02 Galvanized Rigid Steel Conduit

(a) General

- Material: Constructed of mild steel with continuous welded seam
- Coating (ext): Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
- Coating (int.): Baked enamel for a smooth surface
- Threads: Galvanized after cutting
- Standard: ANSI C80.1, UL 6 and UL 514B, CSA C22.2 #45

(b) Fittings

- Body: Malleable iron, cadmium-plated; steel, hot-dipped galvanized; or steel, zinc-plated with aluminium enamel finish.
- Covers: Malleable iron, cadmium-plated.
- Gaskets: Neoprene integrally fused to or recessed into the body.
- Bond jumpers: Tinned copper flexible braid or beryllium copper grounding spring.
- Locknuts: Malleable iron, zinc-plated.
- Fittings: Threaded unless otherwise noted. Same material and finish as the conduit with which they are used.

(c) Fittings in Non-Hazardous & Non-Corrosive Locations

The following additional requirements apply:

- Insulators: Phenolic, thermosetting: Minimum 105 Degrees C UL rating.
- Fittings: Hubs shall be rain tight.
- Ground Saddle: Tin-plated copper or bronze suitable for use with copper and aluminums conductors.
- Standards: UL 6, UL 467, UL 514 & UL 1242

(d) Fittings in Hazardous Locations

The following additional requirements apply:

- Expansion: 12 to 25mm straight-line total conduit movement. Steel, zinc-plated.
- Drain: Stainless steel or brass.
- Breather: Stainless steel or brass.
- Fittings: Hubs shall be air tight sealed with UL listed compound intended for use of sealing fittings.
- Standards: UL 514 & UL 886. Listed for use in Class I, Groups C & D locations.

6.03 PVC Coated Galvanized Rigid Steel Conduit

(a) General

- Material: Conduit, prior to plastic coating, shall meet requirements for RGS
- Coating (ext): Continuous polyvinyl chloride. A PVC sleeve extending one pipe diameter or 5cm, which ever is less, shall be formed at every female fitting. The sleeve inside diameter shall be matched to the outside diameter of the conduit.
- Coating (int): Corrosion resistant urethane coating shall be uniformly applied to the interior of all conduit and fittings.
- Threads: Protected by application of a urethane coating.
- Standard: NEMA RN 1-1998.

(b) Fittings

- Body: All materials shall be consistent with the requirements for RGS.
- Fittings: All fittings shall be externally coated with polyvinyl chloride and shall have a corrosion resistant interior coating and shall be threaded. A PVC sleeve extending one pipe diameter or 5cm, which ever is less, shall be

formed at every female fitting. The sleeve inside diameter shall be matched to the outside diameter of the conduit.

- Standards: NEMA RN1 - 1998

6.04 Aluminium Rigid Conduit

(a) General

- Material: Aluminums alloy 6063 in temper designation T-1
- Standards: ANSI C80.5, UL Standard #6

(b) Fittings

- Body: Aluminums alloy 6067
- Fittings: Threaded
- Standards: UL-6, ANSI C80.5, CSA C22.2 No. 45

6.05 Liquid-Tight Flexible Steel Conduit

(a) General

- Material: Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked. Extruded PVC outer jacket positively locked to the steel core. Liquid and vapour tight construction
- Standard: UL 360

(b) Fittings

- Body: Malleable iron, zinc-plated
- Ferrule: Steel, zinc-plated
- Nuts: Malleable iron, zinc-plated
- Sealing ring: Neoprene
- Standard: UL 514.

6.06 Installation

(a) General

The following requirements apply to the use and installation of conduit.

- Install conduit and fittings, including offsets and crossovers, as required for a complete system. Installation is to be neat and in compliance with all applicable codes.
- Raceway sizes are normally shown on the Drawings. If a size is not shown on the Drawings, or if a minimum size is not stated in the Specifications, then size such as to

provide minimum 25% spare space for future expansion or room for 2 additional cables of the larger size installs in the conduit which ever is the greater.

- Provide and fully finish to not less than the same standard as surrounding surfaces, and all required openings in walls, floors, and ceilings for conduit penetration. For existing construction, core drill openings in masonry, and concrete, avoiding structural members and rebar.
- Conduits shall be installed to eliminate moisture pockets. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run. Drain fittings shall be installed in locations that are readily accessible by maintenance personal (e.g. in case of buried conduit, manholes must be provided if drains are required between buildings).
- Provide pull boxes, conduits, pulling elbows or tees as needed.
- Install conduit into boxes with hubs using thread lubricant.
- Conduits shall not be smaller than 20mm trade size.
- Recommended manufacturer and NFPA 70 practices and procedures shall be followed unless specified otherwise.
- Do not place concrete or soil until the City's Project Manager has inspected the conduits. The contractor will be required to uncover any conduits buried prior to inspection and take whatever restorative measures are required subsequent to the inspection.

(b) Locating

- Run in straight lines parallel to, or at right angles to building lines.
- Install conduit adjacent to walls and floors.
- Conduit, which is installed above suspended ceilings, shall follow the most direct, practical, route, without crossovers.
- Maintain minimum 150mm separation between instrumentation and power conduits.
- Maintain minimum 150mm separation from process, gas, air, and water pipes. Ensure that conduit does not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation and maintenance.
- Summation of the angles of all bends in a conduit run shall not exceed 180 degrees. Provide junction pull boxes as required.
- Avoid routing conduits through areas of high ambient temperature or radiant heat.
- All conduits within a structure shall be installed exposed except those located above suspended ceilings and those within stud, masonry, and concrete walls of finished areas.
- Where conduit is hidden, the exact location shall be indicated on "As Constructed" Drawings.
- Raceway runs, where shown, indicate the preferred location. Site conditions may affect actual routing. Coordinate routing and measurement with other trades and with equipment suppliers to avoid interference with equipment, piping, ductwork, etc.

(c) Detailing

- Every effort shall be made to prevent damage to the protective coatings.
- All nicks, mars, or damage to protective coatings shall be repaired to the same standards as original manufacturing.
- Fill openings in walls, floors, and ceilings and finish flush with surface. The same materials of construction shall be used for non-fire-rated walls.
- After the conduit run has been completed, pull a standard flexible mandrel, having a length of not less than 300mm and a diameter approximately 5mm less than the inside diameter of the conduit, through each conduit. Then pull a brush with stiff bristles through each conduit to remove any foreign material left in conduit. Finally swab the conduit by pulling a clean, tight-fitting rag through the conduit.
- Tightly plug ends of conduit with tapered wood plugs or plastic inserts until used.
- Ensure each and every conduit installed is complete with pull cord irrespective as to whether the conduit is in use or spare.
- Pull cord to consist of smooth 6mm nylon cord and shall be installed free of kinks and splices. Length of cord shall extend 1000mm beyond end of conduit at both ends.
- Remove moisture and debris from conduit before pull cord is pulled into place.
- In cases where existing conduit is reused, ensure following completion of work that these also have pull cords installed.
- Upon completion of work ensure removal of all unused cabling and wiring except for provision of spares as specified.

(d) Seals

- Install seals in each conduit in Class I and Class II location between an enclosure required to be dust ignition-proof and an enclosure that is not required to be dust ignition-proof.
- Install so that the filler plug and drain are accessible.
- Install complete with sealing fibre and compound.

(e) Support Systems

- All conduit support shall be accomplished using devices that have been specifically designed to work with the specific material that the conduit is made from.
- All conduits shall be provided with enough support to prevent deflection of more then 1cm in all possible ambient conditions.
- The following minimum requirements apply to conduit support system component parts.
  - Channels: Hot rolled carbon steel sheet hot-dip galvanized once formed
  - Brackets: Hot rolled carbon steel sheet hot-dip galvanized once formed
  - Nuts & Bolts: Mild steel bar stock, case hardened then hot-dip galvanized
  - Threaded Rods: Mild steel bar stock, case hardened then hot-dip galvanized

- Fittings: Hot-dip galvanized structural steel
- Clamps: Low carbon hot rolled steel sheet hot-dip galvanized once formed
- Standards: ASTM A153, A570, A36, A635, A569, A575, A307, A563

- Ensure support systems are provided which are compatible with the material and finish of the conduit to be supported.
- All steel support shall be hot-dip galvanized or constructed of stainless steel to provide corrosion protection.
- Conduits shall be supported from the building structure. Do not support conduit from process piping, gas piping, air ducts, water piping, or any other non-structural component.
- Provide hangers and brackets as follows:
  - Ensure that the maximum uniform load on a single support does not exceed 10kg. Support manufacturers recommended loading of supports shall be not less than 10kg.
  - Do not exceed maximum concentrated load recommended by the manufacturer on any support.
- Hangers shall be constructed as follows:
  - Consist of continuous threaded rods combined with struts or conduit clamps.
  - Do not use perforated straphangers and iron bailing wire.
  - Do not use suspended ceiling support systems to support raceways.
- Hangers in metal roof decks:
  - Utilize fender washers.
  - Do not extend above top of ribs.
  - Do not interfere with vapour barrier, insulation, or roofing.
  - Provide Conduit support system fasteners:
  - Use sleeve-type expansion anchors as fasteners in masonry wall construction. Do not use concrete nails and powder-driven fasteners.
- Maximum spacing between conduit supports:
  - Spacing between supports shall not exceed 3m
  - Support all conduits within 1m of the conduit termination.
  - Support all conduits within 100mm of 90-degree bends and vertical drops.
- Provide substantial vertical support for all conduit drops for stability and to minimize vibration.

(f) Sleeves, Connections & Bends

Sleeves Through Walls And Floors

- Sleeves through walls and floors shall be hot-galvanized steel except in sludge dewatering and designated areas where stainless steel shall be used.

Connections

- Stagger conduit joints at intervals of 15cm vertically.
- Make conduit joints watertight and in accordance with manufacturer's recommendations.
- Threaded connections shall be made wrench-tight.

- Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.
- Make plastic conduit joints by uniformly brushing plastic solvent cement on inside of plastic coupling fitting and outside of conduit ends. Slip conduit and fitting together with a quick one-quarter turn twist to set joint tightly.
- Transition from PVC to RGS conduit requires a minimum of 1.5M prior to entering a structure or going above ground.
- Conduit joints shall be watertight where one of the following criteria exists:

* *Where exposed to possible submersion.*
* *In areas classified as wet.*
* *Underground.*

Bends

- Accomplish changes in direction of runs exceeding a total of 5 degrees by long sweep bends having a minimum radius of 25 FT.
- Furnish manufactured bends at end of runs. Minimum radius of 500mm for conduits less than 75mm in diameter and 1000mm for conduits 75mm and over.

Field Bending and Cutting

- Utilize tools and equipment to make all field bends and cuts that are recommended by the manufacturer of the conduit, and designed for the purpose and material.
- Ensure necessary precautions are taken when using tools and equipment to prevent damage to the protective coating of the conduit.
- Do not reduce the internal diameter of the conduit when making conduit bends.
- Degrease threads after threading and apply a zinc-rich paint to the conduit threads.
- Remove burs and smooth the interior and exterior of the conduit after cutting or threading.

(g) Termination

- In NEMA 1 and 12 type enclosures terminate with an insulated grounding bushing on the interior and a locknut on the exterior.
- In NEMA 3R, 4, 4X, and 7/9 type enclosures terminate into a threaded hub with an insulated bushing, unless the hub provides equivalent protection to the conductors.
- When stubbed up through the floor terminate with an insulated grounding bushing.

(h) Flex-LT

- Install Flex-LT shall be used as the final conduit segment for cabling running to motors, electrically operated valves, primary elements (instrumentation), and electrical equipment that are subject to vibration.
- Maximum length shall not exceed:
  - 1000mm to motors.
  - 600mm to all other equipment.

(i) Direct Burial

- For circuits under 600V, install so that top of conduit, at any point, is not less than 0.75m below the surface.
- Ensure the minimum grade does not drop to less than shall be 1mm per 300mm.

(j) Supports and Separators

- Provide conduit supports and separators of concrete, plastic, or other suitable non-metallic, non-decaying material, designed specifically for the purpose.
- Separators shall be provided which maintain a uniform minimum clearance of 50mm between conduits.
- For rigid non-metallic conduit, place supports and separators on maximum centres of not greater than every 1500mm.
- For rigid steel conduit, place supports and separators on maximum centres of not more than 4000mm:
- Securely anchor conduits to supports and separators to prevent movement during placement of concrete or soil.

PART 7 ENCLOSURES

7.01 Common

(a) General

This section describes the requirements for all enclosures, including but not limited to wiring panels, marshalling panels and control panels. The requirements set forth apply to both the provision of custom engineered panels and panels provided as part of equipment packages.

- The City will provide a list of existing panels that can be reused at time of tender. If a list is not provided, all panels related to the works shall be replaced.
- Provide enclosures rated as specified.
- Enclosures used for control panels shall, as a minimum, be classified NEMA 4X.
- Arrange and size such that doors extend no further than 24 inches beyond the enclosure when opened to the 90-degree position.
- Except as noted within this standard, provide enclosures fabricated of high grade cold rolled steel, phosphate coated, primed, and painted with ASA 61 Grey baked enamel inside and out.
- Sub panels shall be 12 gauge CRS finished.
- Enclosures mounted in corrosive environments, exposed to high humidity, or mounted outside shall be constructed of 316 Stainless with brushed finish.
- Door handles shall be, lockable with replaceable lock cylinders compatible with existing City of London lock mechanisms. Design shall provide full three-point latching. Contractor to coordinate with the City of London to ensure the correct lock mechanisms are provided.

Free-standing Enclosures and consoles – Steel or Stainless Steel

- Provide freestanding, single-door, front access enclosures. Enclosures shall be 14 gauge steel minimum. Consoles shall be designed for either sitting or standing. All enclosure doors shall be hinged on the left side unless left sided installation may impede safe equipment operation or violate codes. .
- Provide structural reinforcements on the back of the panel face and the backs of doors to limit vibration, and to provide rigidity, during shipment, installation, and operation without distortion or damage to the panel or to any panel mounted device.

Wall Mounted Enclosures – Steel or Stainless Steel.

- Provide wall mounted single-door enclosures. Enclosures shall be 16 gauge steel minimum. All enclosure doors shall be hinged on the left side unless left sided installation may impede safe equipment operation or violate codes.

- Provide structural reinforcements on the back of the panel face and the backs of doors where required to limit vibration, and to provide rigidity, during shipment, installation, and operation without distortion or damage to the panel or to any panel mounted item.

Provide with each panel the following additional components from the same manufacturer as the enclosure.

- Louvers, forced ventilation, heaters, and air conditioners as required to maintain internal operating temperature shall between 5 and 45 C with ambient temperatures of between 5 and 40 C for panels mounted inside heated buildings and –40 (in 90 kph winds) and 40 C (in direct sunlight) for unheated locations.
- Door mounted print pocket.
- Door activated switched internal fluorescent lighting.

7.02 Custom – Additional Requirements

(a) General

If custom fabricated enclosures are needed, the following requirements apply in addition to the previously general requirements and requirements necessary to achieve appropriate NEMA rating.

- Fabricate enclosures from sheet steel or stainless steel as follows.
  - Single-door enclosures with 12-gage sides top and back.
  - Double door enclosure with a 10-gage back and 12-gage top and sides.
  - Multi door enclosures with 10 gage sides top and back.
- Construct enclosures with internal structural steel framework and bracing to permit lifting without racking or distortion.
- Provide steel stiffeners on the back of the panel face to prevent deflection due to instruments, operation of equipment, or opening/closing of doors. Use 0.25-inch high by 1 inch wide by 0.5-inch deep minimum stiffeners tack welded to the panel before painting.
- Design with removable lifting rings designed to facilitate rigging and lifting of the enclosure during installation. Provide plugs that fill the lifting ring holes after installation is complete.
- Grind and sand exterior welds to a smooth finish, free of burrs. Make surfaces free of ridges, nuts, bolt heads, and similar protrusions before painting.
- For cabinets constructed of sheet steel, prime and finish with 2 coats of ANSI baked enamel. Paint the exterior with ANSI 61 medium grey epoxy paint. Paint interior white.

7.03 Enhancements

(a) General

- Provide windows as shown on drawings.
- Mount heaters near the bottom centre of the enclosure. Do not mount electronic components closer than 6 inches to the heater.
- Furnish enclosures with vapour phase protective corrosion inhibitors. Provide adequate corrosion inhibiting devices, tape, or emitters for the individual panel volume for a period of not less than 2 years.
- All enclosure enhancements are shall be factory installed by the manufacturer of the panel and shall be products of the same manufacturer. Enhancements shall be provided as specified.

(b) Window Kits

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Panel windows, if specified, shall be provided by the manufacturer of the enclosure and shall be constructed of lexan.
- Provide window kits suitable for NEMA type 4 and type 12 enclosures.
- Provide windows with 0.25-inch clear acrylic with steel frames. Use stainless steel frames and lexan window for NEMA type 4X enclosures.
- Provide an oil resistant gasket to ensure a watertight seal around the window and window frame.
- Window size shall be as shown on drawings.

(c) Louvers

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Include washable aluminium air filters with louvers used for ventilation.
- Except for enclosures mounted with their backs directly adjacent to a wall, place louvers in the rear of the enclosure, top and bottom. For enclosures mounted with their backs directly adjacent to a wall, place louvers on the sides. Only where both backs and sides are adjacent to solid structures mount louvers in the door.

(d) Fans

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide forced ventilation fans, where required, with washable, aluminium air filters and finger guards.

- Operate fan motors on 120 Vac, 60 Hz power. Include thermal protection. Use motors rated for continuous operation without lubrication or service.
- Provide electrical noise reduction filters in panels containing PLC Hardware.
- Provide intake and exhaust grilles with filters.
- Minimum Performance
  - Temperature: 0 to 50°C
  - Relative Humidity: 5 to 95%
  - Vibration: 0.25G from 5 to 100 Hertz
  - MTBF/MTTR: 40,000 hours/3 hours

(e) Closed Loop Air Conditioners

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide closed loop cabinet air conditioners as specified elsewhere or shown on the plans.
- Mounted vertical on side or back depending upon installation requirements.
- All coils and copper lines shall have corrosion protection coatings.
- Minimum Performance
  - Power: 120 Vac, 60 Hz
  - Capacity: As required by the cabinet equipment
  - Temperature: 0 to 50°C
  - Relative Humidity: 5 to 95%
  - Vibration: 0.25G from 5 to 100 Hertz
  - MTBF/MTTR: 100,000 hours/3 hours

(f) Heaters For Condensation Control

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide thermostats that sense air temperature in the panel.
- Minimum Performance
  - Rating: 100 Watts for panels less than 0.5 cubic meters
  - 200 Watts for larger panels
  - Power: 120 VAC, 60 Hz.
  - Temperature: 0 to 50°C
  - Relative Humidity: 5 to 95%
  - Vibration: 0.25G from 5 to 100 Hertz
  - MTBF/MTTR: 100,000 hours/3 hours
  - Thermostat Range: Continuously adjustable from 7 to 27 C.

(g) Heaters For Freeze Protection

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide thermostats that sense air temperature in the panel.
  - Rating: 100 watts for panels smaller than 0.05 cubic meters
  - 250 watts for panels smaller than 0.15 cubic meters
  - 500 watts for panels smaller than 0.50 cubic meters
  - Power: 120 VAC, 60 Hz.
  - Temperature: 0 to 50°C
  - Relative Humidity: 5 to 95%
  - Vibration: 0.25G from 5 to 100 Hertz
  - MTBF/MTTR: 100,000 hours/3 hours

(h) Corrosion Inhibitors

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Furnish enclosures with vapour phase protective corrosion inhibitors.
- Provide adequate corrosion inhibiting devices, tape, or emitters for the individual panel volume.

PART 8 PANELS

8.01 Common

(a) General

The following requirements apply to all panels.

- The panel shop constructing the panel must be CSA certified and ISO 9002 certified. Panels shall be assembled in entirety in the shop before shipping to site.
- All cables and connection devices required for the connection of the system shall be provided as part of the panel.
- Cabling shall be double insulated and connector electrical contact surfaces shall be gold-plated, and connectors shall incorporate shielded type hoods
- All mounting screws, blots, fasteners etc. shall be stainless steel.
- Panel construction shall comply with all installation requirements set forth for specific components mounted within the panel.
- The panel builder shall make whatever adjustments are necessary to panels as shown on "For Tender" drawings in order to ensure the panels provided shall provide the intended functionality.
- Panel mounted lamps, switches, and buttons shall be kept to an absolute minimum. Unless specifically approved by the City, programmable data panels shall be provided in place lamps, switches and buttons.
- The following components, unless approved by the City for a specific application (approval will only be granted on a case-by-case basis), shall not be used.
    - Interposing relays
    - Control transformers
- If schematic drawings are provided, be aware that they are only intended to represent the Engineer's interpretation of actual field wiring conditions. Schematic drawings may not show actual termination numbers for existing control circuits and/or field circuits may contain errors and/or omissions. These drawings are only provided to assist a registered electrical contractor to determine wiring requirements in conjunction with field inspection. It is the responsibility of the contractor to review and revise the drawings as part of the pretender field inspection.
- The City does not accept any responsibility for errors or omissions on behalf of the contractor due to the contractor not properly inspecting the work site before bidding.

(b) Classification

- Package panels are of two general types, equipment supplier furnished and specialty panels.
    - Equipment supplier furnished panels include Sequential batch reactor (SBR) control panels, centrifuge control panels, and polymer chemical mixing system control panels.

- Specialty panels are limited to those such as motor control centres, and variable speed drives.

- Specialty panels are not required to meet the requirements set forth in this section as long as the equipment meets City of London Standards for the given device type.
- Equipment supplier furnished panels shall meet or exceed all applicable City of London Standards (i.e. same requirements apply as for Custom Panels).
- The following requirements apply to all panels including speciality panels:
  - The supplier is responsible for the proper operation of the panel. The supplier must perform the detailed engineering design to meet the functional requirements specified.
  - Equipment specific P&IDs shall be developed in accordance with the same requirements specified for process P&IDs.
  - Submissions shall clearly indicate if items shown are standard features, standard options or custom engineered options.
  - Panels must satisfy all requirements set forth in this document regarding identification and documentation.

If there is any question as to which category a panel falls into, it is the responsibility of the Contractor to confirm the category with the City before tendering or assume that the panel must meet the stricter requirements set for equipment supplier panels.

8.02 Control Panels

(a) General

The following additional requirements apply.

- Each control panel shall be provided with a door mounted alarm silence button which shall be wired directly to the RPU
- I/O cards shall be grouped by process function. Where multiple devices are provided, distribute devices between I/O cards to avoid the possibility that the failure of one I/O card would cause total loss of process control.
- All I/O signals shall be individually isolated. Signals associated with process control equipment shall be powered directly by the field equipment and fused at the control panel.
- Process monitoring, control equipment and instrumentation shall be powered from, the controller panel. Separate breakers shall be provided for each device.
- I/O connected to each controller (including I/O connected by serial or network connections) shall be kept below the limits set forth in the City of London Standard for Programming.

8.03 Fabrication

(a) General

- Fabricate panels, install instruments, plumb, and wire in the factory. Test wiring and plumbing prior to shipment.

- Provide and install instrumentation, instrument loop power supplies, mounting hardware, terminal blocks, control circuit breakers, termination, interface hardware, wiring, cabling and all other items required for a complete fully operable panel.
- Use panel fabrication techniques that allow for easy removal and maintenance of all components and devices after installation. Ensure that devices are installed in such a fashion that any device can be removed without requiring the removal of adjacent devices or wiring not specifically attached to the device.
- Provide panels with a 15 A, 120 VAC ground fault detecting 3-wire, duplex receptacle service outlet located within the interior. Provide separate local circuit breaker within panel for receptacle.
- Panels shall be sized with space for the addition of not less than a 20% increase in number of terminal blocks and the addition of one additional full size RPU chassis. The requirement for space for 1 additional RPU chassis applies to all panels irrespective as to whether the panel currently contains a RPU.

8.04 Components

(a) General

- Furnish, mount, and wire control components such as relays, timers, and other equipment to provide the interfacing and interlocking between the motor starter and associated protective circuits, or other control circuit function as specified by the City.
- Face-of-panel mounted devices shall be mounted semi-flush. All such mounted devices shall be mounted such as to provide a uniform appearance.
- Face-of-panel mounted devices that are not weatherproof shall be mounted on a hinged inner door, an outer enclosure door shall be provided with viewing window allowing full view of all mounted devices.
- Mounting of devices within the enclosure behind a single door with viewing window is not acceptable
- Panel components shall be mounted such that the specified NEMA rating for the completed enclosure matches the original enclosure rating when leaving the factory.
- Locate face-of-panel mounted device such that when the panel is installed all devices are mounted between 30 inches and 72 inches relative to the floor.
- Arrange back-of-panel devices in a neat and orderly fashion. Allow room for addition of future equipment as specified.
- Provide over voltage and over current protection for instruments to protect against possible damage due to power supply failure and to protect the power supply from damage due to external power problems.
- Mount power supplies such that dissipated heat does not adversely affect other components.
- Provide external single point ground for all panel mounted components. Earth ground outdoor panels within 10 feet of the panel.

- Line voltage surge suppressors shall be installed in all panels containing solid-state electronic equipment to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices.
- Separate signal line transient protection units shall be installed on each and every control signal line that runs outside of buildings (analog, discreet, digital and communication).
- Provide safety barriers for each signal line connected to equipment in hazardous areas.
- Provide a common push to test button on front of each panel that illuminates all lamps on the panel.
- Provide adequate slack on cable harnesses to permit easy removal of I/O and other printed circuit cards and/or modules during service or repair.
- Provide UPS for each Control panel. UPS shall supply power to all devices within the panel and all instrumentation monitored by the panel.

