Elgin Area/Lake Huron Primary Water Supply System
SCADA Standards
Section 400 Technical Design Guidelines

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SCADA Standards
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401 Design Philosophy and Guidelines

1. General

1. The overall goal of the standards are to ensure that all new construction can properly integrate into the existing SCADA systems. They should also have the same "look and feel" so that the operators do not become confused, resulting from differences in design, in different facility areas.

2. The standards should also ensure that all upgrades/expansion can be completed in an efficient and effective manner.

2. Control Modes

1. REMOTE/LOCAL selector switch(es) is to be provided on the each field station for selecting the control mode for each individual device or piece of equipment.

2. Manual controls will only function when the selector is in the Local position.

3. Computer control will only occur when the selector is in the Remote position.

4. A discrete contact will be present to provide an indication to the computer that the device/equipment is in REMOTE mode, and available for computer control.

5. Control circuits will be designed such that transfer between Remote and Local conditions does not affect operation of the equipment/device (Bumpless Transfer). The physical switching between REMOTE and LOCAL will not change the 'pre-'switch conditions by itself.

6. Remote to Local: A motor will continue to operate in its previous state (on or off) until manually changed at the Local Control Panel; a valve will carry out its last instruction for settings (open/close/in between), prior to accepting further manual instruction.

7. Local to Remote: The computer will override the LOCAL instructions, and resume automated control, using its evaluation of the conditions and parameters that are programmed to indicate start/stop or open/close of the equipment in question.

8. The designer will be required to evaluate all conditions for bumpless transfer between Auto and any Manual condition.

3. Safety and Permissive Interlocks

1. Equipment and personnel safety interlocks must always be locally hardwired, to operate independently of the automated control system.
   a. Well/ wetwell Low Level Switch (prevent pumps from running dry)
   b. Pump discharge Valve Limit Switch (prevent pump operation against closed valve)
   c. Pump Seal Water Pressure/ Flow (prevent pump operation w/o seal water)

2. Lock-outs must consist of disconnect-style switch complete with padlock connection.

3. Motors controlled by computer or other automatic means must have a power disconnect switch. This switch shall be located on a local panel within sight of the motor, or on the MCC.

4. An auxiliary contact for the disconnect will also be present, which will be open when the switch is open. This will prevent operation of the starter coil, or a starter contact, which would give a false 'Motor Running' reading to the computer.

4. Momentary Versus Maintained Contacts

4.1 Momentary Contacts

1. For momentary contact control, the start, stop, open, and close functions are initiated by momentarily closing a circuit contact. Loss of SCADA control will not affect the controlled device; it will remain in the powered status it is in, or carry out it's last instruction, until wither remote control is restored or control is transferred to local and the manual pushbuttons are used.

2. In the event of a power failure, the circuits are to reset, and the devices/ equipment are to return to safe conditions. Fail-safe conditions are to be evaluated at the pre-design stage.

3. Equipment most suitable for control by momentary contact would be constant speed pumps and full open-close valves.

4.2 Maintained Contacts

1. For maintained contacts, the devices or equipment will require a constant or held down contact to continue operation or position (under local control). This method is essentially full manual operation. An example of this would be solenoid valve control.

4.3 Modulated Control

Modulating or positioned equipment such as variable speed motors/ pumps and control valves should be controlled by analog inputs and outputs.

Equipment such as VFD's will also require digital start/ stop signals.

Analog control loops, which are set by an automatic backup analog controller or manual loading station, can receive manual commands from the computer in 'automatic' mode. An example would be where a chemical metering pump flow rate is set whether directly from a flowmeter, or by a PLC, which has received the same signal from the flowmeter. The SCADA System must ensure no conflict or overlap between analog loops and discrete output contacts. The hierarchy or precedence of signals will be established in the design stage.

Control of critical modulating gates (e.g. influent) should be set up that in the event of loop failure, the gate will move to a failsafe position (30% as an example), dependent upon the process.

Loop failure is recognized when an analog signal is outside the normal range of 4-20mA.

5. Prepackaged Equipment Interfaces

1. Equipment such as chemical make-up systems are often part of a complete system package with their own instrumentation and controls.

2. It will be necessary for the control systems designer to evaluate and incorporate these existing controls and monitoring capabilities into the overall system being constructed. This will include definition of process variables, and alarm & status conditions to be monitored by the system, plus any controls for which the system must operate the equipment.

3. Any interfacing must be documented within both the mechanical equipment and electrical specifications, to ensure system co-ordination and compatibility.

402 *Facility Design*

1. Water Treatment Plant

1. As these facilities are fully constructed, the SCADA upgrades and expansions must follow the design concepts of that facility.

2. Water Pump Stations

As a minimum, the following monitoring shall be provided.

a. Discharge Flow
b. Pressures for each pump's inlet and discharge

Where applicable for health and safety reasons, process optimization, optimal chemical usage, process automation, remote process control operational decisions, site security, and/or required for compliance reporting C of A requirements), the following monitoring shall also be provided.

a. Discharge chlorine residual if chorine is added at facility.
b. Discharge fluorine residual if fluorine is added at facility.
c. 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.
d. 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.
e. CO levels in ppm in workshops, garages, generator rooms. And all other locations where there exists the possibility of CO collection.

3. Reservoirs

As a minimum, the following monitoring shall be provided:

a. Storage volume and level.
b. Discharge chlorine residual

Where applicable for health and safety reason, process optimization, optimal chemical usage, process automation, remote process control operational decisions, site security, and/or required for compliance reporting C of A requirements) the following monitoring shall also be provided:

a. Pre-chlorination chlorine residual if chorine is added at facility;
b. Post fluoridation fluorine residual if fluorine is added at facility.
c. 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 addictive used to enhance the treatment process.
d. 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.
e. CO2 levels in ppm in workshops, garages, generator rooms, and all other locations where there exits the possibility of CO collection.

4. Water Distribution Chambers

As a minimum, the following monitoring shall be provided.

a. Line Pressure
b. Where pressure regulation is provided, individual line pressure for each line

Where applicable for health and safety reasons, process optimization, optimal chemical usage, process automation, remote process control operations decisions, site security, and/or required for compliance reporting C of A requirements), the following monitoring shall also be provided.

a. Chlorine storage volumes, volumetric flow rates for each chemical feed line, dosage and chlorine residual on the discharge side at locations with chlorination.
b. Cl2, SO2CH4 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.

403 Major Equipment Design

1. Gates and Valves

The criteria for degree of monitoring and/or controlling of gates and valves is dependent upon both the type of, and frequency of, use of the unit itself.

1.1 Open/Close Control Valves

Monitoring of fully open, and fully closed positions is required for automated flow