8.05 Modification

(a) General

- Unless specifically stated by the City of London that a panel may be reused, all existing panels which would otherwise require modification shall be replaced in their entirety.
- If existing panels are to be modified, the panel will be identified on tender drawings and modifications shall be completed in accordance with the project schematic and site plan location drawings.
  - Modify existing panel access doors and interior chassis assemblies to mount and wire new operator devices and components as shown on the document drawings and as necessary to accomplish the design intent.
  - The Contractor shall provide as-built termination drawings for final records.
  - Modifications to existing control panels shall include modifications not specifically described but which are required in order to provide a complete system that meets the operation intent of the contract.
  - Remove all existing controllers, indicators, switches, and wiring not being used as part of the automation upgrade. Deliver all removed components, except wire, to the City of London. The contractor shall remove and dispose of all wire before providing components and equipment to the City of London.
  - Refurbish panel fronts and doors to like new condition filling any openings left as the result of removal of devices.
  - Ensure resulted finished panel meets all requirements for certification in its entirety to the enclosure original NEMA rating.
  - Fabricate and install new rack mounting hardware and sub-panels as required.
  - Before undertaking modifications install new permanent insulation barriers for exposed 600 VAC buss

- Field test and manually operate each in-service device after panel modifications and before proceeding to modify other circuits. Test simulated operation of out-of-service equipment to verify operation of motor starters and accessory devices.

8.06 Panel Monitoring

(a) General

In addition to requirements set forth elsewhere the following panel device status information shall be connected to and monitored by the RPU.

- DC loop power supply On/Off status for each power supply
- Circuit breaker On/Off/Tripped status for each breaker
- Transient protection status indication

8.07 Field Installation

(a) General

Field installation of panels shall conform to the following requirements.

- Confirm panel location with the City of London's Project Manager prior to fixing.
- Mount floor-standing panels on a 100mm concrete pad unless panels will be mounted as part of an existing suite or MCC installation in which case mount at the same height as existing panels.
- Where two or more enclosures are shown mounted immediately adjacent to one another, bolt them securely together with their front faces parallel.
- Locate and install controllers and panels such that they are easily accessible for maintenance and readability of displays.
- Stainless steel surfaces, displays and keyboards shall be protected during the construction and commissioning period without restricting function. The contractor shall repair any damage to the satisfaction of the City. If the damage can not be repaired to the satisfaction of the City, the contractor shall replace the item with a newly manufactured replacement free of damage and free of defects.
- When drilling conduit entry points in panels, protect internally mounted equipment from vibration, shock or metal filings.
- After cutting or drilling enclosure, grind all cut edges until rounded and smooth then finish edges with corrosion resistant finish to match factory finish.
- Place knockouts for the wiring of freestanding panels at the top of the panel. Cover holes for future devices with a plastic plate.
- Activate corrosion inhibitors upon delivery to the site. Do not store panels with inhibitors inactive. If necessary, cover panels to reduce ventilation and prolong inhibitor life.
- Panels and conduit installation processes and procedures must not impact on the NEMA rating of the finished installation.

PART 9 ELECTRICAL DEVICES

9.01 Common

(a) General

This section describes the requirements for electrical devices, which may be mounted in panels depending upon the scope of the project. These requirements apply to all devices, irrespective as to whether they provided separately or as part of a complete assembly or process package.

The contractor shall assume that equipment supplied shall be installed in an environment which is classed as harsh, possibly prone to hydrogen sulphide contamination in the air and condensing humidity (resulting in mild sulphuric acid precipitants) and/or low levels of free chlorine. As such, either equipment shall be rated for installation in such an environment or the contractor shall provide the suitable protective enclosures.

Devices shall be rail mounted, rack mounted, or panel door mounted. All products of a given type shall be provided from a single manufacturer.

The total number of manufacturers shall be kept to a minimum by purchasing as many types of devices as possible from the selected Manufacturers.

Electronic style relays shall be used for control signals (analog and discrete).

9.02 DC Loop Power Supplies

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Solid State Design
- Classified NEMA type 1
- DIN rail mountable
- Surface barrier screw terminals for connection to load
- Integral circuit breaker with externally accessible reset
- Relay contact remote monitoring for on/off status of power supply

(b) Minimum Performance

- Input Power: 60Hz, 120 Vac +/-10%, 60 Hz.
- Output Voltage: 24 Vdc
- Output Current: 125% Peak Demand
- Output Voltage Adjustment: 5 percent.
- Line Regulation: +/- 0.05 percent for 10% line change.
- Load Regulation: +/- 0.15 percent no load to full load
- Ripple: 3 mV RMS.
- Linear Operating Temperature: 0 to 60 C
- Transient Response: 50 micro seconds for 50% load change
- Temperature: 0 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.03 Controller Circuit Transformers

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Controller circuit transformers shall be 600V primary, 60 Hz, three-phase dry type providing contacts for 240 & 120Vac.
- Transformer only shall be provided with secondary fuse if required based upon specific application.

(b) Minimum Performance

- Capacity: > 250 kVA & 150% Peak Design Load
- Temperature: 0 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.04 Circuit Breakers:

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- True on-line uninterruptible power supply (connected devices to always be running off battery inverter).
- Current rating shall be as indicated on the Drawings.
- Provide breakers with integral ground fault interrupter where specified.
- Thermal-magnetic tape, UL listed:
- Over-centre toggle handle operated.
- Quick-make, quick-break actions independent of toggle handle operation.
- Common tripping of all poles. Break action to disconnect all power phases feed to device.
- Moulded-in ON and OFF markings on breaker cover.
- Three position handles indicating ON, OFF, and TRIPPED.
- Removable from panel board without disturbing adjacent circuit breakers.
- Tandem or half-size circuit breakers shall not be used.
- Relay contact for remote monitoring status of On/Off status of breaker.

(b) Minimum Performance

- Minimum Rating: 10,000AIC
- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.05 Transient Protection - Power Line

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Over voltage and over current protection
- Status indication contact (for monitoring by RPU)
- Integral surge arrester, RFI filter, and voltage clamp
- Screw terminals for incoming and load wires
- Non depleting surge absorption design
- Designed to not trip power feed circuit breakers during surge
- Designed for continuous duty industrial use

(b) Minimum Performance

- Power: 120 VAC, 15 A, 60 Hz.
- Response Time: Less than 5 nanoseconds.
- Transient Reduction: 30db attn to IEEE 587, cat B 6 kV impulse.
- Regulation: Less than + 1 percent of load over all load ranges.
- Operating Temperature: -40 to 70 C.
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.06 Transient Protection - Signal Line

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Support for signal transmitters, analog inputs and outputs, digital inputs and outputs, communication cables, and phone circuits.
- Provide full optical isolation
- Designed for continuous duty industrial use

(b) Minimum Performance

- Power: 120 VAC
- Response Time: 0.1 ns.
- Peak Voltage: 15,000 Volts
- Peak Current: 5,000 A, 8 microsecond rise/20 microsecond decay.
- Operating Temperature: -20 to 60 degrees C.
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.07 Safety Barriers

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- With dual channel, galvanic isolated intrinsic safety barrier with built in amplifier and form C relay contact for the safe area load.
- Designed for continuous duty industrial use

(b) Minimum Performance

- Contact Rating 2 Amp
- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.08 Selector - Switches

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Use NEMA type 13 oil-tight selector switches. Provide units that will accommodate panel thickness from 1/16 inch to 3/16 inch. Provide units that occupy approximately 1 to 1-1/2 inches square face-of-panel space.
- Include operator mechanisms and contact blocks on selector switches. Use heavy-duty type contact blocks.
- Label contact block terminals for identification purposes
- Provide maintained contact selector switches with the number of positions shown on the drawings.
- Provide gold contacts.

(b) Minimum Performance

- Contact Rating: AC Rated: 10 A at 120 VAC breaking
- DC Rated: 0.5 A at 120 VDC
- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.09 Selector - Pushbuttons

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Use NEMA type 13 oil-tight selector pushbuttons. Provide units that will accommodate panel thickness from 1/16 inch to 3/16 inch. Provide units that occupy approximately 1 to 1-1/2 inches square face-of-panel space.
- Include operator mechanisms and contact blocks on pushbuttons.
- Provide flush head type pushbuttons with momentary operation. Ensure buttons are coloured in accordance with London's Identification Standard.
- Provide either normally open or normally closed as required based on application.
- Label contact block terminals for identification purposes.
- If provided with integral indicator lamp, lamp shall be mini bayonet type rated for 50,000 hours with replaceable lens & auxiliary contacts for connection of external power to support common lamp test for panel.
- Provide gold contacts.
- For emergency stops, provide pushbuttons with raised jumbo mushroom style head. Head shall be anodized aluminium unless due to corrosive environment the use of aluminium is not suitable. Pushbuttons shall be mechanical pull to release design. This shall be the only application where pushbuttons shall hold state (i.e. all other applications shall provide only momentary contact). Emergency stops shall provide two separately isolated switch contacts. One contact shall be used for connection to the field device, while the second contact shall be connected to PLC for remote status monitoring.

(b) Minimum Performance

- Contact Rating: AC Rated: 10 A at 120 VAC breaking
- DC Rated: 0.5 A at 120 VDC
- Lamp MTBF: 50,000 hours
- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.10 Disconnect

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Disconnect switches shall be sized as required based on design load.
- Design to allow for padlocking in off position with switch position clearly indicated by colour code on front of enclosure.
- Cover shall be mechanically interlocked to prevent opening when in the on position.
- 120Vac disconnect powered contact to indicate switch closed (power on).
- If fused, fuses shall be sized appropriate to load and fuse blown to deactivate status contact. Fuse holder shall accept standard fuses without adapter.

(b) Minimum Performance

- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.11 Contactors

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Contactors are shall be sized as required based on design load.
- Shall be electrically controlled as specified on design drawings.
- Contactors shall provide four (4) internally powered contacts configured as follows:
  - On/Off Device Status (powered when device on)
  - Fault Device Status (powered when no fault)
  - On/Off Switch Position (powered when in on position)
  - Local/Remote Switch Position (powered when in remote position)
- Provide On/Off switch and Local/Remote switch.
- Provide three lamps with replaceable coloured lens for indication of On, Off & Fault.

(b) Minimum Performance

- Contact Ratings: 0.5A, 120Vac (each)
- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.12 Lamps - Indicator

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Use NEMA type 13 oil-tight LEDs. Provide units that will accommodate panel thickness from 1/16 inch to 3/16 inch. Provide units that occupy approximately 1 to 1-1/2 inches square face-of-panel space.
- Label contact block terminals for identification purposes. Use heavy-duty type contact blocks.
- Provide indicating light units that allow LED removal and replacement through the front of the unit.
- Lamps shall be designed for 120 Vac supply voltage.

(b) Minimum Performance

- Contact Rated: 10 A at 120 VAC breaking current.
- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.13 Lamps - Strobe

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Strobe light shall be constructed as modular system and shall have an integral flasher module, which shall flash at the rate of 60 times per minute.
- Lamp module shall be LED and shall have an amber Lexan lens.
- Lens shall be not less than a diameter of 60mm and height of 60mm.
- Base shall be Nylon or other similar corrosion resistant material.
- Lamp unit shall be rated IP65 & NEMA 4X.
- Lamps shall be designed for 120 Vac supply voltage.

(b) Minimum Performance

- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.14 Relays - Light Duty (10 amp 120 VAC Contacts)

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide clear polycarbonate cover for protection against dust and mechanical damage.
- Provide contacts that are normally open, break-before-make, and rated for continuous duty.
- Use three (3) pole, double throw, electrically held relays, unless magnetic latching relay specifically stated as required.
- Where shown on drawings, use two (2) pole, double throw magnetic latching relays.
- Relays shall be field convertible contact type (NC to NO).
- Provide relays that have an indicator lamp that lights when the coil is energized.
- Provide with captive screw terminal relay sockets designed to accept one (1) #12 or 2 #14 AWG wires. Incorporate spring action pin retainers into the sockets to hold relay pins. Provide sockets with relay hold-down spring clips.
- Install relay sockets adjacent to one another on standard DIN mounting rails using steel mounting clips. Provide mounting rails.

(b) Minimum Performance

- Contacts: 10A at 120VAC
- Temperature: 0 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.15 Relays - Heavy Duty (Industrial Grade - 20 amp 120 VAC Contacts)

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide contacts that are normally open, break-before-make, and rated for continuous duty.
- Install relay sockets adjacent to one another on DIN mounting rails using steel mounting clips. Provide mounting rails.
- Use Multi-pole convertible contact cartridge type, electrically held relays, unless magnetic latched specifically stated.
- Provide relays that have an indicator lamp that lights when the coil is energized.
- Provide with captive screw terminal relay sockets designed to accept one (1) #10 or 2 #12 AWG wires. Incorporate spring action pin retainers into the sockets to hold relay pins. Provide sockets with relay hold-down spring clips.

(b) Minimum Performance

- Contacts: 20A at 240VAC
- Temperature: -40 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.16 Relays - Electronic

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide polycarbonate cover for protection against dust and mechanical damage.
- Provide contacts that are normally open, break-before-make, and rated for continuous duty.
- Install relay sockets adjacent to one another on mounting tracks using steel mounting clips. Provide mounting rails.
- Use general-purpose type with low current duty contacts of bifurcated gold overlay silver.
- Relays shall be electronic style free of any mechanical parts.
- Provide with captive screw terminal relay sockets designed to accept #12 through #18 AWG wires. Incorporate spring action pin retainers into the sockets to hold relay pins. Provide sockets with relay hold-down spring clips.

(b) Minimum Performance

- Contacts: 3A at 120VAC
- Temperature: 0 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.17 Relays - Time Delay

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide polycarbonate cover for protection against dust and mechanical damage.
- Provide contacts that are normally open, break-before-make, and rated for continuous duty.
- Install relay sockets adjacent to one another on DIN mounting rails using steel mounting clips. Provide mounting rails.
- Use solid-state 2 pole, double throw time delay-on and time delay-off relays. Provide a timing unit integral with the relay. Pneumatic style time delay relays are not acceptable.
- Time shall be adjustable without need for tools by means of an integral front of relay adjustment knob.
- Relay shall provide reset contact which when initially energized will reset timer.
- Provide with captive screw terminal relay sockets designed to accept #12 through #18 AWG wires. Incorporate spring action pin retainers into the sockets to hold relay pins. Provide sockets with relay hold-down spring clips.

(b) Minimum Performance

- Contacts: 10A at 240VAC
- Timer Interval: 0.1 second to 100 minutes
- Accuracy: +/- 2% of setting over entire range
- Maximum Reset Time: 100 ms
- Temperature: 0 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.18 Signal Transmitters

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Entirely Solid-state
- House units individually in NEMA type 1 rated enclosures and furnish with brackets for back-of-panel mounting.

(b) Minimum Performance

- Linearity: +/-0.1 % of span except as noted.
- Repeatability: +/-0.1 % of span.
- Ambient Temperature: -10 to 55 degrees C.
- Temperature Effect: +/-0.01 % / degree of C
- Power Supply: 120 Vac, 60 Hz
- Power Supply Effect: +/-0.10 % for +/-20 percent power variation
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- Output: 4 to 20 mA (1 per channel)
- Channels: 1, 2, 3 or 4 each individually isolated
- Isolation: 600 V
- Controls: 20 turn zero and span potentiometers
- Input: To match operational requirements
- MTBF/MTTR: 100,000 hours/5 minutes

(c) Installation

- Where three or more units are mounted in the same panel, furnish plug-in units in rack-mounted multiple instrument enclosures suitable for 19 inch rack mounting.
- Provide front or rear terminal access options to allow various panel access modes. Provide individually removable plug-in units which can be replaced without affecting the operation of remaining units. Provide barrier terminal strips located on the transmitter enclosure.

9.19 Power Switches (120 V)

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Industrial heavy-duty type
- Rated for use with both fluorescent and incandescent lighting.
- Ivory urea moulded housing.
- Silver alloy contacts.

(b) Minimum Performance

- Rating: 20 A at 120 VAC.
- Temperature: 0 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.20 Receptacles

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Industrial heavy-duty type duplex receptacle
- Suitable for use with No 8 to 12 AWG.
- Connection by side wired screws.
- Triple wipe contacts and riveted grounding contacts.
- Designed for use as split powered.
- Ivory urea moulded housing.

(b) Minimum Performance

- Rating: 20 A at 120 VAC.
- Temperature: 0 to 50°C
- Relative Humidity: 5 to 95%
- Vibration: 0.25G from 5 to 100 Hertz
- MTBF/MTTR: 100,000 hours/5 minutes

9.21 Utility Box Covers

(a) General

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- General purpose Stainless Steel.
- Exterior use – Spring loaded double lift cast aluminium complete with gaskets.
- Covers for gang type outlet boxes shall be specifically designed for the device combination and outlet box size. Covers for flush outlet boxes shall not be used for surface mounted boxes and vice-versa.

PART 10 INSTRUMENTATION

10.01 Common

(a) General

This section defines various requirements that apply to all instruments.

- The standards set forth within this section apply to all instrumentation unless a clause is specifically deleted within the specific standard for the device in question.
- The contractor shall assume, unless otherwise stated in the tender documents, that equipment supplied shall be installed in an environment which is classed as harsh, possibly prone to hydrogen sulphide contamination in the air and high condensing humidity (resulting in mild sulphuric acid precipitants) and/or low levels of free chlorine. As such, either equipment shall be rated for installation in such an environment or shall be provided with suitable protective enclosures.
- Provide only new, standard, first-grade materials throughout, conforming to applicable codes and standards and so marked, together with manufacturer's brand or trademark.
- Use a single manufacturer for each instrument type. Select a single model suitable for all installation locations.
- Use the same manufacturer for different instrument types whenever possible.

(b) Communication Protocol

- Equipment shall be provided complete with integral Profibus DP or PA Interface In cases of modifications to existing facilities where one of the other protocols is already in predominant use at the facility, the protocol in predominant use shall be selected unless advised otherwise by the City.
- Provision of an external signal and/or protocol converter is not acceptable unless explicitly approved by the City of London. This approval, once granted, shall apply only to the specific installation at the specific location which has been approved and shall not be considered to be a blanket approval for continued use in future applications.
- Loop powered instrumentation, and instrumentation requiring calibration, shall fully support the HART protocol (both digital and analog signalling). This includes, but is not limited to, the ability to perform all calibration and configuration procedures over the HART communications link.
- All devices shall support simultaneous serial communication and conventional individual signals.

(c) Examination of Site

The contractor is responsible for ensuring the accuracy of the drawings with regards to suitability of the proposed placement of equipment and to make adjustments as required ensuring equipment is mounted in accordance with these standards and in conformance

with the recommendations of the manufacturer. As such, the following steps shall be followed.

- Examine drawings and perform a site inspection to ensure suitability of mounting location.
- Ensure instruments and their associated sensors, local isolation valves, isolation switches and other related accessories will be located so that they are readily accessible for operation, maintenance or removal.
- Field measure lengths for transducer cables, and similar items including sampling tubing prior to ordering to ensure correct lengths are ordered such that connections are kept to a minimum.
- Review appropriate standards and manufacturer recommendations to confirm suitability of proposed installation.
- Investigate the route through which the signal cables and/or sample tubes must pass and ensure the suitability of the proposed route.

If any problems are identified the contractor shall notify the City before ordering the equipment to minimize cost implications of possible required changes. Costs incurred as a result of rectifying any problems not identified at this stage shall be the sole responsibility of the contractor.

10.02 Chlorine Residual Analyzer

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies required where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

(b) Sensor (Primary Element)

- Principal: Amperometric
- Housing: Corrosive resistant housing and mounting hardware
- Mounting: Vertical surface mounted
- Pressure Comp: Minimum 5kPa
- Electrolyte Service: Minimum four months between refills
- Auto cleaning: Continuous self cleaning cell
- Process connection: 6mm or larger corrosive resistant sampling line

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

- Front panel keypad for parameter selection and calibration data entry.
- Set up and calibration from user programmable and/or predetermined choices accessible from menu prompts.
- Output span adjust for sensitivity and range of measurement.
- Output zero-adjust for range zero reference independent of span adjustment.

Display:

- Front of enclosure backlit 75mm x 100mm graphical display, discernible from 10 feet.
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall be calibrated to display in scaled engineering units as follows:

* *Temperature: Direct reading in ºC*
* *Level: Direct reading in m*
* *Flow: Direct reading in m3/hr*
* *Pressure: Direct reading in kPa*
* *Concentration: Direct reading in ppm*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP communication link
- Simultaneous 4-20mA and serial communication
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.
- Power consumption of 50 watts, or less.

(d) Minimum Performance

Range:	0 to 2.0 mg/l Total Chlorine Residual
Accuracy:	+/- 1.0 % of range
Resolution:	0.01 mg/l.
Repeatability:	+/- 0.03 mg/l.
Stability:	+/- 0.03 mg/l.
Response time:	90% of measurement value within one (1) minute
Warm up time:	< 24 hours
Sensor Operating Temp:	0 to 50 degree C
Analyzer Operating Temp:	-5 to 50 degree C

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.

- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Chlorine Analyser

- The following installation requirements are in addition to or deviations from the requirements set forth for instrumentation "City of London General Instrumentation Standard".
- Physically locate the sample point so is does not contribute unnecessary dead time in the chlorine residual analysis. Take care to ensure the sample point is clean, thoroughly mixed, and representative of the process stream.
- Locate the analyzer next to a floor drain. Provide shutoff (block) and bleed valves: size valve and select type and material for the application.
- Provide a table nearby with the necessary equipment and chemicals to perform calibration checks.
- Provide flushing facilities for cleaning probes.

10.03 Magnetic Flow Meter

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - *General Fault*
  - *Flow Direction*
  - *No Flow*
- Outputs – Analog
  - *Flow rate*
  - *Total Flow*
  - *Fault Code*

(b) Design

The flow meters are to deploy the following basic design principal

- General Application: Pulsed D.C. powered flow tube coils
- Solids over 5%: A.C. powered flow tube coils & low noise electrodes
- Pulsating Flows: Converter must be rated by manufacturer for pulsating flows at not less than twice the maximum frequency of the positive displacement pump (e.g. metering pump, sludge pump, etc.)

For high solids applications (i.e. over 5%), the use of special purpose high current pulsed D.C. systems may be acceptable. Approval for use of such systems as an alternate to A.C. powered tubes shall be granted by the City of London on an application-by-application basis. It is the responsibility of the contractor to ensure that requirements are clarified prior to tendering.

(c) Sensor (Primary Element)

- Flow Tube: Type 304 stainless steel
- Housings: Silicone rubber sealed or fully welded construction
- Flanges: 300lb CS ANSI Flanges unless otherwise stated
- Body: Steel construction
- Epoxy polyester paint
- Silicone rubber housing sealant
- Max pressure: Entire flow tube must meet the ratings of the flanges
- Submergence: > 4.5 meters (NEMA 6P)
- Minimum Conductivity:
- General Application 5 µS/cm
- Demineralised Water 20 µS/cm
- Transmitter Cable: > 10 m

(d) Liners & Electrode

Application	Liner	Electrode	Max Fluid Temp
Chemical Systems – Corrosive	Kynar PVDF	Platinum	180C
Chemical Systems – Dilute Polymer	Ceramic	Platinum	150C
Chemical Systems – Low-conductivity	Ceramic	Capacitive Coupled	150C
High Temp (>110C)	Teflon PFA	Hastalloy C-22	250C
Sewage – Influent (Raw)	Polyurethane	Hastalloy C-276	70C
Sewage – Mixed Liquor	Teflon ETFE	Hastalloy C-276	70C
Sewage – Settled (primary overflow)	Polyurethane	Hastalloy C-276	70C
Sewage – Final Effluent	Hard Rubber	Hastalloy C-276	70C
Sludge – Activated	Polyurethane	Hastalloy C-276	70C
Sludge – Digester Supernatant	Polyurethane	Hastalloy C-276	70C
Sludge – Primary	Neoprene	Hastalloy C-276	70C
Sludge – Thickened	Teflon ETFE	Hastalloy C-276	70C
Sludge – Waste (Digester)	Polyurethane	Hastalloy C-276	70C
Water – Potable	Hard Rubber	Hastalloy C-276	70C

If the manufacturer suggests a different combination shall be superior to what is listed for a particular application, the City shall be provided with the option to select either the materials listed or those recommended by the manufacturer at no additional cost.

(e) Analyzer/Transmitter

Design:

- Integrated analyzer, transmitter, serial communication protocol module and power supply.
- Conformably coated printed circuit boards
- Microprocessor based technology electronics

- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Continuous automatic re-zeroing calibration and auto ranging
- Adjustable low flow cut-off circuitry locks output signal at 4ma and provides contact signal output for alarm.
- A single analyzer assembly may be used for two flow tubes with the explicit written approval of the City of London. This approval will only be granted on an installation-by-installation basis. Without this approval analyzer assemblies must only be connected to a single flow tube.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Flow: Direct reading in m3/hr*
* *Flow Total: Direct reading in 1000 m3/day*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP compliant communication link
- Simultaneous 4-20mA and serial communication
- Dual, programmable isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Additional scaled pulse output contact for totalizing flow
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*

- *Where internal enclosure temperatures may otherwise rise to over 35 C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

(f) Minimum Performance

Maximum Solids Content:	Not less than 5% for DC, 20% for AC
Process Temperature:	-18 to 60 degrees C
Rated accuracy:	+/– 0.5 % of measured value,
	maximum error over entire velocity range
	(not average or calculated composite error)
Installation requirements:	Not to exceed 5 pipe diameters upstream
	& 2 pipe diameters downstream
Measured repeatability:	+ or - 0.1 % of stated accuracy
Response time:	<1 second for 2 m/s step change to stated accuracy
Warm up time:	<10 minutes from cold start to stated accuracy
Velocity range:	0.3 to 10 meters/sec
Electronics Temperature:	-25 to 55 degrees C

(g) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.

- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Flow Meters

- Install meters downstream from pumps
- Install meters upstream from control valves
- Never install a meter after a double change in planes (e.g., a tee and an elbow)
- Never install a meter where gas can collect or a line can self-drain when flow stops
- Install meters where the pipe remains full at all times
- Install meters in vertical pipes where flow is upward
- Install meters with at least five pipe diameters straight run line upstream and two pipe diameters straight run line downstream
- Install separate conduits for signal and power wiring to the meter and between the transmitter and control panel
- Install a by-pass line and three shutoff valves for critical process units so the meter can be removed without process line shutdown. Provide flushing and draining connections
- Install the transmitter remotely from the primary element where the primary element is in a location where a submergence hazard exists, or on a vertical pipe or on a pipe with high vibration
- Ground the meter in accordance with manufacturer's instructions
- Conduct a factory flow test on the actual meter shall be provided at a ISO certified calibration facility and provide written certificate of conformance to standards. The factory flow test must trace calibration to Canadian, American or International standards. The factory flow test facility must have a calibrated accuracy not less than 10 times greater than the calibrated accuracy of the actual meter (i.e. +/- 0.05% over entire range of calibration).

10.04 Gas Monitor

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - *Analyser Fault*
  - *Sensor Fault for Each Sensor (i.e. Cl2, H2S, LEL, O2, and/or CO)*
  - *Warning Level for Each Sensor (i.e. Cl2, H2S, LEL, O2, and/or CO)*
  - *Danger Level for Each Sensor (i.e. Cl2, H2S, LEL, O2, and/or CO)*
- Outputs – Analog
  - *Concentration for Each Sensor*

Monitors are to continuously send signals corresponding to gas values to control modules located in the monitor/readout unit. Systems that scan the sensors successively are not acceptable.

In addition to provision of the individual modules for each parameter monitored, a complete system shall be provided including rack control module, communication module, power module, appropriately sized chassis, and dust/splash guards for all unused slots.

(b) Sensor (Primary Element)

- Microprocessor based smart sensor with integral self diagnostics
- Over / Under range, calibration check & malfunction reporting to analyzer
- Adjustment-free calibration single point calibration

- Continuous monitoring
- Loop powered
- Field replaceable sensor element
- Local Status LCD/LED for Status, Faults, and Calibration Prompts
- Chemical resistant housing
- Electrochemical cell without need for addition of reagent
- Porous, sintered stainless steel dust guard and splash guard

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Live insertion and removal of modules from bus chassis

Control

- Alarm Inhibit Feature for system testing and calibration
- Adjust warning and alarm set points for each channel
- Place each channel individually into the calibration mode
- Disable or enable channels
- Sealed external push-button alarm reset and audio alarm silencing

Display:

- Separate 3 digit level display LED for each channel (i.e. sensor)
- Overall system status indicator
- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Concentration: Direct reading in ppm*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP communication link
- Simultaneous 4-20mA and serial communication
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Each channel (i.e. sensor) to have dual, high and low; adjustable set-points; isolated output SPDT contacts, 5A 120VAC

- Common alarm relay (5A 120VAC) to energize when an alarm condition occurs on any channel
- System trouble relay to indicate sensor malfunction

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.
- Integral battery backup with automatic charging circuitry to allow for the system to operation upon power failure for at least four hours.

(d) Minimum Performance

Combustible Gas (hydrocarbons)

- Repeatability: +/- 2.0 percent of calibration range
- Zero Drift: +/- 5.0 percent full scale maximum/year
- Analyzer Operating Temp: -15 to 60 degree C
- Analyzer Operating Humidity: 5 to 100%, non-condensing
- Range: 0-100 percent LEL
- Accuracy: +/- 5% of range
- Response: Less than 30 seconds to 90%
- Operating Temp: -40 to 60 degree C
- Operating Humidity: 10 to 95%, non-condensing
- Sensor Life: Minimum of Three (3) years for Element

Oxygen Detector

- Repeatability: +/- 2.0 percent of calibration range
- Zero Drift: +/- 5.0 percent full scale maximum/year

- Analyzer Operating Temp: -15 to 60 degree C
- Analyzer Operating Humidity: 5 to 100%, non-condensing
- Range: 0 to 25 %
- Accuracy: +/- 1% of range
- Response: Less than 15 seconds to 90%
- Operating Temp: -20 to 50 degree C
- Operating Humidity: 0 to 99%, non-condensing
- Sensor Life: Minimum of One (1) year for Element

Hydrogen Sulphide (H2S)

- Repeatability: +/- 2.0 percent of calibration range
- Zero Drift: +/- 5.0 percent full scale maximum/year
- Analyzer Operating Temp: -15 to 60 degree C
- Analyzer Operating Humidity: 5 to 100%, non-condensing
- Range: 0-50 ppm, detection threshold 1 ppm
- Accuracy: +/- 2 ppm
- Response: Less than one (1) minute to 50%
- Sensor Temp: -40 to 60 degree C
- Operating Humidity: 10 to 95%, non-condensing
- Sensor Life: Minimum of Three (3) years for Element
- Selectivity: Unaffected by hydrogen, carbon monoxide, saturated hydrocarbons, or unsaturated hydrocarbons when present at concentrations up to 5,000 ppm and Hydrogen sulphides up to 50 ppm

Chlorine Residual

- Repeatability: +/- 2.0 percent of calibration range
- Zero Drift: +/- 5.0 percent full scale maximum/year
- Analyzer Operating Temp: -15 to 60 degree C
- Analyzer Operating Humidity: 5 to 100%, non-condensing
- Range: 0.0 to 10.0 ppm
- Accuracy: +/- 0.2 ppm
- Response: Less than one (1) minute to 90%
- Sensor Temp: -20 to 40 degree C
- Operating Humidity: 15 to 90%, non-condensing
- Sensor Life: Minimum of Three (3) years for Element
- Resistance: 50,000 ppm chlorine for 30 minutes
- Selectivity: Unaffected by hydrogen, carbon monoxide, saturated hydrocarbons, or unsaturated hydrocarbons when present at concentrations up to 5,000 ppm and Hydrogen sulphides up to 50 ppm

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.

- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Gas Monitors

- Locate sensor and monitor/readout units as shown on the drawings. If not shown, provide locations conforming to the following principles.
  i. Locate sensor head away from fresh air sources, such as open windows and ventilation system discharge points
  ii. Sensors for lighter-than-air gases should be located near ceiling, but they must be accessible for routine calibration. Lighter-than-air gases include carbon monoxide, methane, and hydrogen
  iii. Sensors for heavier-than-air gases should be located within three feet of the floor, but away from locations where the sensor head might be wetted. Heavier-than-air gases include most flammable volatile chemicals, and hydrogen sulphide

- Do not paint sensors. The "DO NOT PAINT" tags attached to each sensor shall not be removed under any circumstances.
- Provide the interconnecting wiring between the sensors and monitor/transmitter units in rigid conduit, following the Canadian Electric Code for Class I-Division 1 areas (explosion proof).
- Provide vertical surface mounting hardware made of non-corrosive material appropriately classified for the location that the sensor is installed. Surface mounting hardware shall be as supplied by the manufacturer of the sensor.

10.05 pH/ORP

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - General Fault
- Outputs – Analog
  - ORP Level
  - pH Level

(b) Sensor (Primary Element)

- Mounting: Submersion / flow through as specified
- Process Connection: 38mm male NPT
- Maximum Pressure: 650 kPa @ 50 C
- Process Temperature: 0 to 50 C,
- Body: Kynar, Liquid Crystal Polymer
- pH Electrode: Glass
- ORP Electrode: Platinum or Gold ORP (depending upon application)
- Electrical Connection: Submergible cable factory sealed to probe
- Self-Cleaning (flow through): Automatic In-line Water Blast Cleaning
- Self-Cleaning (submergence): Automatic Water or Air Blast,
- Ultrasonic self-cleaning if crystalline precipitate possible
- Electrode Life: Minimum 1 year
- Preamplifier: Integrated into probe assembly

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Analyser shall be software selectable as either pH or ORP, or shall simultaneously support both pH and ORP
- Analyzer shall automatically recalibrate for temperature
- Accurate reading shall be provided within 2 minutes of applying power.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *pH: Direct Reading (0-14)*
* *ORP: Direct Reading in mV*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Simultaneous 4-20mA and Profibus DP compliant communications
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*

- *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
- *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(d) Minimum Performance

Accuracy:	+/- 0.01 pH, +/- 0.1 mV ORP
Repeatability / Stability:	0.03 pH, +2.0 mV ORP (stability per 24 hours)
Temperature Compensation:	Automatic pH, 0 to 50 C
pH Range:	0-14 pH (range field adjustable)
ORP Range:	+/- 2000 mV (range field adjustable)
Ambient Temperature:	-20 to 60 C (operating range)

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.

- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

pH/ORP

- The following installation requirements are in addition to the requirements set forth for instrumentation "City of London General Instrumentation Standard".
- For flow-through applications mount the flow cell in a readily accessible location to permit preventive maintenance and inspection of the electrode assembly. Provide isolation valves, drain valve, and a bypass loop so the electrode sensor can be removed and inspected without shutting off the flow stream.
- Wire the probe using manufacturer's recommended flexible cable to a local junction box to permit withdrawal of the probe for maintenance. For wiring from the junction box to the transmitter, use manufacturer's recommended wires and separate rigid conduit for signal and power wires.

10.06 Power Monitor

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - General Fault
  - kWh Pulse Output
- Outputs – Analog
  - Average Power (kW)
  - Voltage for each phase & total
  - Current for each phase & total
  - Phase Imbalance

(b) Sensor (Primary Element)

Supply individual factory calibration curve with each integrated transducer and transformer set supplied.

POWER TRANSDUCER

- Stability: +/-0.25 percent per year, non-cumulative
- Temperature Effect: +/-0.5 percent max
- Response Time: Less than 400 ms to 99 percent
- Power Transformer: Provide if required in order to reduce voltage to 110V

CURRENT TRANFORMER

- Accuracy: +/-1.0 percent
- Repeatability: +/-0.5 percent
- Calibration Adjustment: +/-10 percent
- Current Transformer: Provide if required to reduce peak current to < 5A

(c) Analyzer/Transmitter

Design:

- Facility Calibrated
- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Shall provide accurate reading within 2 minutes of applying power
- Log and time stamp 200 events and alarms
- Record 7-days work of logged data by exception reporting to conserve
  Functions: Current - per phase, N, G, 3phase
- Voltage - L-L, L-N
- Real Power - per phase, 3phase
- Reactive Power - per phase, 3phase
- Power Factor - per phase, 3phase
- Frequency
- Total harmonic distortion
- K-factor
- Temperature (internal ambient)
- Accumulated Energy, Real & Reactive
- Waveform capture
- 12-cycle event capture
- Sag/swell detection

Display:

- Digital LED/LCD 12 character, (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units.
- Front panel keypad for configuration.

Outputs:

- Ethernet communication of all parameters (Modbus TCP or Equivalent)

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit

- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(d) Minimum Performance

- Operating Conditions: 0 to 65 C, 10 to 90% non-condensing humidity

	Metering Accuracy	Metering Resolution
Current / Voltage	±0.1%	0.05%
Frequency	±0.01% @ 20 to 75 Hz ±0.01% @ 75 to 120 Hz	0.005 Hz 0.005 Hz
Power, Demand, Energy	±0.1%	0.05%
Power Factor	±0.2%	0.1%
Harmonics (through 40th)	±5%	---------

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.

- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Power Monitors

- Power monitors shall be mounted in the MCC enclosures for the equipment that is being monitored.

10.07 Pressure

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - General Fault
- Outputs – Analog
  - Pressure

(b) Sensor (Primary Element)

Design:

- Dual sensing ports connect to pressure source and atmosphere for pressure, and to two pressure sources (high - low) for differential pressure
- Diaphragm type, capacitance based, process isolating cell
- Microprocessor based electronics generates output proportional to pressure.
- Snubbers, when required, shall be standard equipment from the primary element supplier.

Process flanges and adapters

- Potable Water: Cadmium or nickel-plated carbon steel
- General Purpose: 316 stainless steel
- Hastalloy C-276: Corrosive or abrasive applications
- Wetted o-rings: Viton
- Fill fluid: Silicone oil or inert fluid
- Bolts: Cadmium-plated carbon steel

Isolating diaphragm & Drain and vent valves:

- General Applications & Digester Gas: 316 stainless steel
- Chlorine, corrosive or abrasive: Hastalloy C-276
- Electronics housing: Painted cast aluminium for exterior installations
- Cover O-rings: Buna-N
- Pain: Epoxy-polyester
- Electrical connections: 1/2 inch-14 NPT weather proof conduit
- Process connections: 1/4 inch-18 NPT on flanges
- or 1/2 inch NPT on adapters

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Previous accurate measurement within 2 minutes of start-up
- Internal security switch to protect calibration
- Adjustable damping

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Pressure:* *Direct reading in kPa*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1). Output driven to 2mA In fault conditions with full HART support.
- Profibus DP at locations with Profibus communications and all new facilities.
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

Design:

- Profibus communication at locations with Profibus.

(d) Minimum Performance

Accuracy:	+/- 0.1% of calibrated span
Accuracy:	+/- 0.5% full scale
Repeatability:	+/- 0.5% of range
Response time:	0.5 seconds for one time constant
Warm up time:	< 5 seconds
Temperature effects:	+/- 0.5% of span for 56 C
Vibration effect:	+/- 0.05% of range per g to 200Hz in any axis
Power Supply effect:	< 0.005% of calibrated span per volt
Rangeability:	100:1
Sensor Temperature Range:	-18 to 71 C
Analyzer Temperature Range:	-40 to 85 C
Pressure ranges:	0.62 to 62.0 kPa, to 250 to 25000 kPa
Damping	0 to 16 seconds in 0.1sec units

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Pressure Instruments

- Provide universal mounting bracket for handrail or vertical surface or 50 mm (2 inch) pipe.
- Provide stainless steel valve manifold assembly with line shutoff valve for pressure.

- Provide stainless steel valve manifold assembly with lines shutoff valves and lines drain/vent valve for differential pressure.
- Locate such that indicator display is readily readable at eye level from floor elevation.
- Locate transmitter with adequate clearance and accessibility for service.
- Locate transmitter as close as possible to the process connection.
- Connect unit to liquid process lines horizontally. Slope lines 8 cm/meter (1 in/foot) downward to allow gas bubbles to bleed back to the process line
- Connect unit to gaseous process lines at the top of pipes or tanks to minimize moisture or solids entry to sensing line.
- Provide for flushing lines with air or water where contaminant fouling may occur.
- Provide filled diaphragm seals for severe process fluids where contamination or fouling will occur.

10.08 Temperature

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Analog
  - Temperature

(b) Sensor (Primary Element)

- Use > = 99.99 percent pure platinum wire wound about a ceramic or glass core and hermetically sealed within ceramic or glass capsule. Provide lead configuration of one lead connected to one end of the sensor, two to the other end.
- Assemble as per ANSI (ISA) 96.1 standard. Provide 6mm (1/4 inch) diameter probe of 316 stainless steel mounted in thermowell.
- Provide insulated leads from each other and the probe housing using ceramic oxide insulation.

(c) Thermowell

- Unless shown otherwise, provide thermowell conforming to the following requirements matching the sensor.
- Thermowell constructed of 316 stainless steel or Inconel 600.
- Provide appropriate length for necessary immersion length and mounting requirements. For pipes, provide approximately 1/3 pipe diameter immersion depth plus 75mm (3 inch) extension.
- Provide with standard NPT fitting or standard flange at the cold end of the thermowell.

- Provide a NEMA 7 RTD/thermocouple junction head with a screw termination block to handle necessary connections for sensor lead wires and a ground terminal for shield grounding.
- Use a rigidly mounted thermowell assembly. Provide necessary mating flange or threaded tee or bracket for mounting the thermowell.
- Wells shall be used with remote mounted vapour pressure sensor bulbs are to include a 316 stainless steel 1/2 inch NPT split nut and rubber grommet to hold the sensor bulb in the well.

(d) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.
- Provide RTD break protection selectable either up or down scale. Provide accessible zero and span adjustment controls.

Display:

- Digital LED, or illuminated LCD 32 character (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters with front panel keypad for parameter selection and calibration
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Temperature: Direct reading in ºC*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Serial slave RS-485 bi-directional communication link
- Simultaneous 4-20mA and serial communication
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X outdoors, NEMA 7 indoors.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.
- Front panel keypad for parameter selection and calibration data entry.
- Indicator

(e) Minimum Performance

- Accuracy: +/ - 2.0 percent of range.
- Stability: +/- 0.1 percent of range at constant temperature
- Drift: +/- 0.25 percent of range
- Linearity: +/- 0.25 percent of range
- Response time: 90% of measurement value within 1 minute

(f) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.

- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Temperature Instruments

- The following installation requirements are in addition to or deviations from the requirements set forth for instrumentation "City of London General Instrumentation Standard".
- Unless shown otherwise, provide a temperature transmitter for each temperature sensor
- Wire to permit convenient withdrawal of the sensor assembly for service or replacement. Provide suitable armour cable with the sensor connection head.
- Where the sensor is used to measure temperature of fluid in a pressurized conduit, provide thermowell with fluid seal fittings to make the installation safe and leak proof. Provide for sensor removal for service without interrupting process.
- Install vapour pressure switches in an orientation where the sensing element is in a vertical plane.
- Install bi-metallic switches in an orientation where the sensing element will not contact other surfaces.
- Allow sufficient clearance for cover removal and adjustment of switches.

10.09 Dissolved Oxygen

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete

  General Fault

- Outputs – Analog

  DO Concentration

(b) Sensor (Primary Element)

- Housing: Corrosive-resistant including mounting hardware
- Electrodes: Platinum and lead metals (Galvanic)
- Pressure Compensation: Submergence to 35 meters (115 feet),
- or 50 psig maximum.
- Temperature Compensation: Automatic in range 0 to 50 degrees C (122 degrees F).
- Electrolyte Service: Minimum life six months.
- Mounting: Extension probe assembly, on handrail for in-situ measurement with convenient access for service and cleaning. See attached mounting detail diagram.

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards

- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Rechargeable internal battery maintains sensor polarizing voltage (for quick warm-ups after power outage)

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Concentration: Direct reading in ppm*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Modbus or Profibus DP compliant communications link. When only modbus is available the devices will be brought on to the Profibus network using a modbus to Profibus converter
- Simultaneous 4-20mA and serial communication
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*

- *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(d) Minimum Performance

Range:	0 to 10 and 0 to 20 mg/l (ppm) dissolved oxygen
	(other ranges field selectable).
Operating Range:	0 to 10 mg/l (ppm),
	(control for aeration between 0.5 and 2.0 mg/l (ppm)
Accuracy:	+ or - 0.3 percent of range 10 mg/l (ppm) and 20 mg/l (ppm).
Resolution:	0.01 mg/l (ppm)
Repeatability:	+ or - 0.03 mg/l (ppm)
Stability:	+ or - 0.03 mg/l (ppm)
Response time:	90% of measurement value within 1 minute.
Warm up time:	less than 24 hours for cold start.
Operating temperature:	-20 to 50 degrees C

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.

- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Dissolved Oxygen

- The following installation requirements are in addition to or deviations from the requirements set forth for instrumentation "City of London General Instrumentation Standard".
- Attach DO sensor to a swing arm pipe and rotating bracket assembly that is used to hold the probe sensor in the process stream and provide easy access to the probe for service. Route the sensor signal cabling through the pipe to a local junction box, or directly to the analyzer/transmitter.
- The DO analyzer/transmitter is mounted by itself or in a local standard instrument enclosure and wired to control power, the sensor signal cable, and the remote receiving controller panel unless otherwise shown on drawings.
- Cabling and mounting hardware shall be designed to allow for ease of relocation to any another location in the vestibule.
- Note that many manufacturers supply sensors with cable of standard lengths of 15 meters (50 feet), optional length to 30 meters (100 feet). Non-standard lengths are usually at extra cost. It is up to the contractor to locate sensors and transmitters to accommodate these cable lengths if practical.

10.10 Orifice Plate Flow Meter

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete

(b) Sensor – Orifice Plate

- Meter Body: Designed to withstand accidental submergence
- Steel plate: ANSI 316 stainless steel
- Orifice Flanges: Class 150 raised face compatible with the pipe material
- Ambient Operating Temp: -40 to 60 degrees C
- Process Operating Temp: -15 to 93 degrees C
- Operating Pressure: 10 bar (150 psig) maximum
- Operating Humidity: 5 to 100 percent
- Measurable Flow Rate: Re = 5,000 to Re = 7,000,000
- Linear Flow Rate: Re = 20,000 to Re = 7,000,000
- Fluid Properties: Viscosity, pressure & density negligible accuracy impact

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Flow:* *Direct reading in m3/hr*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP compliant Communicationslink
- Simultaneous 4-20mA and serial communication
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(d) Minimum Performance

- Accuracy: +/-1.5 percent.
- Repeatability: +/-0.20 percent.
- Linearity: +/-0.5 percent.
- Linear Range: 18 to 100 percent flow
- Operating Temperature: -25 to 55 C
- Operating Humidity: 0 to 95 percent, non-condensing

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.

- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Orifice Plate Flow Meter

- The following installation requirements are in addition to or deviations from the requirements set forth for instrumentation "City of London General Instrumentation Standard".
- Locate on the main meter body, unless locations subject to accidental flooding in which case provide remote mounted transmitter within 15m (50 feet) of the meter body above risk of flood.
- Install flow meters and transmitters as shown on the mechanical drawings.
- Provide flexible watertight signal cable between the flowmeter body and all remote transmitters.
- Provide results from factory flow test on the specific meter provided (not a generic test result from a similar meter). The factory flow test must trace calibration to approved international standard.

10.11 Vortex Shedding Flowmeter

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  General Fault
- Outputs – Analog
  Flow Rate

(b) Sensor (Primary Element)

Meet the following unless otherwise noted on the instrument schedule:

- Operating Principle: Shedding of vortices due to flow past sharp corners of bluff body. The frequency at which the vortices are shed is proportional to the velocity of the flow. This allows measurement of the flow rate by sensing the frequency of vortex formation.
- Meter Body: Provide a meter body designed to withstand accidental submergence and exposure to severe climatic conditions in an unprotected, out of doors environment. Provide a wafer type meter body constructed if ANSI 316 stainless steel and compatible with class 150 raised face flanges.
- Bluff Body: Provide a bluff body designed for maximum corrosion and erosion resistance to the measured fluid. Provide a bluff body of ANSI 316 stainless steel unless otherwise indicated on the instrument schedule.

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Microprocessor based technology electronics:
- Self-diagnostics aids to maintenance and service.
- Modular construction with plug-in circuit cards and options.
- Modbus or Profibus communication connections with RS485 interface.
- HART (Highway Addressable Remote Transducer) protocol two way digital communication (simultaneous 4-20ma and digital signals).
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Flow:* *Direct reading in m3/hr*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP compliant communicationslink
- Simultaneous 4-20mA and serial communications
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- Weatherproof type NEMA 4 construction with watertight seals for access cover and wire ways.

- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

- *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
- *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
- *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
- *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
- *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.
- 5 watts.

Mounting:

- Locate on the main meter body.
- For locations subject to accidental flooding provide a remote mounted transmitter within 15m (50 feet) of the meter body.

(d) Minimum Performance

Provide instruments which are capable of meeting the following flow rate performance requirements when installed in accordance with the manufacturer's recommendations:

- Sensor
- *Operating Temperature:* *Ambient:-40 to 60 C*
- *Process:-15 to 93 C*
- *Operating Pressure:* *0 to 1500 kPa*
- *Operating Humidity:* *5 to 100%*
- *Measurable Flow Rate:* *Re = 5,000 to Re = 7,000,000.*
- *Linear Flow Rate:* *Re = 20,000 to Re = 7,000,000.*
- *Fluid Properties:* *Viscosity, pressure & density negligible accuracy impact*
- Analyser
- *Operating Temperature:* *-25 to 55 C (-20 to 130 degrees F).*
- *Operating Humidity:* *0 to 95 percent, non-condensing.*
- *Accuracy:* *+/-1.5 percent.*
- *Repeatability:* *+/-0.20 percent.*
- *Linearity:* *+/-0.5 percent.*
- *Linear Range:* *18 to 100 percent flow.*

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.

- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Vortex Shedding Flowmeter

- Provide flexible watertight signal cable between the flow meter body and all remote transmitters.

10.12 Positive Displacement Flowmeter

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  Scaled pulse flow total
- Outputs – Analog
  Flow Rate

(b) Sensor (Primary Element)

Meet the following unless otherwise noted on the instrument schedule:

- Operating Principle: Positive displacement meters split the flow of liquids into separate known volumes based on the physical dimensions of the meter, and counts or totalize them. In this type of meter, two lobed impellers, which are geared together to maintain a fixed relative position, rotate in opposite directions within the housing.
- Meter Body: Provide a meter body designed to withstand accidental submergence and exposure to severe climatic conditions in an unprotected, out of doors environment. Provide a wafer type meter body constructed if ANSI 316 stainless steel and compatible with class 150 raised face flanges.

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards

- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Flow: Direct reading in m3/hr*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1) with full HART support (both 4-20mA and digital multi-drop.
- Profibus communication link
- 4-20mA
- Isolated pulse output contacts, 5 A 120VAC for flow totalization
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X with watertight seals for access cover and wire ways.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(d) Minimum Performance

Provide instruments which are capable of meeting the following flow rate performance requirements when installed in accordance with the manufacturer's recommendations:

- Sensor
- *Operating Temperature:* *Ambient: -40 to 60 C*
- *Process: -15 to 93 C*
- *Operating Pressure: 0 to 1500 kPa*
- *Operating Humidity: 5 to 100 percent.*
- *Measurable Flow Rate: Re = 5,000 to Re = 7,000,000.*
- *Linear Flow Rate: Re = 20,000 to Re = 7,000,000.*
- *Fluid Properties: Viscosity, pressure & density negligible accuracy impact*
- Analyzer
- *Accuracy: +/-1.5 percent.*
- *Repeatability: +/-0.20 percent.*
- *Linearity: +/-0.5 percent.*
- *Linear Range: 18 to 100 percent flow.*
- *Operating Temp: -25 to 55 C*
- *Operating Humidity: 0 – 95%, non-condensing*

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.

- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Positive Displacement Flowmeter

- Provide flexible watertight signal cable between the flowmeter body and all remote transmitters.
- Locate transmitter on main sensor panel unless location susceptible to possible flooding in which case mount transmitter remotely.

10.13 Sludge Blanket Level

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  General Fault
- Outputs – Analog
  Blanket Level

(b) Sensor (Primary Element)

Sensor electronics components are imbedded in epoxy coated and sealed corrosive resistant housing with sealed standard length signal cable for connection to transmitter.

Non-corrosive wetted parts and monitoring materials.

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Built-in diagnostics for maintenance and calibration

- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Graphical display of sludge profile trends with 160x240 pixels, graphical display mode.
- Adjustable sensitivity, adjustable output range and separate zero adjust
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Backlit LCD 32 character, (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters with keypad for parameter selection and calibration
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Level: Direct reading in m*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1) with full HART protocol support (4-20mA and digital multi-drop).
- Profibus slave communication link
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz, 50Watt, or loop powered.

(d) Minimum Performance

- Accuracy: + or - 0.5 percent of range.
- Repeatability: + or - 0.5 percent of range
- Response time: 90% of measurement value within 1 minute.
- Warm up time: < 24 hours
- Primary clarifiers Typical solids 10,000 to 50,000 mg/l, tank empty 3-10mm
- Secondary clarifiers Typical solids 3,000 to 20,000 mg/l, tank empty 3-10mm
- Operating temperature:
- Sensor: 0 to 50 C
- Analyzer: -15 to 50 C

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.

- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

Sludge Blanket Level

- Where indicated, provide immersion sensors mounting assembly for simple handrail installation, easily pivoted and removable for cleaning and service.
- Install the sensor cable/probe assembly and the analyzer transmitter at the locations shown on the drawings and/or as described on the instrument schedule.
- When cable/probe assembly is located more than 5m from the analyzer/transmitter, provide a weather-proof junction box for cable connection at the sensor location.

* *Wire from the sensor to the junction box within 3m of the sensor location.*
* *Wire from junction box to the analyzer transmitter, no greater than 30m from the sensor location, using manufacturer's recommended cable in conduit.*

- Provide transmitter enclosure mounting to flat surface or handrail as indicated.
- Use corrosion resistant mounting hardware.

10.14 Phosphate Analyzer

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - General Fault
  - Sample Ready (1 for each of 4 sample lines)
  - Sample Failure

- Outputs – Analog
  - Phosphate concentration (separate output for each of 4 sample lines)

(b) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs

- Principal of operation shall be by multi frequency spectral analysis of primary & secondary light absorbance combined with controlled chemical digestion.
- Auto Zeroing
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Concentration: Direct reading in ppm*

Outputs:

- Minimum of 4 isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus communication link
- Simultaneous 4-20mA and serial communication
- Minimum of 5; adjustable; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power 10A.

(c) Sample Handling Equipment

- Sample sequence controller controls the automatic sampling and handles communication to the SCADA system.
- Motor operated, 50mm (2 inch) ball valves, stainless steel, flanged connection.

- Double-disc, positive displacement, sample pump with 3 Hp, TEFC, 240/480 Vac motor and vacuum and pressure side dampers and cut-off switch on both sides.
- Cross Flow Ultrafilter System comprised of four membrane elements in two banks.
- Filter Cleaning System with chemical reservoir and timer.
- Pressure gauges, isolation valves and piping to form complete sample handling system.

(d) Minimum Performance

Meet the following combined sensor and transmitter performance requirements when installed according to the manufacturer's recommendations:

- Accuracy: +2-5 percent of full scale.
- Repeatability: +2 percent of full scale.
- Ambient Temperature: 0 to 35 degrees C (32 to 105 degrees F).
- Temperature Compensation: Automatic, 0 to 35 degrees C (32 to 105 degrees F).
- Phosphate Range: 0 – 10 mg/l total phosphorus

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.

- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

10.15 Hydraulic Pressure

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Analog
  - Pressure

(b) Sensor (Primary Element)

- Hydraulic cell sized to the specific application.
- Cell made of non-corrosive, temperature stable parts. Rolling diaphragm type able to tilt up to 4 degrees without affecting accuracy.
- Tubing connections made of stainless steel, quick disconnect fittings.

(c) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs

- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.
- Output span adjust for sensitivity and range of measurement. Output zero adjust for range zero reference independent of span adjustment. Set point adjustable.

Display:

- Backlit LCD 32 character graphic display, (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters with keypad for parameter selection and device calibration.
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Pressure: Direct reading in kPa*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP compliant communication link

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(d) Minimum Performance

- Range: 0 - 1000 kg
- Sensor operating temperature: 0 to 50 C
- Analyzer operating temperature: 15 to 50 C
- Accuracy: +/- 0.5 percent of range
- Repeatability: +/- 0.5 percent of range
- Response time: 90% of measurement value within 1 minute

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.

- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

10.16 Level

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - Sensor Fault
  - Transmitter Fault
- Outputs – Analog
  - Level

(b) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Level: Direct reading in m*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP communication link
- Simultaneous 4-20mA and serial communication
- Four (4); adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(c) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.

- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

10.17 Sludge Density

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - General Fault
- Outputs – Analog
  - Sludge Density

(b) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Density: Direct Reading in kg/m3*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP compliant communications
- Simultaneous 4-20mA and serial communication
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(c) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.

- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

10.18 Tachometer

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Analog
  - RPM

(b) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters

- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall be calibrated to display in direct reading.

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Serial slave RS-485 bi-directional communication link
- Simultaneous 4-20mA and serial communication
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(c) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.

- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

10.19 Turbidity

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

Outputs – Discrete

- General Fault

Outputs – Analog

- Turbidity

(b) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Temperature: Direct reading in ºC*
* *Level: Direct reading in m*
* *Flow: Direct reading in m3/hr*
* *Pressure: Direct reading in kPa*
* *Concentration: Direct reading in ppm*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP compliant communications link
- Simultaneous 4-20mA and serial communication
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(c) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

10.20 Weather

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
    - General Fault
- Outputs – Analog
    - Wind Direction
    - Wind Speed
    - Rainfall
    - Ambient Temperature

(b) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters
- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Wind Direction: Direct reading in º*
* *Wind Speed: Direct reading in km/h*
* *Rainfall: Direct reading in mm*
* *Ambient Temp: Direct reading in ºC*
* *Atmospheric Pres: Direct reading in kPa*

Outputs:

- Profibus DP communication link
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(c) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.

- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

10.21 Weight

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

Outputs – Analog

- Weight

(b) Analyzer/Transmitter

Design:

- Conformably coated printed circuit boards
- Microprocessor based technology electronics
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Built-in simulator and test switch verifies operation and set-up
- Continuous on-line self-diagnostics
- Simultaneous functionality of all inputs & outputs
- Provide instruments that provide accurate measurements within two (2) minutes following a power interruption.

Display:

- Digital LED, 3 digit (minimum) displays in appropriate engineering units. 12 mm (1/2 inch), minimum, high characters

- Front of instrument local indicators must be provided for all transmitters visible without opening cabinet. Local indicators shall calibrated to display in scaled engineering units as follows:

* *Weight:* *Direct reading in kg*

Outputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm), linear proportional to range selected (in accordance with ISA-S50.1).
- Profibus DP compliant communicationslink
- Simultaneous 4-20mA and serial communication
- Dual, high and low; adjustable set-points; isolated output SPDT contacts, 5 A 120VAC failsafe to open
- Alarm Inhibit Feature for system testing and calibration

Signal Cable:

- Manufacturer's recommended sensor signal cable connection direct from sensor to instrument without joints or splices via flexible weatherproof conduit
- Quick disconnect style sensor cable connectors shall be used where offered by the manufacturer

Housing:

- As a minimum, instrument housing shall be NEMA 4X.
- Include all environmental conditioning required to protect the equipment mounted in the panel from the environmental conditions experienced at the mounting location. This includes but in not limited to:

* *In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.*
* *In hazardous areas, meet the CE Code Class, Group, and Division as shown or specified.*
* *In areas subject to flooding, enclosures shall be rated for submergence to 10m.*
* *Where exposed to freezing and condensation, provide internal heater(s) with thermostatic control.*
* *Where internal enclosure temperatures may otherwise rise to over 35 degrees C, provide cooling fans, or air conditioning equipment, to ensure enclosure remains below 40 degree C.*

Power Supply:

- Provide instruments which operate on 120 VAC +/-10 percent, 60 Hz power or loop powered.

(c) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.

- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.

PART 11 SWITCHES

11.01 Proximity

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- The contractor shall assume that equipment supplied shall be installed in an environment which is classed as harsh, possibly prone to hydrogen sulphide contamination in the air and high condensing humidity (resulting in mild sulphuric acid precipitants) and/or low levels of free chlorine. As such, either equipment shall be rated for installation in such an environment or shall be provided with suitable protective enclosures.
- Instruments shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment including mounting hardware shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - Proximity Detected

(b) Sensor (Primary Element)

Meet the following requirements:

- Principle: Hall effect, where external motion of a metallic object distorts the magnetic field within the probe causing cyclic collapse and re-establishment of the magnetic field which induces voltage in the probe sensing circuit conductors.
- Sensor: Epoxy encapsulated NEMA 4 weatherproof construction with 316 stainless steel body, threaded body.

(c) Minimum Performance

- Accuracy: +/-1.0 percent of actual pulses.
- Repeatability: +/-0.5 percent of actual pulses.
- Rating: DPDT contacts, 5 amp, 120 Vac
- Range: Adjustable 5 – 25mm

(d) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).

Locating & Mounting

- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.
- Install such that sensor clearance can be adjusted with a standard wrench and screwdriver
- Mount proximity sensor to each piece of equipment in such a position so that the moving gear teeth come within 0.125 inches of the end of the proximity detector.
- Terminate the proximity sensor leads in a NEMA 4 weatherproof junction box, after passing them through flexible conduit. Use rigid conduit from the junction box to the local control panel.

Manufacturer Directions

- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.

Where these standards define specific installation requirements for a similar analog device, these requirements also apply.

11.02 Level - Capacitance

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - General Fault
  - Where Applicable
    - High High Level
    - High Level
    - Low Level
    - Low Low Level

(b) Sensor (Primary Element)

- Designed for use either for horizontal or vertical mounting
- 316 stainless steel for construction of all wetted parts
- Provide sufficient strength of measuring section to withstand process environment.
- Make circular cross-sections of probe approximately 12mm diameter.
- Equip probe head with standard NPT fitting or a standard flange to facilitate mounting of the probe.
- NEMA Type 4 construction of junction box used with the probe for electrical connection.
- Probe length to match engineering design requirements.
- Coating or build-up to have no effect on output
- Provide necessary mounting hardware to complete the installation as required in the instrument schedule and as shown on the mounting detail.

(c) Analyzer/transmitter

- Enclosure: NEMA Type 4 either wall or pedestal mounted type.
- Output: Status relay contact, for each alarm level DPDT, rated 0.5A / 115 Vac
- Controller fault relay contact, SPDT, rated 0.5A / 115 Vac
- Power: 115 Vac, 60 Hz, 10 VA.
- Controllability: Field programmable probe calibration set point

(d) Minimum Performance

- Sensing Voltage: < 50 volts
- Operating Temperature: 5 to 110 C (Probe)
- -40 to 55 C (Controller)
- Repeatability: +/-1% of probe length
- Response Time: Less than one second
- Time Delay: Programmable 0 to 25 seconds
- Drift: +/-0.1 picofarad per 15 degree C
- Sensitivity: < 0.5 PF (picofarad)
- Set point Accuracy: +/-0.5 percent of probe length

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).

Locating & Mounting

- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.

- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.

Manufacturer Directions

- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Where these standards define specific installation requirements for a similar analog device, these requirements also apply.
- Isolate the probe from vibration and possible physical damage. Do not mount it in the direct stream of process fluid. If required, use a deflecting baffle in front of the probe in the direction of flow. Locate probe shall be easily removable for maintenance. Provide adequate clearance for probe removal.
- Wire the probe using manufacturer’s recommended flexible cable to a junction box close to the probe to facilitate withdrawal of the probe for maintenance. Use manufacturer’s recommended wires and rigid conduit from junction box to transmitter. If the transmitter can be located close enough, the junction box installation can be omitted.
- Ensure that nothing is in contact with the probe anywhere along its length, except for the fluid shall be measured.
- Provide a grounding probe or other suitable grounding scheme for applications in non-conducting vessels.

11.03 Level - Float

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - Hi Level

(b) Design

- Constructed of moulded polyethylene or approved equal.
- Float shall be equipped with two switches. One switch shall be closed and the other open below the float's set point. Above the set point, the switch positions shall reverse.
- Cable insulation suitable for continuous submergence in water or hydrocarbons. Conductors shall be minimum 14 AWG stranded copper. Cable length to suit the installation.
- Terminate float switch cables on terminal strips mounted in a NEMA 4X junction box located for ease of maintenance. Locate weatherproof cable connectors on the bottom of the box only.
- Include pipe-mounting hardware.

(c) Minimum Performance

- Repeatability: +/- 1.0 inch of float setting.
- Temperature: 0 to 55 C
- Electrical: DPDT 5 amp 120 Vac switch.

(d) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).

Locating & Mounting

- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.

Manufacturer Directions

- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.

- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Where these standards define specific installation requirements for a similar analog device, these requirements also apply.
- Mount float switches on a rigidly held standpipe. Wire the switch using the manufacturer's recommended flexible cable to a junction box close to the switch to facilitate removal for maintenance. Wire from the junction box to the control panel using the manufacturer's recommended wires and rigid conduit by the supplier.
- Provide easily removable switch for maintenance or cleaning, without emptying the tank or sump in which they are mounted.
- Intrinsic barriers where required

11.04 Temperature - Liquid Pressure

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
    - General Fault
    - One or more of the following as applicable
        - High High Alarm
        - High Alarm
        - High
        - Low
        - Low Alarm
        - Low Low Alarm

(b) Sensor (Primary Element)

- Stainless 314 steel vapour pressure sensing bulb with armoured capillary tube in thermowell housing.
- NEMA 4X construction with an epoxy coated aluminium case and male 12.5mm NPT connection.
- Provide assembled with 10 feet of stainless steel capillary tubing between bulb and switch. Capillary shall have braided stainless steel armour
- Automatic reset, snap action output contact. Field adjustable range.

(c) Thermowell

- Unless shown otherwise, provide thermowell conforming to the following requirements matching the sensor.
- Thermowell constructed of 316 stainless steel or Inconel 600.
- Provide appropriate length for necessary immersion length and mounting requirements. For pipes, provide approximately 1/3 pipe diameter immersion depth plus 75mm (3 inch) extension.
- Provide with standard NPT fitting or standard flange at the cold end of the thermowell.
- Provide a NEMA 7 RTD/thermocouple junction head with a screw termination block to handle necessary connections for sensor lead wires and a ground terminal for shield grounding.
- Use a rigidly mounted thermowell assembly. Provide necessary mating flange or threaded tee or bracket for mounting the thermowell.
- Wells shall be used with remote mounted vapour pressure sensor bulbs are to include a 316 stainless steel 1/2 inch NPT split nut and rubber grommet to hold the sensor bulb in the well.

(d) Minimum Performance

- Set point Accuracy: +/-1.0 percent of full scale.
- Repeatability: +/-1.0 percent of adjustable range
- Dead band: 1 percent of range
- Operating Temperature: -15 to 155 C
- Operating Pressure: Up to 70 bar
- Relay: 10A, SPDT 120VAC

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).

Locating & Mounting

- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.

- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.

Manufacturer Directions

- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.

Where these standards define specific installation requirements for a similar analog device, these requirements also apply.

11.05 Temperature - Bi-Metallic

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards. The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
  - General Fault
  - One or more of the following as applicable
    - High High Alarm
    - High Alarm
    - High
    - Low
    - Low Alarm
    - Low Low Alarm

(b) Sensor (Primary Element)

- Bi-metal differential expansion temperature sensing element
- Field adjustable set-point in the range specified in the instrument schedule
- 10A @ 120 Vac, 5A @ 240 Vac, SPDT, snap action output contact
- Fully automatic reset – Open/close on rise/drop as specified in the instrument schedule
- ¾ inch rigid conduit connection reduced to 1/2 inch at entry to switch
- Reversible mounting flange for curved or flat surfaces

(c) Thermowell

- Unless shown otherwise, provide thermowell conforming to the following requirements matching the sensor.
- Thermowell constructed of 316 stainless steel or Inconel 600.
- Provide appropriate length for necessary immersion length and mounting requirements. For pipes, provide approximately 1/3 pipe diameter immersion depth plus 75mm (3 inch) extension.
- Provide with standard NPT fitting or standard flange at the cold end of the thermowell.
- Provide a NEMA 7 RTD/thermocouple junction head with a screw termination block to handle necessary connections for sensor lead wires and a ground terminal for shield grounding.
- Use a rigidly mounted thermowell assembly. Provide necessary mating flange or threaded tee or bracket for mounting the thermowell.
- Wells shall be used with remote mounted vapour pressure sensor bulbs are to include a 316 stainless steel 12.5mm NPT split nut and rubber grommet to hold the sensor bulb in the well.

(d) Minimum Performance

- Set point Accuracy: +/- 5 percent of range
- Thermal Sensitivity: < 1 degree F
- Temperature Range: -20 to 200 degrees F
- Reset Dead band: +/- 5 degrees F

(e) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).

Locating & Mounting

- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.

- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.

Manufacturer Directions

- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.

Where these standards define specific installation requirements for a similar analog device, these requirements also apply.

11.06 Temperature - RTD

(a) General

This section defines device specific requirements. These are in addition to the various generic requirements set forth above and elsewhere in these standards.

The following general requirements apply:

- All required signal-processing equipment, including, but not be limited to, process sensing and measurement, termination, transducers, signal converters, conditioners, transmitters, receivers, and power supplies shall be provided.
- Instruments are shall be provided complete with enclosures, junction boxes, mounting hardware, floor stands, wall brackets, or instrument racks as recommended by the manufacturer. Mounting Hardware material shall be selected to prevent erosion, damage, or destruction by the environment that is typical for the area in which they are installed.
- Refer to the tender drawings and the manufacturer's documentation to confirm the necessary hardware and specific mounting assemblies where such details are not specified herein.
- Unless the manufacturer is unable to furnish an item, all component parts and associated equipment shall be provided by the manufacturer of the primary instrument
- The instrumentation shall be designed for continuous online process monitoring.

These standards require the devices to provide additional IO such that a common device may be used for multiple purposes. The following list defines the minimum IO which the Contractor must ensure is interfaced to the City of London's integrated distributed control system irrespective as to what may be shown on design drawings released for tender.

- Outputs – Discrete
    - General Fault
    - One or more of the following as applicable
        - High High Alarm
        - High Alarm
        - High
        - Low
        - Low Alarm
        - Low Low Alarm

(b) Sensor (Primary Element)

- Use > = 99.99 percent pure platinum wire wound about a ceramic or glass core and hermetically sealed within ceramic or glass capsule. Provide lead configuration of one lead connected to one end of the sensor, two to the other end.
- Assemble as per ANSI (ISA) 96.1 standard. Provide 6mm diameter probe of 316 stainless steel mounted in thermowell.
- Provide insulated leads from each other and the probe housing using ceramic oxide insulation.
- Field adjustable set-point in the range specified in the instrument schedule
- 10A @ 120 Vac, 5A @ 240 Vac, SPDT, snap action output contact
- Fully automatic reset – Open/close on rise/drop as specified in the instrument schedule

- 19mm rigid conduit connection reduced to 12.5mm at entry to switch
- Reversible mounting flange for curved or flat surfaces
- Thermowell constructed of 316 stainless steel or Inconel 600.
- Provide appropriate length for necessary immersion length and mounting requirements. For pipes, provide approximately 1/3 pipe diameter immersion depth plus 75mm extension.
- Provide with standard NPT fitting or standard flange at the cold end of the thermowell.
- Provide a NEMA 7 RTD/thermocouple junction head with a screw termination block to handle necessary connections for sensor lead wires and a ground terminal for shield grounding.
- Use a rigidly mounted thermowell assembly. Provide necessary mating flange or threaded tee or bracket for mounting the thermowell.
- Wells shall be used with remote mounted vapour pressure sensor bulbs are to include a 316 stainless steel 12.5mm NPT split nut and rubber grommet to hold the sensor bulb in the well.

(c) Minimum Performance

- Accuracy: +/ - 1.0 percent of range.
- Stability: +/- 0.1 percent of range at constant temperature
- Drift: +/- 0.25 percent of range
- Linearity: +/- 0.25 percent of range
- Response time: < 1 minute

(d) Installation

General

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration.
- Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyzer (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).

Locating & Mounting

- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.

- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City of London at no charge to the contract.

Manufacturer Directions

- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.
- Follow the Manufacturer’s recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Where these standards define specific installation requirements for a similar analog device, these requirements also apply.
- Wire to permit convenient withdrawal of the sensor assembly for service or replacement. Provide suitable armour cable with the sensor connection head.
- Where the sensor is used to measure temperature of fluid in a pressurized conduit, provide thermowell with fluid seal fittings to make the installation safe and leak proof. Provide for sensor removal for service without interrupting process.
- Install vapour pressure switches in an orientation where the sensing element is in a vertical plane.
- Install bi-metallic switches in an orientation where the sensing element will not contact other surfaces.
- Allow sufficient clearance for cover removal and adjustment of switches.

PART 12 CONTROL DEVICES

12.01 Generic

(a) General

In addition to specific monitoring requirements, and where specific requirements are not set forth within this document, the following shall be monitored:

- Run Status (provided by auxiliary run contacts at starter)
- Auxiliary contact on disconnect switches and breakers (open contact when disconnect open)
- Local lockouts and interlocks (where applicable)
- Hand / Off / Remote Selector Switch Position (where applicable)
- Remote Start / Stop Contacts (where applicable)
- Local Power-disconnect
- Emergency Stop Switch (where applicable)

The following minimum alarm status information shall be provided for all motors (the list is additive in nature, e.g. a 25 hp device must comply with all lesser requirements as well as those for 25 hp & over):

- General Fault
- Submerged Devices
  - Moisture.
- 5 peak hp & over
  - General Failure.
  - Overload status.
- 25 peak hp & over
  - Temperature.
  - Vibration.
- 40 peak hp & over
  - Individual Power Monitoring (kWh and A).
- 250 peak hp & over
  - Inboard & Outboard bearing temperature.
  - Winding temperature.
  - Discharge air temperature (where applicable).

Where the failure of linkages between devices (motor, pump, screw, compressor, etc.) may result in a health and safety risk, damage to equipment, and/or an environmental hazard, the operational status of the connected device shall be monitored separately from the motor or actuator.

Details regarding P&I Interface I/O for analysers are addressed in the analyser specification section of this document.

(b) Communication Protocol

- Equipment shall be provided complete with either an integral RS-485 Modbus RTU Slave Interface, Profibus DP Interface or DeviceNet Interface. All instrumentation supplied for a given facility shall conform to the same protocol standard as already in predominant use at the facility.
- All devices shall support simultaneous serial communication and conventional individual signals.
- Provision of an external signal and/or protocol converter is not acceptable unless explicitly approved by the City of London. This approval, once granted, shall apply only to the specific installation at the specific location for which approval has been requested.
- Loop powered instrumentation, and all instrumentation requiring calibration, shall fully support HART protocol (both digital and analog signalling). This includes, but is not limited to, the ability to perform all calibration and configuration procedures over the HART communication link.

12.02 Uninterruptible Power Supply (UPS)

(a) General

The UPS shall conform to the following design criteria

- UPS shall be an on-line uninterruptible power supply (connected devices to always be running off battery inverter) with true sine wave power output.
- Batteries shall be leak-proof, sealed, maintenance-free lead-acid batteries specifically designed specifically for use with a UPS and rated for extended duty cycle.
- Design to maintain batteries in a fully charged state while main power source is available.
- Batteries not fitting into the UPS enclosure shall be mounted in a matching battery cabinet. Provide all cables necessary to connect the externally mounted batteries to the UPS.
- Unit to provide internal protection from overload and short circuit conditions.
- UPS shall be compatible with engine driven emergency generator as power source.
- Provide UPS with integral power disconnect switch and external maintenance bypass switch allowing removal of the UPS for service without interruption of service. The maintenance bypass switch shall be a three-position switch with make-before-break contacts to prevent intermittent loss of power during switching between "LINE" and "UPS" positions.
- UPS shall be sized such that connected power does not exceed 80% of rated FULL LOAD for UPS.
- Provide the following status indication.

✓ The UPS shall have LED indicators or LED displays for the following: UPS online status; UPS alarm status; and Mains power "On" status.

✓ For units greater than 2.1 KVA, the UPS shall have LCD displays for the following: Feeder input volts and current; UPS output volts and current; Output frequency; Battery voltage; and Percent load.

✓ As a minimum, the UPS shall provide the following alarms: Low battery voltage; High and low output voltage; Output overload; and High temperature.

✓ UPSs powering computers shall be provided with Ethernet communication modules. UPSs powering PLCs shall be provided with relay contacts, which shall be monitored by the PLC.

✓ UPS shall provide a modular 10/100BaseT Ethernet SNMP communication port.

✓ The UPS shall provide relay contact module with the following minimum controls:

1) General Fault
2) Low Battery
3) UPS Online
4) Mains Power Failure

(b) Minimum Performance

The technical specifications shall exceed the following minimum requirements.

MTBF:	> 150,000 hours for all components except battery
	> 50,000 hours for battery
Efficiency:	> 85 percent under full load
Noise level:	< 55 dB at 1m
Input voltage:	> 2.1 kVA – 240 Vac, 60 Hz, 3-phase
	< 2.1 kVA – 120 Vac, 60 Hz, 2-phase
Output voltage:	120 VAC, 2-phase
	> 2.1 kVA – also provide 240 Vac, 3-phase power
Noise Rejection:	120 dB Common Mode, 60 dB Transverse Mode.
Isolation:	< 2 pf effective capacitance, fully isolated neutral
Voltage Spike:	> 2000:1 attenuation from line
Voltage Regulation:	< +/-3 percent nominal
Output Frequency:	60 Hz <+/-0.5 Hz
Harmonic Distortion:	< 5 percent line to neutral maximum at full load
Power Rating:	> 130 % Peak design load
Overload Capacity:	> 125 % for 10 minutes, >150 % surge on power-up
Battery Capacity:	> 90 Minutes operation at rated FULL LOAD output
Recharge Cycle:	Recharge from 5 % to 95% charge level within 2 hours
Discharge Recovery:	100 % after 29 day deep discharge (DIN 43 539)
Temperature:	0 to 50°C
Relative Humidity:	5 to 95%
Vibration:	0.25G from 5 to 100 Hertz

12.03 Variable Speed Drives (VSD)

(a) General

The equipment shall be installed such that the following minimum IO is interfaced to the City of London's integrated distributed control system by serial communication link.

- Inputs – Discrete
  - To be communicated to controller using Devicenet communications
- Inputs – Analog
  - To be communicated to controller using Devicenet communications
- Outputs – Discrete
  - To be communicated to controller using Devicenet communications
- Outputs – Analog
  - To be communicated to controller using Devicenet communications

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(b) Design

- The AFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 40° C ambient and 10 kHz switching frequency below 30Hp, and 3.6 kHz above.
- The AFDs shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Insulated Gate Bipolar Transistors (IGBTs) shall be used in the inverter section.
- The AFDs shall run at the above listed switching frequencies and upon over temperature shall fold back the switching frequency to reduce the operating temperature. The AFD shall return to the rated switching frequency after the over-temperature condition has passed.
- The AFDs shall have an efficiency at full load and speed that exceeds 97%. The efficiency shall exceed 90% at 50% speed.
- The AFDs shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
- The AFDs shall have a one (1) minute overload current rating of 150% and a two (2) second overload current rating of 250% for constant torque drives. The AFDs shall have a one (1) minute overload current rating of 110% for variable torque drives.
- The AFDs shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the AFD.
- The AFDs shall limit harmonic distortion reflected onto the utility system by utilizing the standard 3% nominal impedance integral ac three-phase line reactor.
- The AFDs shall be able to start into a spinning motor. The AFDs shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the AFDs shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.

- Thermal magnetic breaker to provide a disconnect means. Operating handle shall protrude the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position. Interlocks shall prevent unauthorized opening or closing of the AFD door with the disconnect handle in the ON position.
- AC input line current limiting fuses shall provide a means of disconnecting the AFD from the line under fault conditions.
- Three contactor bypass shall include a drive input disconnect, an AFD input isolation contactor, bypass contactor and an AFD output contactor that is electrically and mechanically interlocked with a bypass contactor. This circuit shall include control logic, status lights and motor over current relays. The complete bypass system Hand-Off-Auto with Inverter-Bypass selector switch(s), and inverter/bypass pilot lights shall be packaged with the AFD. The unit shall be set up for Automatic bypass operation upon an AFD trip.
- AC output contactor to provide a means for positive disconnection of the drive output from the motor terminals.
- Fused space heaters with thermostat
- Motor over current relay to provide motor over current sensing of a given level of load current.
- Input isolation transformers, shall be mounted in NEMA 1 enclosure.
- Motor dv/dt filter shall be provided for use on motor cable runs exceeding 50 ft.
- Dynamic braking control circuitry shall be provided to decelerate the motor faster than the internal losses can absorb. Dynamic braking shall cause a resistor bank to, be switched onto the dc link to absorb the regenerative energy. The resistor bank, shall be located external to the drive enclosure to prevent overheating of the drive.
- Provide an input EMI filter to minimize conducted electrical noise such that VSD meets all requirements of IEC 61800-3.
- Installation design procedures shall minimize possible interference with serial communication at the facility.
- Harmonic filtration shall meet requirements set forth under IEEE Standard 519.
- Drives shall have AC Input circuit breakers.
- Drives shall have internal EMC filters.
- Drives shall have integrated open industry standard multi-drop connectivity providing full access to all operating parameters communication shall be by Modbus RS-485, RTU, DeviceNet, or Profibus DP as required to interface to RTU.
- Output transient voltage surge suppression (dv/dt filtering) shall be provided which limits instantaneous voltage spikes to less than 200% of the normal operating voltage.
- Load inertia dependant carryover (ride through) during utility loss.
- Insensitive to input line rotation.

(c) Control Functions

- Frequently accessed AFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the AFD. The AFDs shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
- A graphical control keypad shall be provided consistent of a LCD keypad located on the front of the AFD. Features shall include: Pushbuttons for selection, display, and modification of the AFD characteristics.

- The keypad LCD panel shall provide a choice of 8 lines of text or a 64x128 pixel graphical display of key waveforms or a combination of both.
- The operator shall be able to scroll through the keypad menu to choose between the following: Monitor, Operate, Parameter setup, current parameter values, Active faults, Fault history, LCD contrast adjustment, installed options and software version.
- The following functions shall be provided: Start command from keypad, remote or communications port, Speed command from keypad, remote or communications port, Motor direction selection, Maximum and minimum speed limits, Acceleration and deceleration times, two settable ranges, Critical frequency avoidance, Torque limit, Multiple attempt restart function, Multiple preset speeds adjustment, Catch a spinning motor start or normal start selection, Programmable analog output, DC brake current magnitude and time, Proportional/Integral process controller.
- Standard advanced programming and trouble-shooting functions shall be accessible over standard digital communication link. Windows based software shall be provided on CD which allows all diagnostic, monitoring and configuration to be performed remotely. The CD shall also contain a comprehensive electronic manual.
- Inputs in addition to serial communication - A minimum of six (6) programmable digital inputs, two (2) analog inputs shall be provided.
- Outputs - A minimum of three (3) discrete programmable digital, and one (1) programmable analog output shall be provided.
- Programmable relay outputs shall be Form C contacts rated for 120VAC.
- Monitoring and Displays - The AFD's display shall be a LCD type capable of displaying three (3) lines of text and the following status indicators: Run, Forward, Reverse, Stop, Ready, Alarm, Fault, Local Panel Remote, Hand, auto and off.
- Monitoring Functions:
    - Output frequency, Output speed, Motor current, Motor torque, Motor power, Motor voltage, DC-link voltage, Heat sink temperature, Total operating days counter, Operating hours (resetable), Total megawatt hours, Megawatt hours (resetable), Voltage level of analog input, Current level of analog input, Digital inputs status, Digital and relay outputs status, Motor temperatures rise, and percentage of allowable rise.
- Protective Features:
    - Over current, Over voltage, Inverter fault, Under voltage, Phase loss, Output phase loss, Under-temperature, Over temperature, Motor stalled, Motor over-temperature, Motor under load, Logic voltage failure, Microprocessor failure, DC injection braking. Ground fault protection during power-up, starting, and running
- Diagnostic Features:
    - Fault History Record and log faults Indicate the most recent first, and store up to 9 faults.

(d) Minimum Performance

- Incoming Power: Three-phase, 600 Vac (+10% to -15%) and 50/60 Hz (+/-5 Hz)
- Frequency stability: +/-0.05% for 24 hours
- Voltage regulation : +/-1% of maximum rated output voltage
- Speed regulation: +/- 0.5% of base speed.
- Humidity: 0 to 95% (non-condensing and non-corrosive).
- Ambient Temperature: -10 to 50º C

(e) Enclosure

- The AFD enclosure shall be NEMA 12. The AFD shall have complete front accessibility with easily removable assemblies.

12.04 Generator Controller

(a) General

The general controller shall provide full-featured power metering, protective relaying, simultaneous engine and generator parameter viewing, and expanded AC metering. Engine and generator control, diagnostics, and operating information shall be accessible via the control panel key-pads or remotely by industry open serial communications link. Transfer switch control shall be an internal part of the generator controller design.

- Modular microprocessor-based control
- Environmentally sealed, die-cast aluminium housing
- Full-featured power metering, accessible with one key-pad touch, which shall display generator set kW, kV•A, kV•AR, kW hours, kV•AR hours, percent rated power, and power factor.
- Programmable protective relay's, shall be programmable as alarm or shut down conditions, for under voltage, over voltage, under frequency, over frequency, over current, and reverse power.
- Shall allow, simultaneous viewing of engine, generator parameters, with toggle between auto parameter scrolling, and individual parameter display, all AC L-L voltages, all AC L-N voltages, or all AC line currents.
- Individual Lamps for each alarm condition. Separate lamp for each fault and warning condition. Not less than 16 alarm conditions shall be individually displayed. Lamp test switch and alarm acknowledge button.
- The controller shall fully activate the Genset start/stop cycle.
- Environmentally sealed
- Impervious to salt spray, fuel, oil and oil additives, coolant, spray cleaners, chlorinated solvents, hydrogen sulphide and methane gas, and dust.
- Input and output protection all inputs and outputs are protected against short circuits to (+/-) battery and reverse polarity.
- Reverse polarity, protected.
- Lamp test and acknowledge/silence switches.
- Genset shall include local emergency stop panic button
- The alarm modules shall meet and exceed the standards of the National Fire Protection Association (NFPA).
- Protective relays shall be programmable. The controller shall provide the following adjustable protective functions:
    - Alarm enable/disable
    - Alarm threshold level
    - Alarm time delay
    - Shutdown enable/disable
    - Shutdown threshold level
    - Shutdown time delay
- Setpoints are factory set for optimum performance and generator protection.
- Setpoint values may be viewed with the engine running or stopped.

(b) Transfer Switch

Design

- Every portion of the contactor shall be positively mechanically connected. No spring loaded clutch drive or friction drive mechanism.
- Switches shall have arc runners and suppressors providing rapid arc extinction. Switches shall have separate making and breaking continuous current carrying and arcing contacts.
- Transfer switch shall meet the following standards:
  - UL 1008, listed & tested (withstand & closing ratings)
  - NFPA 99 & NEC 517
  - NFPA 70 & NEC 90
  - NFPA 110
- All components shall be front adjustable and front removable.
- Engine start contacts shall be gold plated and shall close on power failure.
- All printed circuit boards have a conformal coating for environmental protection.
- Main contacts shall be of silver alloy.
- Switch shall be mounted in a NEMA 12 enclosure, with hinged door and key lockable handle. The manual operating handle shall be located inside enclosure.
- Switching shall be performed by single solenoid, electrically operated, mechanically held.
- Switch assembly, shall be provided as a single integrated controller with transfer mechanism and solid state intelligence panel
- There shall be three indicating lights on face of panel for normal, standby, and standby operating
- Four-pole (factory installed) when the generator neutral is required to transfer. This offers isolation of the standby and normal source neutrals.
- Generator control module shall consist of a Programmable logic controller with in-phase monitoring — providing for an in-phase transfer between two live voltage sources. Functionally shall include:
  - Time delay neutral (0.1-10 seconds, factory set at 5 seconds)
  - Cool-down timer (1-30 minutes, factory set at 10 minutes)
  - Engine minimum run (5-30 minutes, factory set at 20 minutes)
  - Return to utility (1-30 minutes, factory set at 5 minutes)
  - Standby voltage (75-95%, factory set at 90% rated)
  - Standby frequency (80-90%, factory set at 90% rated)
  - Engine warm-up (5 seconds to 3 minutes, with an override switch, factory set at 1 minute)
- Remote automatic control circuit to cause engine start/stop and transfer switch operation from a remote signal
- Manual bypass selector switch (three-position — normal, auto, standby)

(c) Communication

- The generator controller shall provide an internal Modbus TCP,r Profibus pr Devicenet communication providing interface to the following:
- Monitored Parameters (available real time)
  - Digital (LCD) Indication: AC voltage — 3 phase (L-L & L-N), AC amps (3 phase & total), kW (total & per phase), kV•A (total), kV•AR (total), kWhr (total), kV•ARhr (total), PF (Average total & per phase), % of rated (total), Frequency, DC voltage, Coolant temperature, Oil pressure, Rpm, Hours run, Crank Speed
  - Alarms: Emergency stop, Over-voltage, Under-voltage, Low oil Pressure, Over speed, Over Crank, Shutdown on Fault, Over Frequency, Under Frequency, Over Current, Low Coolant Level, High Oil Temperature
- Controlled Parameters
  - Remote Stop
  - Remote Start

(d) Minimum Performance

- Electrical noise immunity: 100 volts/meter
- AC Metering: True RMS 0.5% for volts, amps, and power parameters.
- EMI Immunity: IEC 801-2, IEC 801-3, IEC 801-4, EN 5082-2
- EEC Certification: 89/392/EEL
- Enclosure: NEMA 1, IP22
- Humidity: 0 to 100% relative humidity
- Input/output protection: All inputs and outputs protected against short circuits
- Horn Output: 80dB(A) nominal
- Input voltage range: 14 to 45 VDC
- Power requirements: 16 watts
- (generator in standby: all lamps & alarm horn on)
- Reverse polarity: Integral protection
- Shock: > 20 g
- Temperature range: -40° C to 70° C Operating
- Vibration: > 2.0 g @ 18 to 500 Hz
- Single-phase voltage and frequency on standby (80% of rated)
- Loss of utility interrupt delay (time delay start) — 0.1 to 10 seconds

12.05 Sampler

(a) General

The controller shall provide the following functionality.

- Programmable number of sample retries before alarming on sample failure
- Automatic rinse and purge cycles
- Comprehensive diagnostics including scheduled maintenance projections
- Alarm Inhibit Feature for system testing and calibration
- Integrated keyboard for configuration and 8 digit LCD display
- RS-485 serial communications interface
- Integrated battery backup for configuration with support for power interruptions of 30 days and low battery level alarm
- The Sampler Controller shall be microprocessor controlled and provide the following sampling modes.
- Uniform time intervals selectable in one minute increments up to 96 hrs
- Non-uniform time intervals selectable in one minute increments up to 24 hrs
- Flow paced sampling based on a 4 – 20ma primary flow signal
- Flow paced sampling based on sample pulse

The Sampler shall support the following sample collection methodology:

- One (1) bottle composite sample
- Two (2) bottle composite sample in multiple bottles
- Two (2) bottle duplicate composite samples
- Eight (8) bottle composite samples in multiple bottles
- Eight (8) bottle sequence of samples
- Twenty-four (24) bottle multiple samples in separate bottles
- Twenty-four (24) bottle single samples in separate bottles

Input Signals

- Flow rate - Isolated 4-20mA current signal into 500-ohm load (maximum 750 ohm) linear proportional to range selected. In accordance with ISA-S50.1.
- Sample Pulse - isolated SPDT contacts, 5A 120VAC

Output Signals

- Profibus PB communication link
- Simultaneous 4-20mA and serial communication
- Sample Cycle in process SPDT contact, 5 A 120VAC
- Programmable Fault SPDT contact, 5 A 120VAC (failsafe to open position)

Enclosure

- Controller enclosure: NEMA 4X
- Polyester-resin, fibre glass or 304 stainless steel enclosure construction

(b) Sample Storage

- Refrigerated and heated storage compartment made of high-impact ABS plastic
- Insulated with non-CFC foam
- Adjustable sample temperature setpoint from 0 to 8 C
- Conductivity level probe with full bottle shut-off and alarm.
- All parts protected against harsh environment. Condensing coil powder coated with UV resistant polyurethane resin or enamel. Evaporating coil powder coated with epoxy resin.

(c) Performance

- Maximum Solids: 2%
- Ambient Temperature: -40 to 55 C
- Power Supply: 120 Vac, 60 Hz
- Electrical Requirements: 20 amp
- Maximum Size: 1200 x 700 x 700 mm, H x W x D
- Maximum Weighing: 80 Kg
- Sample Bottle size
- One (1) 10 litre
- Two (2) 5.0 litre
- Eight (8) 1.0 litre
- Twenty four (24) 0.25 litre

(d) Installation

- Install the sampler as part of a complete sampling system. All requirements set forth for sample collection systems apply.
- Sampler shall be of integrated design complete with sample collection peristaltic pump and all tubing.

12.06 Sample Collection System

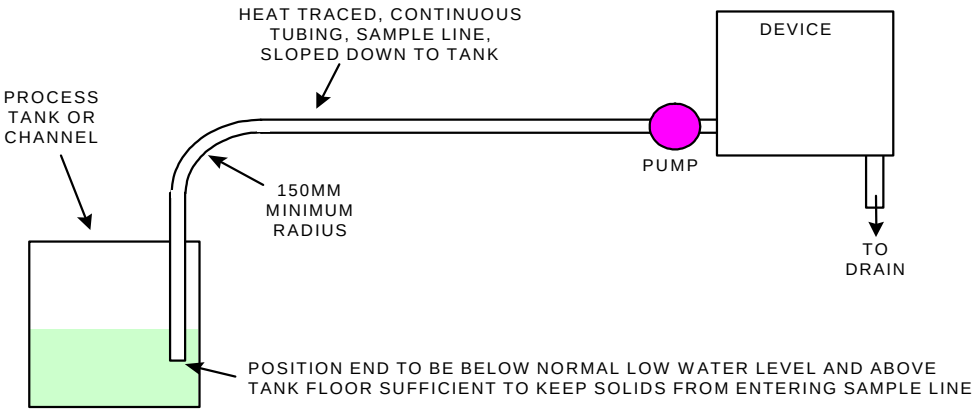
(a) General

- Sampling systems shall only be used where an inline instrument cannot be used (e.g. samplers).
- A sampling system consists of collection, transport, analysis and return of the sample stream to the process.
- The sampling point selected shall be selected to ensure a clean, thoroughly mixed, and representative sample of the process stream. The sample point shall be selected such that dead time will not adversely affect the analysis and the length of sample line will provide a desirable transport time.
- Provide test/calibration connection with isolating valves and removable end-caps between pressure sensing instrument and source isolation valves. Test connection must be easily accessible and, located within 600mm of the analyzer outside the instrument housing.
- Provide a source of clean water and necessary valves adjacent to, but outside the instrument housing along with necessary fittings to allow the sample line shall be back flushed to prevent plugging.
- Where an instrument is distant (> 5m) or not visible from the process tapping point, provide isolation valves local to the instrument, appropriate for the process fluid.
- Unless otherwise directed, provide process sensing/sampling lines of 316 S. S. tubing, minimum diameter of 12mm (1/2") adequately supported and protected throughout its length.
- Provide coiled or flexible tube connections to sensing equipment where conditions warrant (locations susceptible to vibration, high temperature, temperature variations, etc.) to compensate for possible movement between process pipe and instrument
- Provide drain plugs such that all fluid can be drained from the sample lines by gravity without need to move any piping. Ensure downward horizontal grade toward drain plugs is not less than 1% for the entire length of all tubing.
- Design sampling system in a manor that supports the ability to easily remove and clean the sample pick-up line.

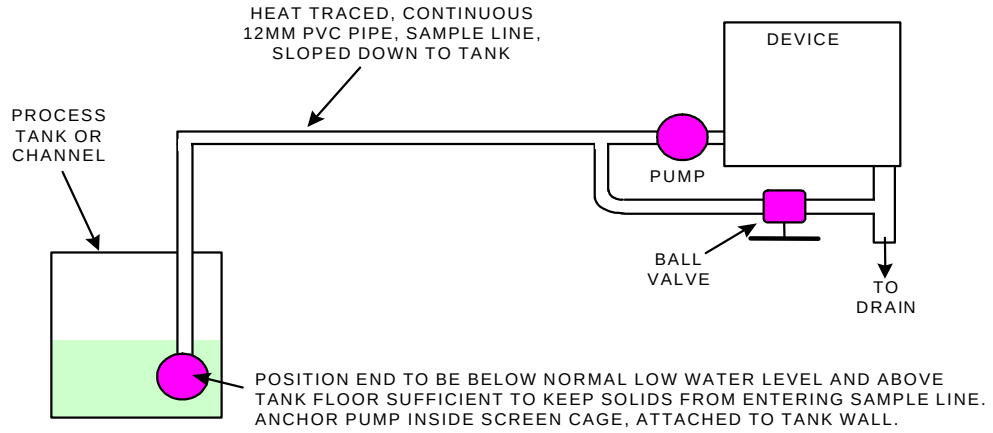
(b) Minimum Performance:

- Tube Length: 1 to 30m of 6mm vinyl or 10mm Teflon
- Tube Flow Velocity: 1.0 to 3.0m/s
- Suction Lift: 8.0m
- Pumping Rate: 3 litre/min @ maximum lift
- MTBF: 40,000 hours
- Line Filter: Located at source rated for 0-3.0L/min,
- Designed to remove all particles over 100 microns,
- Self cleaning design

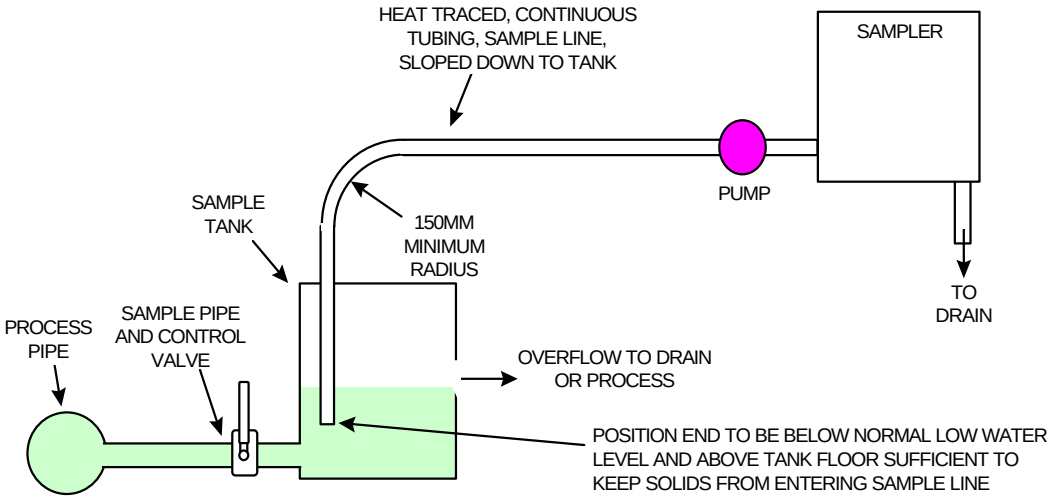
Follow the guidelines given in the following typical schematics.



METHOD A: DIRECT SAMPLE



METHOD B: INDIRECT SAMPLE, WITH SAMPLE SUPPLY PU



METHOD C: DIRECT SAMPLE - PRESSURIZED PROCESS CONNECTION

12.07 Door Entry Monitor

(a) General

The door entry monitor shall provide the following IO:

- Inputs – Discrete
  - Remote Arm
- Outputs – Discrete
  - Intrusion (NC contact)
  - Enabled (NC contact)

(b) Sensor

The sensor shall consist of a two piece magnetic reed proximity switch. One piece shall contain the switch and the other the magnet. Normal position shall be with the magnet in close proximity to the switch causing the switch contact to close. When the magnet is moved away, the switch contact shall open.

(c) Analyzer/transmitter

- Provide a reset switch activated by numeric keypad with 4 or 6 digit pass code.
- Dual programmable SPDT outputs assigned as intrusion detection defeat enabled, and intrusion detected
- Dual programmable SPDT inputs assigned as remote arm.
- Security system keypad shall indicate clearly which individual sensor has been triggered. It is not acceptable for sensors to be grouped such that it is not possible to determine which sensor has been triggered.
- The system will be capable of 1,500 user codes
- By entering an administrative pass code, the keypad shall allow the user to scroll through the 1000 most recent pass code attempts, whether or not successful.

(d) Minimum Performance

- Sensor Contact Rating: 200 mA at 48 Vdc.
- Temperature: -30 to 40 degrees C (-20 to 120 degrees F)

(e) Installation

- Mount the intrusion detection switches on each exterior door, window or hatch.
- Connect the intrusion detection switches such as each individual switch is uniquely monitored.

12.08 Device – Bar Screen

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - Start / Stop
  - Remote Lockout
- Outputs – Discrete
  - Running / Stopped
  - Local / Remote
  - Local Auto / Local Manual
  - Overload / Motor Fault
  - Over torque / Screen Fault
  - Forward / Reverse

12.09 Device – Blower, Throttling

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - Blower Start / Stop
- Inputs – Analog
  - Throttle Set Point
- Outputs – Discrete
  - Blower Local / Remote
  - Blower Running / Stopped
  - Blower General Fault
  - Blower Motor Overload
  - Throttle Local / Remote
  - Throttle Fault
- Outputs – Analog
  - Throttle Position (% open)
  - Current Draw (amperes)

12.10 Device – Compactor

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - Start / Stop
- Outputs – Discrete
  - Local/Remote
  - Overload
  - Running / Stopped
  - Forward / Reverse

12.11 Device – Generic, Discrete Monitor and Control

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - For single speed devices
    - Start /Stop
  - For multi-speed devices, where applicable
    - Run Fast
    - Run Medium-Fast
    - Run Medium
    - Run Medium-Slow
    - Run Slow
  - For devices with direction control
    - Forward / Reverse
- Outputs – Discrete
  - For single speed devices
    - Running / Stopped
  - For multi-speed devices, where applicable
    - Running Fast
    - Running Medium-Fast
    - Running Medium
    - Running Medium-Slow
    - Running Slow
  - General Fault
  - For devices with motors
    - Overload
  - For devices with direction control
    - Forward / Reverse
  - For devices with self contained controllers
    - Automatic / Manual

12.12 Device – Generic, Discrete Monitor Only

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Outputs – Discrete
  - For single speed devices
    - Running / Stopped
  - For multi-speed devices, where applicable
    - Running Fast
    - Running Medium-Fast
    - Running Medium
    - Running Medium-Slow
    - Running Slow
  - General Fault
  - For devices with motors
    - Overload
  - For devices with direction control
    - Forward / Reverse
  - For devices with self contained controllers
    - Automatic / Manual

12.13 Device – Gravity Belt Thickener

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - Remote Stop
- Outputs – Discrete
  - Booster Pump Running
  - GBT Running
  - GBT Automatic / Manual
  - GBT Fault
  - Polymer Feed Pump Running
  - Sludge Feed Pump Running
- Outputs – Analog
  - Polymer Feed Pump Speed
  - Polymer Flow Rate (L/s)
  - Sludge Feed Pump Speed
  - Sludge Flow Rate (L/s)
  - Belt Speed

12.14 Device – Screw

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - Start / Stop
  - If Reversible
    - Forward / Reverse
- Outputs – Discrete
  - Local / Remote
  - Shear Pin Failure
  - Overload
  - Running / Stopped
  - If Reversible
    - Forward / Reverse

12.15 Device – UV Disinfection Unit

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - Enable / Disable
- Inputs – Analog
  - Process Flow Rate
- Outputs – Discrete
  - Controller Fault
  - Minor Fault (servicing required, however still operational)
  - Major Fault (system offline)
  - Low UV Dose
  - Bank Fault (repeat for each bank of lamps)
  - Bank On (repeat for each bank of lamps)
- Outputs – Analog
  - UV Intensity (repeat for each bank of lamps)
  - Bank Lamp Life Hours (repeat for each bank of lamps)
  - Bank Runtime (repeat for each bank of lamps)

12.16 Device – Channel Grinder

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - Enable / Disable
- Inputs – Analog
  - Process Flow Rate
- Outputs – Discrete
  - Run status
  - Forward/reverse
  - Overload
  - Minor fault
  - Major fault
  - Grinder Overload
  - Motor Overload
  - Oil High Temp
  - Low Oil Level.

12.17 Device – In-line Grinder

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Outputs – Discrete
  - Run Status
  - Grinder Fault

12.18 Device – Pump, Sludge Cake

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Inputs – Discrete
  - Enable / Disable
- Outputs – Discrete
  - Hand Selected
  - Remote Selected
  - High Oil Temp
  - High Oil Pressure
  - Motor Overload
  - Local Alarm Reset
  - Motor Run Status
  - Hydraulics in Bypass
  - Hydraulic Overload
  - Low Oil Level
  - Dirty Oil Filter
  - Local Audible Alarm Energized
  - Motorized Valve Positions (Open/Closed & Local/Remote)
  - Emergency Stop
- Outputs – Analog
  - Pump Speed Set point (0-100%)
  - Screw Speed Set point (0-100%)
  - Pump Speed Indicator (0-100%)
  - Screw Speed Indicator (0-100%)
  - Hydraulic Fluid Pressure
  - Hydraulic Fluid Temperature
  - Feed Rate (L/m)
  - Pump Efficiency (% Fill)
  - Total Litres Pumped (double precision)

12.19 Device – Valve, Modulating

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply. All the following inputs and outputs to be communicated on Profibus DP

- Inputs – Analog
  - Position Set Point
- Outputs – Discrete
  - Remote
  - Valve alarms
  - General Fault
  - Over torque
  - Full Open
  - Full Closed
- Outputs – Analog
  - Position Feedback

12.20 Device – Valve, Open / Closed

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply. All the following inputs and outputs to be communicated on Profibus DP

- Inputs – Discrete
  - Open
  - Close
- Outputs – Discrete
  - Remote
  - Fault
  - Full Open
  - Full Closed

Device – Power, Phase Failure Detector

(b) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Outputs – Discrete
  - Phase Failure

12.21 Device – Power (Current) Analyser

(a) General

As the City of London does not currently have detailed standards for this device type, the following minimum interface requirements shall be provided. All general requirements within these standards also apply.

- Outputs – Analog
  - Current

12.22 Metering Pumps

(a) General

The equipment shall be installed such that as a minimum the following information is interfaced with the RPU.

- Inputs – Analog
  - Dosage Set Point (mg/l)
  - Process Flow Rate (m3/d)
- Outputs – Discrete
  - General Fault
  - Local / Remote
  - Running / Stopped
- Outputs – Analog
  - Dosage Rate

In addition to requirements set forth elsewhere in these standards, the following specific requirements apply:

- Provide devices of rugged construction designed shall be suitable for the site conditions.
- Unless the manufacturer is unable to furnish an item, the manufacturer of the pump shall provide all component parts and associated equipment.
- Provide only new, standard, first-grade materials throughout, conforming to standards established by Underwriter's Laboratories (UL), Inc., and so marked or labelled, together with manufacturer's brand or trademark.
- Provide material and equipment in accordance with applicable codes and standards, except as modified by the specifications.

(b) Controller Design:

- Microprocessor based technology electronics
- Conformably coated printed circuit boards
- Digitally controlled stroking rate
- Precise automatic flow-proportional dosing
- Integral Fault Monitoring including: Stroke error, diaphragm failure, and no flow
- Continuous stroke length adjustment from 0 - 100%
- Non-volatile memory feature stores all system set-up and calibration data to save critical information during power outage
- Automatic restart sequence with diagnostic self-checking after power interruptions
- Self-diagnostics aids to maintenance and service

Display:

- Back lit LCD indicator for current operating status
- Selectable feed rate display in strokes/min. or l/h
- LED indicator for fault indicators
- Configuration by menu-driven graphics display and integral keypad

Inputs:

- Isolated 4-20mA into 500-ohm load (maximum 750 ohm) linear proportional to range selected. Programming shall support both flow rate when configured for automatic flow pacing, and remote dosage set point adjustment in l/h when configured for remote control.
- Dual isolated input SPDT contacts, 5 A 120VAC. One input shall be programmed to support remote stop, the other input to support low tank level lockout.

Outputs:

- Dual isolated output SPDT contacts, 5 A 120VAC failsafe to open. One shall be programmed to indicate device in auto, the second to indicate device failure / fault.
- Alarm Inhibit Feature for system testing and calibration

Wetted Components:

- Integral self-bleeding head where applicable such as hypo applications
- Built in high-pressure bypass valve
- Material (suitability for a specific application shall be confirmed with manufacturer)
  - General Purpose — Acrylic Glass
  - Diluted Polymer Solution — Ceramic
  - Chlorine Solutions — Acrylic Glass
  - Solutions susceptible to crystallization — Acrylic Glass
  - Strongly corrosive (acid & alkaline) — PTFE
  - Solvents & liquids containing oil — Stainless Steel

Housing:

- As a minimum, housing to meet NEMA 4X requirements
- Housing shall be rated IP65
- In aggressive and/or corrosive environments, housings shall be constructed of corrosion resistive chemical resistant materials.
- In hazardous areas, meet the CE Code Class, Group, and Division requirements.

Power Supply:

- < 0.5 hp, 110V 60 Hz Single-phase
- > 0.5 hp < 5hp, 220V 60 Hz Three-phase
- > 5 hp, 600V 60 Hz Three-phase

(c) Communication:

- Provide fully functional two-wire RS-485 serial slave communications interface. Serial protocol address shall also be field adjustable and provide support for up to a minimum of 255 devices on each serial multi-drop.
- Communication protocol provided shall be Profibus unless otherwise stated in the tender documents.

(d) Minimum Performance:

These standards are in addition to specific requirements set forth on specific product data sheets provided for each pump.

- Accuracy: < ± 2 % of dose selected
- Suction height: To match installation requirements
- Discharge pressure: To match installation requirements
- Rated Flow: To match installation requirements
- Operating Temperature: 0 to 60 degrees C
- Dosage Range: Motor Driven 20:1
- Solenoid driven 1000:1

(e) Examination of Site

- The contractor is responsible for ensuring the accuracy of the drawings with regards to suitability of the proposed placement of equipment and to make adjustments as required in order to ensure equipment in mounted in accordance with these standards and in conformance with the recommendations of the manufacturer. As such, the following steps shall be followed.
- Examine drawings and perform a site inspection to ensure suitability of mounting location.
- Ensure pumps will be located so that they are readily accessible for operation, maintenance and removal.
- Review appropriate standards and manufacturer recommendations to confirm suitability of proposed installation.
- Investigate the route through which chemical feed lines and signal cables must pass and ensure the suitability of the proposed routes.
- If any problems are identified the contractor shall notify the City before ordering the equipment to minimize cost implications of possible required changes. Costs incurred as a result of rectifying any problems not identified at this stage shall be the sole responsibility of the contractor and shall not result in any extra being paid to the contractor.

(f) Installation

- The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration. Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the pumps.
- The following general installation guidelines shall apply unless the City specifically instructs the contractor otherwise.
- Mount pumps 1.4 m above finished floors, grade or platforms.
    - Do not mount pumps on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
    - Do not mount pumps below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.

- Install the pumps and auxiliary devices (including isolation valves) such that they are accessible for maintenance. Provide space between pumps and other equipment and piping for ease of removal and servicing.
- Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that displays and controls are properly oriented for easy viewing and configuration.
- no charge to the contract.
- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise by the City, ensure installations conform to the manufacturer's installation recommendations.
- Install separate conduits for signal and power wiring to the pump.
- Install shutoff valves so the pump can be removed without process line shutdown. Provide flushing and draining connections.
- Ground the pump in accordance with manufacturer's instructions.
- Where indicated, conduct a factory calibration verification of the pump and provide written certificate. The factory flow test must trace calibration to national or international standards.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed by the City at

PART 13 SUPPORT SERVICES

13.01 Common

(a) General

Suppliers shall maintain, as part of a national network across Canada, engineering service facilities to provide start-up service, emergency service calls, repair work, service contracts, spare parts inventory, maintenance and training of customer personnel.

(b) Delivery, Storage, and Handling

Each manufacturer shall provide and securely attach tag identification numbers, instructions for proper field handling and installation instructions to each item prior to packaging.

- Packaging shall be designed to provide protection against shipping damage, dust, moisture, and atmospheric contaminants.
- All shipping containers shall include a shipping label which contains tag number and description, instructions for unloading, transporting, storing and handling upon arrival at site.
- The Contractor shall provide for unloading, transporting, storing, and handling items at the site, in accordance with manufacturer instructions.
- The Contractor shall inspect all deliveries for damage in shipment and return damaged items to the manufacturer for replacement. It is not acceptable for items damaged in shipment to be repaired; items must be replaced with newly manufactured items. The City is not responsible for any project delays resulting from this, or any other, requirement set forth.
- The contractor shall not store instrumentation or other environmentally sensitive items out-of-doors, but shall provide dry, permanent storage facilities at site.
- The contractor shall restore instrumentation to a clean and like new condition prior to final acceptance. This includes but is not limited to removing shipping stickers, paint splatters, dirt, grease and other contaminants.

(c) Product and Support Availability

The following local support shall be provided for all equipment.

- Replacement electronics, sensors and transmitters must be stocked locally and the stocking location must provide for customer pick up of parts. Locally is defined as within 90km of the facility where the instrumentation shall be installed.
- Mean time to response for a manufacturer authorized service technician to arrive on site for an emergency service call shall be less than 2 business hours.
- All non-stock items shall be available for shipment within 96 hours of notification.

- Replacement wetted parts must be stocked locally, within 150km of the facility where the instrumentation shall be installed.

13.02 Participants and Responsibilities

(a) Contractor

The contractor shall be responsible for the following tasks:

- Gather information and prepare test forms prior to commencing;
- Schedule testing;
- Identify assistance required from City personnel;
- Review schedule with City plant supervisors and adjust schedule based on the City's scheduling requirements;
- Provide labour, material, and protection as needed for participants to access the test locations.
- Certify that the manufacturer's installation instructions have been reviewed and devices have been installed in accordance to those instructions.
- Coordinate testing and ensure testing is witnessed by appropriate City Staff.
- Prepare then present findings and reports to the City.

(b) Manufacturer's Representative

As a minimum, the contractor shall have the Manufacturer's Representative perform the following functions:

- Installation Review and Verification;
- Calibration Verification;
- Maintenance Personnel Training;
- Inspection and final adjustments.
- Operational and functional checks of equipment and spare parts.
- Necessary measurements in order to ensure conformance with all applicable standards.
- Verify general assembly of the equipment, and installation is as specified by the manufacturer, and that wiring, application dependant adjustments, and proper operation have been verified.
- Prepare a signed report verifying all equipment has been installed as per manufacturer recommendations, equipment is properly calibrated, the calibration information matches the product data sheets, and City staff has been properly trained on how to maintain the equipment.
- There shall be onsite support for resolution of all problems which arise during the warrantee period.

The Manufacturer's Representative shall have the following minimum qualifications:

- Five years of experience in installation and maintenance of similar equipment.

- One year's experience in installation, calibration and maintenance of the Manufacturer's products.
- Factory trained by the Manufacturer on the specific product for which services are being provided.

(c) City Staff Involvement

The City shall participate in testing activities at the City's discretion.

- If deemed appropriate by the City, plant staff shall assist in the testing in order to both provide site knowledge, local co-ordination when necessary and perform specific operational procedures. In addition, City staff shall witness all tests.
- This participation does not relieve the Contractor from the specified requirements for testing.
- Recognize and adjust for possible City involvement in developing test procedures and schedules.
- The City will attempt to ensure that participation, other than that which is requested by the Contractor, does not adversely affects specified testing requirements. In order to claim an extra due to the City's staff's involvement in testing all of the following criteria must be satisfied.
  - *The City Management is verbally notified that the City's continued actions could cause delays and advised as to specific action that the City must take in order to avoid the delay.*
  - *The City does not cease with the delay activities within a reasonable period of time following notification.*
  - *The claim is submitted in writing within 24 hours of the occurrence describing the action, the perceived impact and requested compensation.*

All testing shall be performed within 100 km of London City Hall or the contractor shall pay the following costs associated with four representatives of the City attending each test and retest if required.

- Provide single person lodgings for each person at facilities equivalent to Holiday Inn, Ramada Inn, Sheraton Inn or similar chain. Total number of days for each testing period (consecutive test days) shall be based upon the assumption that City staff will have to travel to site the day before any testing and return to London the day following any testing.
- Provide transportation to the factory via commercial air carrier and ground transportation. While at the location of the factory the contractor shall provide a rental car for the use of City Staff furnished by Hertz, Avis, or National OR pay for mileage at the going rate paid to staff by the City of London.
- The City shall choose the method of transportation.
- Provide a per diem meal allowance of $50 per person per 24-hour period or part thereof.

13.03 Testing Schedule

(a) General

The purpose of the testing is to demonstrate under simulated conditions, similar to those that will be encountered once installed, compliance with the specifications and ability to perform as required.

The Contractor is responsible for setting a test schedule which is agreeable to all parties (Supplier, Contractor, Engineer & City) in accordance with the following requirements:

- Testing not to exceed ten consecutive working days;
- Saturday and Sunday work is only allowed with the agreement of all parties;
- Limit testing to eight hours per day including a 30-minute break for lunch and two 15-minute coffee breaks;
- Commence each day with a review of the day's test schedule;
- At the end of the test, document the results of the test including identifying all deficiencies (the City will indicate those deficiencies which must be corrected and retested prior to shipment);
- End each day with a review of the day's test results and revise the next day's test schedule if necessary.
- The testing schedule shall be set not less than two (2) weeks in advance of commencement of testing.
- Before commencement of any testing, all submittals related to the devices and all related devices and component parts must be submitted and all identified deficiencies resolved.
- Within seven (7) days following completion of each series of tests, documented test results shall be submitted to the City for approval and for record purposes.

(b) Approval & Coordination

Submit testing procedures and schedules of work no less than one (1) month prior to the projected test date for the components to be tested. This will include specific dates for each test procedure, and clear identification of plant staff assistance required to complete the field portion of the tests.

- The City, prior to the commencement of any field tests, must approve the schedule and test procedures in writing, in order for testing to proceed.
- The Contractor shall allow some flexibility in the schedule to allow for emergency requests from plant staff, plus unexpected field and operational findings.
- The test reports must be presented one week after completion in order to identify and resolve all critical issues that affect scope, cost or schedule in a timely manner.
- When requested by the City, testing shall be scheduled outside normal business hours to accommodate operating issues and/or low flow conditions.

- The contractor shall coordinate all field-testing for the subsequent day with the City's representative before 4:00 pm on the preceding weekday.
- The City may make changes to the schedule for testing at any time as long as the following conditions are met:
  - *The change does not result in more than a one-hour interruption to the testing to move test equipment and test personnel to the new unit process.*
  - *There is no change in the amount of test equipment or personnel requirements.*
  - *The redirection is not arbitrary. Process operational constraints, personnel availability, and coordination with other work are valid reasons for redirection.*
- No testing that affects plant operation shall commence without City approval.

13.04 Factory Acceptance Testing (*FAT)*

(a) General

The following standard factory tests shall be performed on the equipment provided. All tests shall be in accordance with the latest version of UL, CSA and NEMA standards.

- All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
- All final assemblies shall be tested at full load and all fault conditions to be trapped by integrated protection shall be simulated to confirm effectiveness.
- After all tests have been performed, each device shall undergo a burn-in test under full design load. Following the burn-in test, comprehensive testing shall be performed to confirm that the equipment still conforms to the original specifications.
- As part of the FAT procedures, perform the following test procedures on each UPS.
  - *Switch on the UPS and leave on until batteries are fully charged. Check indicators or displays for proper input power and battery status.*
  - *Test the UPS by disconnecting the input power and check battery and inverter operation and output voltages for proper back-up power.*
  - *Check battery back-up time by connecting the UPS to the prescribed design load and running until the UPS shuts down on low power.*
  - *Restore input power and recharge batteries.*

The City reserves the right to request the testing of any specified function, whether or not explicitly stated in the test submittal.

13.05 Site Acceptance Testing (SAT)

(a) General

- The objective of the pre-commissioning testing to determine that the equipment and systems have been installed correctly and to develop a work plan that integrates the knowledge and intent of the process engineers, design engineers, construction and operations staff.
- The pre-commissioning testing will be used to determine as nearly as practical that each individual component or equipment will operate as intended prior to testing the entire

process as a unit. The equipment shall be operated a sufficient period of time to determine the system operating characteristics (temperature, pressure, steady state flow rates, etc.) and to allow initial adjustment of operating controls.

- The equipment will be broken down into five categories for testing: equipment (pumps, motors, compressors, mixers, hoists, etc.), instruments, valves and piping, basins and channels, filters and chemical feed and storage systems.
- Pre-commissioning testing and associated activities will not be performed on any component or system, until all the manufacturer's inspection reports for the particular component or system have been received and accepted by the City of London.
- Conduct tests in the presence of a City of London representative, except when advised by the City that their presence will not be necessary.
- Include tests and inspection recommended by the equipment manufacturer, unless specifically waived in writing by the City.
- The Contractor shall ensure any damage to equipment or material due to improper testing is restored to original condition with all damaged parts replaced by newly manufactured parts – not remanufactured parts.
- Furnish and use safety devices such as rubber gloves and blankets, protective screens, barriers, and danger signs to adequately protect and warn all personnel in the vicinity of the tests.
- As each component or system is installed, the Contractor and City of London shall inspect it. The results of these inspections and subsequent tests shall be documented in writing on the equipment check out sheets.
- As a minimum, the equipment installation inspections and tests carried out at this stage shall include:
  - Equipment and System Conformance Verification
    - *Verification of conformance to specifications and field requirements.*
  - Pressure and/or leakage tests
    - *Pressure tests will be completed on piping systems. The system shall be pressurized to 150% of the nominal working pressure, but not less than 700kPa, and the test pressure shall be maintained for a period of not less than 2 hours.*
    - *Allowable leakage under pressure shall be nil. The Engineer shall witness the tests and upon successful completion of the test will sign off on the test forms.*
    - *If pressure tests fail, the contractor shall take appropriate measures to rectify.*
    - *Testing will be repeated until a satisfactory test result is obtained.*
  - Resistance tests for electrical equipment and electrical systems.
    - *Electrical equipment and all cables shall be subject to megger testing.*
    - *Uncoupled rotation of all motors checked.*
    - *Overloads verified with electrical motor nameplate ratings.*
- Complete manufacturer's inspections of all mechanical equipment, all Process equipment, all instruments, SCADA System, hoists, and gas detection.
- When testing requires the use of another system such as electrical power, compressed air, control air, or instrumentation, which has not yet been placed in service, the Contractor shall provide alternative sources.

- Do not start-up any equipment, system or facility prior to issuance of a 'certificate of correctness of installation' from the manufacturers or suppliers of equipment and/or systems.
- The testing of a system shall be deemed complete when substantially all of the component equipment, and the system as a whole, have been confirmed to be in accordance with the Contract Requirements.
- The Pre-installation Software Test Report shall be used to identify and manage all outstanding issues in the Pre-installation test, until they are resolved.
- The Field Test Reports shall be used to identify and manage all outstanding issues in the field, until they are resolved.
- Where it is identified that the original contract requirements do not achieve the operational requirements, the Contractor must assist the City in identifying the differences, and will recommend solutions to the City of London, and once approved the Contractor will implement the necessary changes for the process control system to work properly.
- If there are additional costs associated with the recommended changes then the Contractor must identify the costs and receive approval from the City before implementation.
- Where it is identified that the Contract Requirements have not been met, the Contractor will be required to rectify the deficiencies and then retest the entire system including all component parts thereof.
- The Contractor shall organize teams made up of qualified representatives of equipment suppliers, the subcontractors, design engineers, and others, as appropriate, to efficiently and expeditiously calibrate and test all equipment and systems. The objective of the testing program will be to demonstrate to the City of London that the facility will operate as intended.
- The Instrumentation and Controls Integrator shall be responsible for all calibration and control system configuration verification.
- All test procedures shall be submitted for approval by the Engineer at least thirty days prior to start of testing.

(b) Instruments

The following additional testing requirements apply to instrumentation.

- After the instrument is fully installed, (including mounting, process connections, signal connections and power connections) and before the process is put into test mode or actual operation, calibrate the instrument and perform any preventive maintenance recommended by the manufacturer.
- Calibrate measurements over the range of the instrument including zero, full range and three intermediate points.
- Demonstrate alarms by varying process conditions.

- On the Product Data Sheet(s), document the results of calibration and note any settings or adjustments made.
- Check the calibration of each instrument and where necessary, re-calibrate in accordance with City of London directions and the manufacturers instructions.
- Ensure that qualified technicians carry out calibration and commissioning work. If requested by the City, have the work performed by manufactures service representative.
- Irrespective as to who performs the calibration, the contractor shall ensure the field calibration is verified by the manufacturer.
- Adopt calibration method and tools that will not cause greater than +/- 0.5% error in any test. The accuracy of the calibration tools must be traceable to National Standards. The City will review and approve all testing procedures. Electronic calibration equipment shall be used that provides a form of electronic documentation, transferable to a standard spreadsheet format.

The following additional testing requirements apply to instrumentation that does not have a proven history with the City of London.

- Schedule in-situ instrument testing for the process of concern with the selected manufacturer for six month, or longer evaluation period.
- Have in place, or have readily available, a calibration reference instrument, which can be used for comparison to verify accuracy of tested instrument. Record reference instrument output simultaneously with corresponding data of tested instrument, continuously or periodically.
- Record instrument measurements throughout the day during testing. Spot check reference and test instrument measurements daily.
- Whenever possible, secure alternate manufacturer(s) product(s) and test all instruments simultaneously.
- Maintain control of testing without supplier's assistance unless unsolvable problems develop. Have supplier correct any problems immediately and restart testing. Record and file all problems and corrective actions.
- The costs related to testing shall be included in base project cost.

(c) Loop Verification

The intent of loop verification shall ensure that equipment has been correctly connected in order to integrate into the overall facility and to ensure controls function as specified.

Inspect and document that each item matches the reviewed shop drawing. The inspection shall include, but not be limited to the following:

- Verification that instrument product details match shop drawings, contract documents, and device data sheets;
- Confirmation of the soundness of instrument (i.e. no damaged parts);
- Confirmation of the completeness of installation (i.e. no missing components or connections);

- Confirmation of correctness of setting, alignment, and relative arrangement;
- Confirmation that adequate mounting and space is provided for maintenance and operation;
- Inspection of power, signal, and grounding wiring identified on the control schematics;
- Verification of the continuity and polarity of all wiring.

Devices that generate an analog signal shall be tested for their repeatability, accuracy and operation by varying the process and simultaneously measuring and recording the information displayed by:

- An independent measuring instrument;
- The local transmitter indicator;
- All remote digital/mechanical indicators;
- The 4-20mA (or digital value) measured at both RPU panels' and operator panels' terminal blocks and converted into engineering units;
- RPU analog input range;
- Displayed status at the SCADA level.

Instrument switches, such as pressure switches or building flood alarms, shall be tested for their accuracy and operation by varying the process conditions (for example: high then low pressure) and simultaneously measuring and recording the information displayed by:

- An independent measuring instrument;
- The instrument switch;
- All remote lights and indicators;
- The digital input status measured at both the RPU and operator panels' terminal blocks;
- RPU discrete input settings;
- Displayed value at the SCADA level.

Test control devices such as modulating/motorized valves for their accuracy and operation by varying the hand switch positions, and modulating analogs from the RPU control panel terminal blocks to simulate RPU outputs, and triggering field interlocks while measuring and recording the control device operation and indications from:

- Independent measuring devices and/or visual inspections;
- The local indicators and lights;
- All remote indicators and lights;
- The analog and digital signals measured at the RPU panel terminal blocks. Where applicable convert the values into engineering units.

Test control circuits and power wiring related to mechanical and process equipment such as pumps, blowers, and clarifier mechanism for the correct function and the associated safe operation. Conduct tests by varying the hand switch positions and modulating analogs from the RPU control panel terminal blocks to simulate RPU outputs, and

triggering field interlocks while measuring and recording the control device operation and indications from:

- Independent measuring devices and/or visual inspections;
- The local indicators and lights;
- All remote indicators and lights;
- Ability for RPU to turn device on and off;
- The analog and digital signals measured at the RPU panel terminal blocks. Where applicable, convert the values into engineering units.

Individually test all field wiring and mechanical interlocks identified on the control schematics to confirm the device properly stops and cannot be restarted until the condition clears.

Compare test results against standards, specifications, the detailed process narrative operating description, control logic drawings, equipment shop drawings, control schematics and power drawings and RPU output/input voltages and ranges. Verify conformance.

(d) Communication Cable Tests

Provide complete records indicating termination locations, cable type, cable length, DC resistance, continuity, near end crosstalk (NEXT) and steady state noise. Verify and document category/level performance for all cables, end to end, including terminations and patch and room cables.

Upon receipt of the test document, the City of London reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. City of London testing will use the same method employed by the Contractor. Minor variations will be allowed to account for differences in test equipment. This extra testing shall be done under the supervision of the installing Contractor and shall not invalidate the system warranty in any way.

If significant discrepancies are found the Contractor will be notified and shall replace the link in its entirety.

(e) Sub-system Level Commissioning

Sub-system testing is intended to ensure that each subsystem is fully functional and ready for integration into the overall operations. As such, field-testing shall be performed sequentially organized by plant area and by unit process within each area.

- The intent it to ensure that all component parts which make up a given unit process, including all related I/O wiring, will function as per specifications.

Meet the following conditions prior to the start of this phase of testing:

- Correct deficiencies noted during prerequisite tests;
- Provide operations manuals pertinent to the sub-system being tested;

- Complete operator training pertinent to the sub-system being tested;
- Have on site, labelled, and properly stored, spare parts, expendables and test equipment pertinent to the part of the system being tested;
- Recompile, re-list and reload, from supplied source code, programs which are source code and compiler dependent;
- Provide calibration certificates for all instruments.

Once the Pre-commissioning Activities have been completed to the satisfaction of the City of London, individual sub-systems shall be started and operated under a variety of simulated operating conditions.

- These tests shall be performed with the equipment and systems operated in the manual mode.
- Prior to functional tests set alarm limits, timers and control settings and tune regulatory control loops to produce stable control. Use a loop tuning software program for calibrating and documenting loop performance.
  - *For conventional control loops for PI and PID control, use minimum ITAE (Integral of Time and Absolute Error) criteria with overshoot constrained to 10 percent unless otherwise directed by the City.*
  - *Utilize averaging control for liquid level and gas pressure in storage vessels unless otherwise directed by the City.*
  - *Provide reduced gains or filtering to minimize unnecessary output activity to electric actuators as directed by the City.*
  - *Adjust input scan time or time intervals between controller calculations as necessary to produce stable control.*
- Check each function and control strategy defined in the process narrative to ensure that the requirements are met as defined.

Testing shall begin immediately after installation of each major subsystem. A subsystem is an integrated, fully operational subset of the operation including all necessary control equipment to function independently. Testing shall include:

- PLCs programs and I/O controlling subsystem;
- Local Operator Interface (e.g. DataPanel);
- Integration into City SCADA;
- Communication equipment required for operation of the subsystem;
- Field instruments, panels, termination cabinets, control devices and related interconnections for the plant area.

The Contractor is responsible for proper protection of instruments and devices that could be damaged by tests. If damages occur, the contractor shall replace the damaged parts and/or components.

The contractor shall make available for City's use control strategies that have been verified to operate properly immediately subsequent to conclusion of the respective test.

When testing requires the use of another system such as electrical power, compressed air, control air, or instrumentation, which has not yet been placed in service, the Contractor shall provide alternative sources at their cost.

Perform all tests and calibration procedures by following the operation and maintenance manuals word-for-word unless approved otherwise by the City. Lack of complete, detailed manuals will be cause for declaring the test to have failed regardless of the actual test results.

(f) System Level Commissioning

- Integrated system testing will occur once the individual sub-systems have been thoroughly checked. The integrated system testing is the "first fill" for chemicals and "wet test" for basins.
- The integrated system will be operated initially, as practical as possible, in manual mode to ensure that it operates successfully as a complete system.
- Once Facility Commissioning has been completed, all rotating equipment shall be inspected for proper alignment and balance as indicated by the manufacturer. If equipment does not meet the specified alignment and balance requirement, it shall be realigned and balanced. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. All deficiencies shall be corrected to the satisfaction of the City of London.
- The facility will be operated as a complete unit as intended in the original design during this period.
- As a minimum, Integrated System Testing shall demonstrate the following:
  - *All high level strategies ensuring that the requirements, as defined in the process narrative and contract documents, are met as defined;*
  - *All data transfers to the database and other applications, ensuring that the requirements, as defined in the process narrative and contract documents, are satisfied;*
- Real field inputs and outputs will be used in testing. When not possible, I/O will be simulated at the lowest possible control element location.

13.06 Operational Availability Demonstration

(a) General

- Following completion of the Integrated System Testing, the Operations Availability Demonstration (OAD) phase will begin. This phase shall prove that the systems will perform the function for which designed.
- The OAD phase will run for thirty (30) consecutive days without unwanted interruption in service. After each unwanted interruption, the OAD period shall restart. Unwanted interruption is defined as any interruption that can be attributed to the equipment supplied by or work performed by the contractor.

- During the OAD period, the system will be operated in the mode described within the control philosophy as the normal day-to-day operating mode. Its purpose shall test the overall system stability and ability to meet design criteria.
- During this period deficiencies may arise which were not identified during field-testing. All such deficiencies must be addressed before the end of the OAD period. The OAD period will be increased beyond 30 days if required in order to provide adequate time for the Contractor to resolve these problems.
- Following the OAD period, the City will issue a letter confirming full compliance with all design requirements has been achieved.

(b) London Staff Involvement

- Although the City of London will assist in operating the system during this period, the operation shall still be performed under the operating license of the contractor and/or designer as the system has not been accepted by the City.
- The Contractor shall provide a supervisor and skilled labourer familiar with the equipment to assist the City of London during this period to assist with start-up and testing.
- City of London usage will not reduce the availability requirements unless the usage is in a manner contrary to documentation instructions and normal operational practice.

(c) Notification of Failure

- Furnish and post as directed by the City of London, the location and telephone number of the service personnel. Provide a paging service such that support can be controlled 24 hours per day, 7 days per week.
- For cases where the designated telephone is busy, inoperative, or did not answer, it will be retried every 15 minutes for the first hour and no less frequently than once per hour thereafter.
- Do not make a temporary substitution of an alternate location or telephone number for notification except upon written notice at least three working days prior to such substitution.

(d) Correction of Failure

- Upon notification of a failure, diagnose and repair or replace the failed equipment or software. Provide parts, material and labour necessary to return the equipment to operation.
- To assure that the demonstration is representative of normal operating conditions, use only the test and maintenance equipment that is furnished as part of this Contract. Use maintenance procedures set forth in the operating and maintenance manuals.

13.07 Supplies and Parts

(a) General

The following general requirements are in addition to any requirements set forth within specifications for specific items.

- Maintenance materials, special tools & spare parts shall be provided along with appropriate storage containers for protection both during shipment and for permanent storage onsite until such time that the items are required.
- Contents of all storage containers shall be clearly indicated on the exterior including the following:
  - *List of contents (item description, purpose, manufacturers part number);*
  - *Identification Tag Reference for the system(s) for which the items are applicable.*

The main logic board, keypad and power supply modules for each device shall be supplied as spares, one for each different part number supplied.

(b) Instrumentation

The following parts and supplies shall be provided along with the instrument.

- Two (2) year's supply of all consumables and parts required for the regular operation and manufacturers recommended servicing of the equipment supplied.
- One (1) full set of maintenance equipment for every ten (10) product items or part thereof, together with instruction manuals, carrying/storage cases, unit battery chargers (where applicable), special tools, calibration fixtures, cord extenders, patch cords, and test leads, necessary for calibration, field maintenance, and routine operation of the equipment supplied.
- One (1) complete set of manufacturer's recommended spare parts for every ten (10) product items or part thereof supplied.
- One (1) spare set of cables with mating connection between the sensor and transmitter for every ten (10) product items or part thereof supplied (cable length provided shall be such as to allow the cable shall be used for the longest cable run installed).

(c) Use of Spares and Consumables

- All spares and consumables used during the OAD and warrantee period shall be replenished by the contractor within 10 days of use, ensuring a full set of spares and consumables for the plant following the end of the warrantee period.

13.08 Warranty

(a) General

- Warranty to cover all systems and component parts including, but not limited to, materials, workmanship and installation for a period of two (2) years following commissioning.

- During the warranty period defective components shall be replaced at no additional cost within five business days of receipt of defective component. Replacement components shall be new parts – remanufactured components are not acceptable.

(b) Warranty – Communication Cabling

The following provisions are in addition to general warrantee requirements.

- The cabling system shall be backed by a 15-Year Performance Warranty.
- A structured cabling system shall be provided which is Certified and Warranted by the Manufacturer. The performance warranty shall be facilitated by the Contractor and be established between the City of London and the manufacturer.
- The contractor shall maintain current status with the cabling system manufacturer, including all training requirements, for the duration of the Project.
- The Contractor shall staff the project with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the 15-Year Permanence Warranty requirements.
- After installation, the Contractor shall submit all documentation to support the warranty requirements in accordance with the manufacturer's warranty requirements, and to apply for the 15-year warranty on behalf of the City of London.
- The warranty will cover the components and labour associated with the repair/replacement of any failed link within the warranty period.

(c) Warrantee - Instrumentation

Instrumentation shall be warranted to maintain the rated total accuracy for a period of not less than 5 years.

PART 14 DOCUMENTATION

14.01 Common

(a) General

The following general requirements apply to all submissions unless specifically directed otherwise by the City.

- The contractor shall provide a list of all drawings and documents that shall be completed by the contractor within fourteen (14) days of contract award. The list shall include title and proposed submission date. The contractor shall update this index during the project whenever submission dates and revision numbers change.
- Five (5) hard copies shall be submitted of all information intended for review and/or approval. Sheet size is not to exceed 280 x 432 mm
- Documents are not to use external references (e.g. drawings are to contain title blocks; documents are to contain all graphics).
- All document submissions, unless otherwise directed by the City of London, shall be accompanied by copies of the originating electronic files in editable native format (i.e. without password protection). The originating format shall be Microsoft Office, Microsoft Visio, or AutoDesk AutoCAD.
- Electronic copies of all final drawings and documents shall be submitted on CD-Rom. The CD-Rom shall contain copies both in native and in Adobe PDF format.
- Provide a total of 5 copies of the CD-Rom shall be provided.

14.02 Drawings

(a) General

The following general requirements apply.

- **Until acceptable "construction mark-up" drawings have been submitted and approved, the contractor shall not be eligible to claim for substantial completion.**
- The contractor shall maintain two (2) sets of project record drawings upon which the contractor will record accurately all deviations from the Contract Documents. Changes shall be indicated in red ink. In addition to deviations, record the following information:
  - *Depths of all buried elements of the foundation.*
  - *Horizontal and vertical locations of underground utilities and appurtenances referenced to permanent surface improvements.*
  - *Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the structure.*

- The "for construction" drawings which will be provided by the designer as part of the "for construction" drawing set will typically include the following:
  - *Site Plan*
  - *Plan Drawing(s)*
  - *Device Removal Plan(s)*
  - *Process and Instrumentation Drawing(s)*
  - *Single line Diagram(s)*
  - *Wiring & Electrical Plan(s)*
  - *Cable and Device Schedule(s)*
  - *Mechanical Plan(s)*
- The contractor shall generate the following drawings as part of the scope of work:
  - *Loop Drawing(s)*
  - *Shop Drawing(s)*
  - *Panel Drawing(s)*

14.03 Loop Drawing(s)

- Develop in accordance with ISA S5.4 format and show the information called for in the Standard and City of London Automation and Control Design Requirements.
- Include itemized instrument wiring drawings for all analogue process loops and discrete connections. As a minimum incorporate the following details:
  - *Analog instrument signal, analog control loop wiring, and wiring termination in junction boxes and panels.*
  - *PLC terminal numbers, Control Cabinet terminal numbers, field terminal numbers, wire numbers, contact orientation, power source identifications and equipment numbers.*
  - *Identify cables, cable wires and colours, terminal strips, terminal numbers, grounds, shielding and input/output point power sources.*
- Show information for items supplied by others that are necessary for completion of loops.

14.04 Shop Drawings

(a) General

The following general requirements apply to all shop drawing submissions:

- Shop Drawings shall be submitted and approved prior to the ordering of equipment. The contractor is responsible for ensuring that shop-drawing submissions are coordinated as required in order to ensure that the submission and review process does not negatively impact the overall project schedule.
- Shop drawings for each package system, along with all component parts thereof, shall be submitted as a single submission. Incomplete submissions will not be reviewed. Delays resulting from incomplete submissions shall be the responsibility of the Contractor.
- Each shop drawing shall be signed by the Contractor certifying approval of submissions, verifying field measurements & confirming compliance with the specifications.

- Shop drawings submitted shall be stamped by the contractor as either "COMPLIES EXACTLY WITH SPECIFICATION" or "DEVIATES FROM SPECIFICATION".
  - *In the latter case, deviations shall be described exactly and shall indicate how they impact the specified duty of the component.*
  - *In the former case, the specification shall have precedence over approved vendor drawings if a deviation is later discovered. The contractor shall rectify the deviation to the City of London's satisfaction at no additional cost.*
- The City's review of these documents does not relieve the contractor of the responsibility for addressing any errors or omissions irrespective as to whether these where caught during the review process.
- The contractor shall be responsible for revising and resubmitting for approval any drawings that the City identifies during the review as having deficiencies.
- Shop drawings shall be resubmitted for approval if any of information on the original submission should change following the submission. A written letter detailing the reason for resubmission shall accompany any such resubmission.

(b) Product Samples

Where applicable, shop-drawing submittals shall include product samples.

- Samples shall be of sufficient size to determine suitability for proposed application. Quality, finish, colour, pattern and texture shall be evaluated.
- Once reviewed and accepted as part of the shop drawing review process, these samples will form a minimum allowable benchmark for completion of all subsequent work.

(c) Submission Content

As a minimum each submittal shall include the following for each device.

- Covering letter providing the following
  - *Date*
  - *Project title and number*
  - *Submittal number (submittals shall be numbered sequentially)*
  - *Revision number*
  - *List of all drawings making up the submission*
  - *Completed equipment data sheets where applicable*
- An itemized quotation from the proposed instrument or equipment vendor (prices removed), including full description, fabrication details, tag numbers, quantities, options, specifications (e.g. weight, capacity, etc.), typical installation schematic, wiring diagram and performance characteristics. All information shall be provided in SI units.
- Data sheets and catalogue literature edited to indicate specific items provided.
- Installation details depicting mounting assemblies, physical dimensions, field dimensions (including clearances in relationship to adjacent work), base plate details, and process connection sizes (e.g. flange ratings & styles).

- Termination details clearly indicating the type and lengths of external wiring required and electrical connections.
- Power supply rating, input and output signal ranges, maximum measured process range and calibrated scale, physical, electrical and environmental requirements.
- For pumps, compressors & blowers (including ventilation fans), performance curves including capacity, head, efficiency, kW and SPSH from shut-off through the rated range to run-out.
- Complete listings of all programs for package systems that use programmable controllers with detailed rung comments describing the exact function of each logical set of rungs along with complete listings of all IO with detailed descriptions of each point.
- Exact catalogue model numbers for each piece of equipment and its accessory options, and clearly referenced by the respective instrument or equipment tag name given in this document (improperly tagged items shall be rejected).
- Detailed circuitry and schematic diagrams (failure by a manufacturer to provide this information will automatically result in the rejection of the submission).
- List of manufacturers recommended list of spare parts including individual pricing.
- Statement of conformance to all applicable standards along with a list of those standards.
- Written confirmation from the manufacturer of each product stating that it is a current product and that it will be supported (spare parts, software drivers, service, etc.) for a period of not less than 5 years from the date of purchase.
- All other information specifically requested by the City.

14.05 Panel Drawing(s)

(a) General

Panel drawings shall be submitted and reviewed before panel components are ordered. The submittal shall include the following:

- Scale drawings showing the following.
  - *Location of all face-of-panel mounted devices.*
  - *Elementary control wiring and terminations.*
- Legend listing and identifying face-of-panel devices by tag numbers, nameplate inscriptions, service legends, and enunciator inscriptions.
- Listing of all devices and components mounted within the panel including the tag number (where applicable), description, manufacturer, and complete model number.
- Individual shop drawings for each component part as per terms set forth under General Shop Drawing Submittals.
- Instrument loop diagrams, based on the P&I drawings and panel elementary diagrams, similar to and developed from the contract drawings showing the following.

- Analog signals, panel power distribution, and ancillary devices such as relays, alarms, fuses, lights, fans, heaters, etc.
- Individual circuits and components.
- Panel terminal and wire identification numbers.

- Provide power requirement and heat dissipation summary for each panel. State required voltages, currents, phase(s) and maximum heat dissipation in Btu/hr.
- A table of deviations for each control panel as an entity identifying all regards with which the panel does not meet the requirements set out within these standards.
- Data sheets stating specific configuration information such as ranges and options.
- Provide a device list, grouped by device type, for each panel. Include the complete manufacturer's part number, including option designations.

(b) Shop Drawings for Panel Modifications

Panel drawings shall be submitted and reviewed before panel components are ordered. The submittal shall include the following scaled drawings showing:

- A listing of devices which shall be mounted on the existing panels, including the panel identifiers, and panel location designation. Include the tag number, description, manufacturer, model number, and specification data for each device.
- Face of panel mounted devices, including legend detail and materials description.
- Panel modification elementary control wiring. Show actual wiring and actual terminations for each pilot control circuit modification.

14.06 Product Data Sheets

(a) General

Provide completed product Data Sheets specifying instruments and equipment conforming to ISA specification sheet standards. Complete the sheets with the information noted below and any other data pertinent to the equipment and the application.

- Use the product data sheet for documenting installation and testing.
- Include the following upon initial Submission (to accompany Shop Drawings):
  - *Project name.*
  - *Tag number and description.*
  - *Manufacturer, Model and Part Numbers.*
  - *Identification Nameplate details.*
  - *The product manufacturer and the supplier or representative*
  - *The complete model or catalogue number(s) including any special options*
  - *The available adjustment range(s) and the project operating range(s)*
  - *Web link for each product manufacturer*
- On each sheet, add the following information following field calibration:
  - *Serial numbers.*

- *Date of installation.*
- *Date, time and person who performed calibration.*
- *Calibration data:*
    - Input, output, and error at 0, 25, 50, 75, and 100 percent of span for analog instruments;
    - Switch setting, contact action, and dead band, for discrete elements.
- *Certification by installer and acknowledgment by contractor.*
- *Calibration data.*
- *Special procedures and equipment required to duplicate calibration.*
- *Comments, including any calibration changes, repair or replacement works performed.*

- Add the following upon final submission (immediately following site acceptance):
    - *Signature by the Contractor and the manufacturer indicating acceptance.*
    - *Phone and fax numbers of contact person for product support/service.*

14.07 Testing Documentation

(a) General

A detailed test plan will be developed with sufficient information in order to serve as a guidance document for the system start-up. The plan is to include contingency plans for each critical unit if testing should fail and proposed test schedule. The plan shall be provided to the City within thirty (30) days of award of contract.

The Contractor shall also provide standardized test report forms to be used by the City for approval. The Contractor shall incorporate suggested modifications then shall use the templates for the recording of all pre-installation and field-testing. The test report forms shall be submitted not less than two (2) weeks prior to the date of the first test.

Completed Testing Report(s) – Present the findings in an electronic and printed report which contains as a minimum:

- Test reports shall be completed by the Contractor at the time of testing and witnessed by the City Contract Administrator or their representative.
- Scope of the Specific Test(s);
- Specific Objectives;
- Date of test(s), person performing test(s), description of item tested (including manufacturer, model number and serial number)
- Summary of Outstanding Issues
- Completed test forms including description of tests performed, as an appendix.
- Recommendations on improvements or upgrades to Contract scope in order to approve operations. Identify cost of installation(s) for all recommended improvements.
- Within one (1) week following completion of tests, copies of the test reports shall be submitted to the Engineer and the City.

(b) Pre-testing Documentation

The following documents shall be completed and provided to the City prior to pre-installation testing.

- Preliminary Process Narratives;
- Reviewed and accepted shop drawings, for each piece of equipment;
- Reviewed and accepted "For Construction" P&I Drawings, control schematics, mechanical and electrical drawings.
- Prepared equipment test report forms with all equipment numbers, loop numbers and relevant details entered.

The following documents shall be completed and provided to the City prior to field-testing.

- Reviewed and accepted Process Narratives;
- Reviewed and accepted Control Program Listings;
- Pre-installation test report;
- Reviewed and accepted Calibration forms;
- Reviewed and accepted Operations and Maintenance Manuals;
- Prepared equipment test report forms with all equipment numbers, loop numbers and relevant details entered.

14.08 Maintenance and Operation Manuals

(a) General

Maintenance and Operation manuals must be completed prior to field calibration and testing. Calibration and testing shall follow the procedures set forth in the operation and maintenance manuals word-for-word, unless approved otherwise by the City. Lack of complete, detailed manuals will be cause for declaring the tests to have failed regardless of the actual test results. Substantial performance will not be granted until these manuals are complete and have been accepted by the City.

The maintenance and operations manual shall be divided into the following volumes.

- Volume 1 – Plant Operating Manual
- Volume 2 – Electrical & Instrumentation
- Volume 3 – Mechanical Operations & Maintenance
- Volume 4 – Architectural & Structural

The designer (i.e. Engineer) will provide portions of the information to be included in Volume 1 in electronic format to the Contractor. If it is unclear as to exactly what information will be provided by the designer and what information is to be provided by the contractor, the contractor is responsible for obtaining clarification because the contractor is responsible for all information not provided by the designer. The Contractor shall be responsible for the physical generation of all volumes.

Volumes 2 & 3 shall be divided into separate sections for each item (both new and existing) denoted on the projects P&I drawings. The contractor shall be responsible for collection of all material for both new and existing equipment necessary to complete the manuals. At the beginning of each section, an index shall be provided listing each piece of information provided for the item in order of appearance. As a minimum, the following information will be provided for each item:

- The sections within each Volume shall be arranged in a logical, concise manner consistent with the Construction Specifications Institute Master Format. In the front of each manual the following information shall be provided:
  - *Master Volume Index (including breakdown by item within each division);*
  - *Table of all Contractors and Suppliers for the project identifying contact information (name, postal address, email address and phone number) and services provided.*
  - *For Volumes 2 & 3, a cross-reference table shall be provided relating each section and sub-section to the applicable devices by tagname.*
- Training documentation.
- Calibration procedure and frequency.
- Calibration certificates from the manufacturer for each calibrated instrument.
- Device specific performance curves and copies of all associated test data.
- Final Shop Drawings and Product Data Sheets. Include the following additional information, which may or may not have been included at the time of the shop drawing review.
  - *Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items and parts lists.*
  - *Spare parts list, expendable materials and suggested quantities of each to maintain on hand.*
  - *A required and optional accessory lists.*
  - *Methods and materials required for installation.*
- Systematic procedures for operations personnel to start up, shutdown, manually override and locally operate all devices.
- Copies of Record drawings for all purpose-made drawings including:
  - *Electrical/pneumatic signal and power connection diagrams showing power & signal connection details.*
  - *Mounting details for all typical installation requirements and special details for non-typical applications.*
- Copies of manufacturers operation and maintenance information including all special instructions and procedures, including comprehensive trouble-shooting techniques and recommended maintenance intervals.
- Details regarding all other design elements, construction features, and component functionality necessary to ensure effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.

(b) Binding of Manuals

The Contractor shall be responsible for providing (5) five complete sets of bound manuals. The information shall be bound in heavy weight black fibricord expandable spine stainless steel hinged letter sized catalogue binders with spine width not to exceed 150mm. Lettering shall be embossed on the fibrecord in white with the following information printed on the front.

- Name of Project (e.g. Greenway Plant Expansion)
- Name of Manual (e.g. Plant Operating Manual)
- Name of Contractor (e.g. ABC Construction)
- Name of Engineer (e.g. XYZ Consulting)
- Date (e.g. May 2001)
- Volume (e.g. Volume 1)

The following information shall be printed on the spine.

- Name of Project (e.g. Greenway Plant Expansion)
- Name of Manual (e.g. Plant Operating Manual)
- Date (e.g. May 2001)
- Volume (e.g. Volume 1)

If multiple binders are required for a given volume, the binders are shall be numbered "Volume N – Part# of X" where X is the total number of binders required to include all the volume's information. (e.g. Volume 2 – Part 3of 5)

Each section within each volume shall start with a divider of card stock, with laminated index tabs that are numbered and colour coded to match the index. An additional card stock separator sheet without index tab shall be provided at the front and back of each binder.

Each volume shall include a comprehensive bibliography and glossary.

Each set shall include only original product literature and laser printed copy, not photocopies. Printed copy shall incorporate colour wherever the use of colour improves the appearance or the ease of understanding of the material (for example, colour coding of single line drawings).

All printing shall be on high quality low acid 24lb bond paper. All material shall be printed either on a laser printer or on an offset printer.

Before generating the manuals, the Contractor shall submit a sample index complete with suggested colour coding for approval. The City will review the sample and provide feedback within two weeks. The contractor shall incorporate all requested modifications.

PART 15 TRAINING REQUIREMENT

15.01 Common

(a) General

It is the responsibility of the Contractor to coordinate all training as set forth under the terms set forth within this document.

All training must be complete prior to application for a Certificate of Substantial Performance of the Work.

(b) Content

The Contractor shall develop an individualized training plan for the project. The plan shall be focus on operations, maintenance and support needs. Once developed, the City will review the training plan to ensure that everyone's needs are met. The contractor shall revise the training plan as required in order to address all identified deficiencies.

The system operation and maintenance manual data shall be used as the basis for demonstrations and instructions.

The training program shall address the following:

- Remedy deficiencies in skills or knowledge to competently perform tasks described in the O & M manual;
- Instruct maintenance and operations staff, and any other interested parties approved by the City of London, in the changes to the maintenance and operational procedures resulting from the project (emphasis will be on their job functions as they pertain to executing the appropriate maintenance and operational procedures);
- Inform management as to the systems capabilities to perform functions and provide information;
- Inform and instruct personnel in appropriate safety procedures.

Prior to developing the training programs, an analysis of the intended training goals and objectives will be carried out with the appropriate City of London Management Staff.

(c) Format

The contractor shall provide instructors and instructional material, including trainees' handouts, instructor's guides, training aids, equipment and system technical manuals necessary for training the following training criteria shall apply;

- All training shall be done on-site unless otherwise agreed to by the City of London. All costs incurred by City Staff to attend off-site training for meals, accommodation, etc. shall be borne by the Contractor.
- The contractor shall make all necessary arrangements to use the City of London's facilities for courses held on-site.

- Repair or replacement failed or damaged equipment used during training.
- Provide all necessary equipment required for training. If training consists of a hands-on component, provide adequate hardware such that no more than two students need to share equipment.
- Training shall be competency (objective) based.
- Include clearly defined objectives for each training course.
- At the end of each course, assess how well each student met the course objectives. For students who have not met the objectives, detail areas of weakness.
- If the City finds that a majority of students are lacking in certain skills, repeat that area of training at no additional cost to the City.
- Use full-time instructors for each course. Ensure that the instructor does not perform other duties that will interrupt instruction during this period.
- Mix formal instruction with hands-on operation of the equipment. The division of time between formal instruction and hands-on practice shall fall within the ratios of 1:1 and 1:2.

Be aware that not all staff will be able to obtain during a single timeslot as certain staff work shift work and the City may need to withhold staff from training to perform critical operating tasks. As such, it is up to the contractor to repeat sessions as necessary in order to provide training to all staff.

Provide individual follow-up training to each student.

- Hold follow-up training approximately 30 days after initial training.
- Include the use by the instructor of a check-off form to verify operator comprehension and proper use of the system.
- Provide additional emphasis or retraining for areas of weakness.
- Allow time for questions and answers.

Submit signed attendance sheets for each training session.

(d) Submittals

Within 30 days of award of contract the following information shall be forwarded to the City for review and comment.

- A course syllabus for each course in the program.
- A training schedule for each course.
- Name of Proposed Instructor.
- Instructor qualifications.

Thirty days prior to scheduled training, submit detailed course outline, detailed instructor notes (minimum one page for each 30 minutes of training or part thereof), copy of each handout, daily training schedule, daily training objectives and all training materials. No training session shall be conducted without these documents being approved by the City.

One (1) week prior to each training course provide an adequate number of all handouts for each participant to receive a copy.

(e) Quality Assurance

The Instructors primary job function for the firm for which they work shall be the provision of training and end customer technical support. Instructors must be certified as professional adult educators. The contractor shall not use programmers, analysts or system engineers as trainers unless these individuals are specifically trained as instructors and routinely act in this role.

Provide comprehensive training sessions by manufacturer's representative for each instrument type. Provide separate single training sessions for operations and maintenance.

15.02 Operations Training

(a) General

Operations training will be provided to staff that will be using the system to perform their daily duties. The objective of this training shall be to provide the staff members with the following:

- A complete understanding of all the control strategies and how they are implemented within the process control system.
  - *Process definition and understanding.*
  - *Objective of the control strategies and how this objective is accomplished.*
  - *Operator interactions required to accomplish the objectives.*
- Understanding of basic instrument calibration and analysis.
  - *Understanding of the methods used to calibrate the different instruments provided.*
  - *Understand how to evaluate if a device is working properly.*
- A complete understanding of the use of the operator interfaces (these may include wired control panels, electronic device control panels, etc.).
  - *Complete understanding of how to navigate through the application screens.*
  - *Complete understanding of user interface functions including log-on, log-off, password protection, report printing, display navigation, display types and information presented on each display type.*
  - *Complete understanding of how the information is derived, when it is presented incorrectly and the use of guidelines to differentiate between software and hardware problems.*
  - *Complete understanding of how to use the operator interface to provide the operator input required to control the process.*
- A complete understanding of how to use the alarm handling system.
  - *Complete understanding of the process condition that causes each alarm.*
  - *Complete understanding of viewing, acknowledging, logging, and prioritizing alarms.*
- In RPU based systems, understanding of basic RPU system troubleshooting and analysis.
  - *Understanding of basic system components and their purpose.*
  - *Understanding of basic failure indication.*

15.03 Maintenance Training

(a) General

Maintenance training will be provided to Staff that will be responsible for maintaining the system. The objective of this training shall be to provide these staff members with the following:

- A complete understanding of all the control strategies and how the process implements them.
  - *Process definition and understanding.*
  - *Objective of the control strategies and how a strategy is accomplished.*
  - *Operator interactions required to accomplish the objectives.*
  - *Understanding of all system components and their purpose.*
- A complete understanding of equipment & instrumentation provided.
  - *Understanding of each item and its purpose.*
  - *Ability to fully configure and calibrate each item.*
  - *Ability to perform all maintenance activities, both scheduled routine maintenance and breakdown maintenance.*
  - *Ability to backup and restore all configuration information.*
- Where intelligent devices are interconnected by communications bus (e.g. RS-485 or Ethernet), provide training on communications and networking. Course participants to come away from the course with:
  - *Understanding of system components and their purpose.*
  - *Understanding of network analysis software.*
  - *Understanding of the configuration and how to analyze and modify it.*
  - *A complete understanding of the access control functions and password administration.*
- Where a RPU is provided, provide training on the PLC system. Course participants to come away from the course with:
  - *Ability to back up, archive, and restore all programs.*
  - *Ability to maintain and configure the RPU.*
  - *Ability to troubleshooting and analyze the RPU system, understanding failure indications and optimize operation.*
- Where an operator interfaces are provided, complete understanding of the interfaces.
  - *Understanding of how to navigate through the application screens.*
  - *Understanding of user interface functions including log-on, log-off, password protection, report printing, display navigation, display types and information presented on each display type.*
  - *Complete understanding of how the information is derived, when it is presented incorrectly and the use of guidelines to differentiate between software and hardware problems.*
  - *A complete understanding of how to configure the operator interface to provide the operator input required to control the process.*
  - *Ability to backup and restore all configuration information and software components.*
- A complete understanding of how to maintain and modify the alarm handling system.
  - *Complete understanding of the process condition that causes each alarm.*
  - *Complete understanding of how alarms are generated, configured, and displayed.*

- Where the system interfaces with a SCADA system, complete understanding of the functional interrelationships.
  - *Ability to trace information through the SCADA system back to the originating RPU.*
  - *Understanding of the device communication configuration and how to diagnose analyze and modify.*

PART 16 APPROVED VENDORS

16.01 Common

(a) General

The City of London has standardized on a limited number of vendors and products in order to reduce maintenance and support costs. Products may be added or removed from the approved list at any time for any reason by the City.

Inclusion of specific vendors and models were based upon product information available at the time the product category was most recently reviewed. Since manufacturers may from time to time change product specifications without notice, inclusion herein does not absolve bidders from ensuring products provided shall conform to all applicable City of London Standards.

Device types that are currently under review have been indicated as "… – Special Approval". Although these products may be used in certain circumstances, written consent from the City of London is required in advance of tendering. If approval is granted, the approval will state approved vendors, minimum allowable specifications, and terms under which approval has been granted.

If the Contractor has any reservations regarding the use of a given product listed, either with regards to the product itself being able to meet the requirements for a given application or potential project delays resulting from it's use, the Contractor shall raise these concerns at the time of Tender.

(b) Application

These lists are intended to be project independent. As such it is the responsibility of the contractor to ensure that the products and vendors listed can meet the requirements of the project and remove suppliers where necessary. The removal of a product may be required due to a multitude of reasons; however the most common factors are as follows:

- The model listed will not meet the requirements of a specific installation. For example, a project requires Profibus and the supplier only offers Modbus.
- The vendor is unable to meet the required delivery schedule. The bidder shall consider "quoted delivery time frame" and recent experience with the vendor as vendors may on occasion have known delivery problems which may be know by the contractor but not known by the City.

At times, this may require the provision of an alternate product not currently listed within this standard if the listed products no longer meet the requirements set forth under applicable standards. Under this circumstance the contractor shall notify the City before tender close for approval to substitute an alternate. The City may at its option approve the alternate, require a different alternate or wave the criteria which the current vendor does not comply with.

Although not specifically listed, scope of work shall include provision of all component parts required to mount and operate the products in accordance with manufacturer's recommendations and applicable City Standards.

On any single project a single manufacturer shall provide all equipment of a given type. Bidders shall ensure that the same manufacturer provides all parts related to the device (including cable, mounting hardware, filters, signal converters, etc.).

(c) Equivalent Product Substitution

In order for the City of London to accept an alternate product as equivalent, any or all of the following requirements may be required as determined appropriate at the time of review by the City of London.

- The Vendor must arrange for the product to be installed at a City of London facility for evaluation and testing for a period determined by the City of London (typically 4 weeks).
- The Vendor must provide a minimum of five (5) reference contacts where the products have been installed under similar conditions and have been in service for a period of time as defined by the City of London (typically 3 years). The references provided must all recommend the product without qualifications for the application proposed.
- The vendor must prove the product proposed is equivalent to the product listed with regards to available support services, functionality, serviceability and reliability.
- The vendor must prove to the City of London that adopting the product into this standard will not result in increased operating, maintenance, training and/or support costs or complexity.

Following this process, if the City of London deems that the product is equivalent it will be added to the Product Vendor list.

All costs incurred during this process shall be borne by the Vendor. This includes but is not limited to cost of installation, servicing, monitoring, contacting references, and verification of information provided by the Vendor.

(d) Product Distribution

All products must be purchased through distributors authorized to sell products in London Ontario.

16.02 Chlorine Residual Analyzer (in Liquid)

- Prominent Dulcometer D1C with pH and temperature
  - *http://www.prominent.ca*

16.03 Dissolved Oxygen/TSS Analyzer

- Royce 9100 with 95A sensor
  - *http://www.royceinst.com/*
- AYSiX with Optical sensors

http://www.cancoppas.com/pdf_files/a6_analitical/a6_IIG_2000.pdf

16.04 pH/ORP Tranmitter

- GLI P53 with LCP Differential sensor
  - *http://www.hach.com/*

16.05 Gas Monitoring (H2S, LEL,O2)

- General Monitors ##02 Series
  - *http://www.generalmonitors.com/*

16.06 Gas Monitoring (Chlorine)

- Wallace Tiernan- **GMS *Plus* Gas Monitoring System**
  - *http://www.wallace-tiernan.com/mainsite/frame-gas-feed.htm*

16.07 Magnetic Flow Meter

- ABB
  - *http://www.abb.com/*
- Krohne
  - *http://www.krohne.com/*
- E-H Promag 50/53 W
  - *http://www.ca.endress.com/*

16.08 Mass Flow Meter

- Fluid Components International MT-91
  - *http://www.fluidcomponents.com/*
- Kurz K-Bar 2000 probe with 155E2
  - *http://www.kurz-instruments.com/*
- E-H- Promass
  - *http://www.ca.endress.com/*

16.09 Ultrasonic Level Transmitter

- Siemens Milltronics Enviroranger ERS500 Panel Mount
  http://www.siemens-milltronics.com/

16.10 Pressure Level transmitter

- E-H- Waterpilot FMX167
  - *http://www.ca.endress.com/*

16.11 Level Float Switches

- Flygt ENM-10
  - *http://www.ittflygt.ca/*

16.12 Pressure Transmitters

- Emerson - Rosemount Inc. 3051 / 3095FB
  - *http://www.rosemount.com/*

The following shall be provided for locations where Profibus communications is specified

- E-H- Cerabar S PMP71
  - *http://www.ca.endress.com/*

16.13 Temperature Sensor – General

- Thermo-Kinetics
  - *http://www.thermo-kinetics.com/*
- Honeywell
  - *http://www.iac.honeywell.com/*

16.14 Temperature, Liquid Pressure & Bi-metallic Switch

- Allen Bradley
  - *http://www.ab.com/*
- Ashcroft
  - *http://www.dresserinstruments.com/*

16.15 Limit & Proximity Sensors

- TopWorx
  - *http://www.topworx.com/*
- Turck
  - *http://www.turck.com/*
- Pepperl & Fuchs
  - *http://www.pepperl-fuchs.com/*

16.16 Capacitance Level

- Turck
  - *http://www.turck.com/*

16.17 Speed / Motion switch

- Milltronics
  - *http://www.milltronics.com/*

16.18 MCCs, Panel boards, & Circuit breakers

- Eaton - Cutler-Hammer Advantage with DeviceNet
  - *http://www.ch.cutler-hammer.com/*
- Allen Bradley IntelliCENTER with DeviceNet
  - *http://www.ab.com/*

16.19 Circuit Monitors

- To Match MCC

16.20 Soft Starts

- To Match MCC

16.21 Current/power transducers

- To Match MCC

16.22 Power Monitoring Relays

- PML ION 7650
  - http://www.pwrm.com/products/ION7650/

16.23 VFD Drives

- ABB ACS800
  - *http://www.abb.com/*
- Eaton - Cutler-Hammer SVX9000
  - *http://www.ch.cutler-hammer.com/*
- AB Powerflex700
  - *http://www.ab.com/*

16.24 Motor Protection Relays

- GE Multilin 469 w Devicenet Communications

16.25 Feeder Management Relays

- GE F60
  - *http://www.gedigitalenergy.com/multilin/catalog/f60.htm*

16.26 UPS

- Invensys - Powerware Powerware 9000 Series
  - *http://www.powerware.com/*

16.27 Safety Barriers (including Intrinsic)

- Pepperl+Fuchs K-System
  - *http://www.pepperl-fuchs.com/*

16.28 Terminal Blocks and other Rail Mounted Panel Devices

- Entrelec
  - *http://www.entrelec.com/*
- Phoenix Terminal
  - *http://www.phoenixcontact.ca/*
- Weidmuller
  - *http://www.weidmuller.ca/*

The following tables detail specific products shall be used for IO terminal blocks. The same manufacturer as selected for these terminal blocks shall provide all other panel components not specifically listed.

Vendor	Knife	Fused – 120Vac	Fused – 24Vdc
Phoenix Terminal	UK5-MTK-P/P	UK5-HSILA	UK5-HSILED
Entrelec	M4/6.SNBT	M4/8.SFLT	M4/8.SFDT
Weidmuller	WTR 2.5 With disconnect & test sockets	KDKS 1/PE With BFI & test sockets	KDKS 1/PE With BFI & test sockets

16.29 Wiring Ducts

- Panduit Type NE – Colour Grey
  - *http://www.panduiteeg.com/*

16.30 Power Line Transient Protection

- Emerson - Control Concepts ISLATROL Elite
  - *http://www.control-concepts.com/*

16.31 Signal Line Transient Protection

- Phoenix Terminal TRABTECH
  - *http://www.phoenixcontact.ca/*
- Entrelec Protechline Series
  - *http://www.entrelec.com/*

16.32 DC Loop Power Supplies (24 Volt)

- Entrelec Systron Series
  - *http://www.entrelec.com/*
- Phoenix Terminal Interface III CM Series
  - *http://www.phoenixcontact.ca/*
- Weidmuller RS-SNT Series
  - *http://www.weidmuller.ca/*

16.33 Selector Switches, Pushbuttons, Strobes and Indicating Lights

- Allen Bradley 800T
  - *http://www.ab.com/*
- Eaton - Cutler-Hammer 10250T
  - *http://www.ch.cutler-hammer.com/*

16.34 Control & Timing Relays

- Allen Bradley 700-N & 700-HA
  - *http://www.ab.com/*
- Eaton - Cutler-Hammer D3 & TR Series

- *http://www.ch.cutler-hammer.com/*

16.35 Signal Transmitters

- Pribusin Inc. IUC-X9-TXC & IUC-7X-RXC
  - *http://www.pribusin.com/*

16.36 Enclosures & Consoles (inc. Windows, Fans, Heaters, etc.)

- Hammond Manufacturing
  - *http://www.hammfg.com/*
- Hoffman
  - *http://www.hoffmanonline.com/*
- Ralston
  - *http://www.ralstonmetal.com/*

16.37 Valve Actuators – Chemical

- Chemline Q Series & A Series
  - *http://www.chemline.com/*

16.38 Valve Actuators – Process Valves

Provide with Profibus interface or as specified elsewhere in the tender documents.

- ROTORK IQ/AQ Series
  - *http://www.rotork.com/*

16.39 Chemical Metering Pumps

- Alldos
  - *http://www.alldos.de/*
- Prominent
  - *http://www.prominent.ca/*

16.40 Chlorinators

- Wallace & Tiernan
  - *http://www.wallaceandtiernan.usfilter.com/*
- Capital Controls
  - *http://www.capitalcontrols.com/*

16.41 PLC

- GE Fanuc / Horner Electric 90-30 PLC modules
  - *http://www.gefanuc.com/*
  - *http://www.hornerelectric.com/*

Only the following modules are approved for use. The serial port on the CPU is not shall be used for any purpose other than a programming port. Modules other than those listed below will not be used unless approval is granted by the City of London in writing in advance of tendering. The use of the Pac3Xi will be reviewed on a project basis.

- IC693CPU374 Processor, 246K, Dual Ethernet
- IC693PBM200/PBS201 Profibus Master & Slave
- IC693DNM200/DNS201 DeviceNet Master & Slave
- HE693RTM705 Modbus Master
- IC693CMM321 Ethernet
- IC693CHS391 Base, CPU, 10 Slots
- IC693CHS392 Base, Expansion, 10 Slots
- IC693CBL300 Expansion Cable, 1 m
- IC693PWR321 Power Supply, 120/240VAC, 125VDC, Standard
- IC693MDL230 120VAC Isolated Input (8 Points)
- IC693MDL634 24 Vdc Input, Negative/Positive Logic (8 Points)
- IC693MDL930 Relay Output, Isolated, 4 Amp (8 Points)
- IC693ALG221 Analog Input, Current, 4 Channels
- IC693ALG391 Analog Output, Current, 2 Channels

GE Fanuc VersaMax Micro may be substituted for 90-30 for use within Vendor Supplied Control Panels for Package Systems. Currently the following model is acceptable.

- IC200UAA007 28 point; (16) 120 VAC In, (12) 120 VAC Out

Where remote IO is warranted, GE Fanuc VersaMax IO shall be provided. Modules other than those listed below will not be used unless approval is granted by the City of London in writing in advance of tendering.

- IC200PWR102 Power Supply, 120/240VAC, Expanded
- IC200EBI001 Ethernet Interface Module
- IC200CHS101 16 Point Base
- IC200CHS102 16 Point Expansion
- IC200MDL143 120 Vac Isolated Input (8 Points)
- IC200MDL640 24 Vdc Input (2 Groups of 8) 16PT
- IC200MDL930 Relay Output, Isolated, 2 Amp (8 Points)
- IC200ALG230 Analog Input (4 Channel)
- IC200ALG331 Analog Output, Current (4 Channel)

16.42 LOI (Local Operator Interface Panels)

- GE Fanuc 6”Color Touch with Ethernet Adapter
  - *http://www.gefanuc.com/*

16.43 SCADA Software (OI, Historian, Reporting, Paging)

- Wonderware InTouch, InSQL, ActiveFactory, QIAnalyst, SCADAlarm, SuiteVoyager
  - *http://www.wonderware.com/*

16.44 PLC & LOI Programming

- GE Fanuc Cimplicity ME LogicDeveloper,
  - *http://www.gefanuc.com/*

16.45 Networking Components – General Ethernet

- Cisco SNMP Manageable
  12-2955-C, 24-2950-C, 24-3560-C, IE 3000
  - *http://www.cisco.com/*

16.46 Networking Components – Ethernet Cable Systems

- Amp, Nordx, Hubbel

Warning: In order for product vendor's warrantee to apply all cabling components must be purchased from the same manufacturer.

16.47 Networking Components – I/O & Harsh Environments

For installation in harsh environments and/or segments with RPU to I/O, PC to I/O, and/or RPU to RPU communication the following vendor products shall be used and network cabling shall be installed in a redundant fibre path configuration such that upon failure of a single fibre data is rerouted over an alternate path.

- Hirschman SNMP Manageable Industrial Ethernet Series
  - *http://www.hirschmann-usa.com/*

16.48 Networking Components –Ethernet to Serial Converters

- GE Fanuc VersaMax SE
  - *http://www.gefanuc.com/*

16.49 Modems

- Multitech CC1600V.34BL or MT5600BT
  - *http://www.multitech.com/*

16.50 Serial Converters (RS-232 to RS-485)

- Phoenix Terminal PSM Series – Rail Mounted
  - *http://www.phoenixcontact.ca/*

16.51 RS-485 Cabling Connectors and T-Branch Distributors

- Phoenix Terminal SUBCON9/M and PSM-PTK
  - *http://www.phoenixcontact.ca/*

Ensure that correct version of PSM-PTK is ordered depending upon whether communication protocol is Modbus or Profibus.

16.52 Serial RS-485 & Profibus Cabling

- Belden 3079ALS

- *http://bwcecom.belden.com/*

16.53 Site Security (Entry Keypads - Reset switches, Intrusion Detection)

- DSC MAXsys- Models LCD4501 & PC4020
  - *http://www.dsc.com/*

16.54 Sampler

- ISCO 4700FR
  - *http://www.isco.com/*

16.55 Identification Materials

- W.M. Brady

16.56 http://www.bradycorp.com/Special Approval

- **Alarm Horns** **Special Approval**
- **Ammonia Analyser** **Special Approval**
- **Chlorine Titration** **Special Approval**
- **Current to Pressure Converters** **Special Approval**
- **Doppler Flow Meter** **Special Approval**
- **Enclosure Corrosion Inhibitors** **Special Approval**
- **Fluorine Residual Monitor** **Special Approval**
- **Generator Control Board** **Special Approval**
- **Mass density Analyser** **Special Approval**
- **Mass Flow Meters** **Special Approval**
- **Motor to Pressure Converters** **Special Approval**
- **Nitrate / Nitrite Analyser** **Special Approval**
- **Open Channel Flow Meters – Doppler** **Special Approval**
- **Open Channel Flow Meters – Flume** **Special Approval**
- **Orifice Plate Flow Meters** **Special Approval**
- **Percent solids Analyser** **Special Approval**

- **Phosphate Analyser** **Special Approval**
- **Pressure to Current Converters** **Special Approval**
- **Sewage Grinder** **Special Approval**
- **Sludge blanket level Detector** **Special Approval**
- **Streaming current Analyser** **Special Approval**
- **Suspended Solids Analyser** **Special Approval**
- **Ultrasonic Flow Meter** **Special Approval**
- **UV Systems** **Special Approval**
- **Hydraulic Pressure** **Special Approval**
- **Load Cell** **Special Approval**
- **Velocity Sensor** **Special Approval**
- **Vortex Shedding Flow Meter** **Special Approval**
- **Hart to Serial Communication Converter** **Special Approval**

PART 17 GLOSSARY

17.01 Common Acronyms

- CGA Canadian Gas Association
- DPC Distributed Process Controller
- HVAC Heating, Ventilation and Air Conditioning
- I&C Instrumentation and Control
- I/O Input / Output
- ISA Instrument Society of America
- MC Motor Controller
- MCC Motor Control Centre
- NFPA National Fire Protection Association
- P&I Process and Instrumentation
- P&ID Process and Instrumentation Diagram
- PLC Program Logic Controller
- RPU Remote Programmable Unit (typically synonymous with PLC)
- RSC Remote Station Controller
- RTU Remote Termination Unit / Remote IO Unit
- AASHTO American Association of State Highway and Transportation Officials
- ACI American Concrete Institute
- AISI American Iron and Steel Institute
- ANSI American National Standards Institute
- APWA American Public Works Association
- ASME American Society of Mechanical Engineers
- ASTM American Society for Testing and Materials
- AWPA American Wood Preservers Association
- AWWA American Water Works Association
- CGSB Canadian General Standards Board
- CSA Canadian Standards Association
- HEPC Hydro Electric Power Commission
- MOEE Ontario Ministry of Energy and the Environment
- MTC Ontario Ministry of Transportation and Communication

- SSPC Steal Structures Painting Council
- SHIStandards of the Hydraulic Institute
- ASHRAE American Society of Heating, Refrigeration & AC Engineers
- NFC National Fire Code
- NFPA National Fire Protection Association
- ULC Underwriters Laboratory of Canada
- EEMAC Electrical and Electronics Manufacturers Association of Canada
- ASA Acoustical Society of America
- SAE Society of Automotive Engineers
- OPSS Ontario Provincial Standard Specification
- OBC Ontario Building Code
- NBC National Building Code
- CoL City of London

17.02 Definitions are used within this document.

- Hand Manually Engaged in the Energized State
- Remote Controlled by process area PLC
- Local Controlled locally by internal controller
- Auto PLC Logic based control
- Manual SCADA Fixed control state
- Outputs Information provided by field devices
- Inputs Control signals sent to field device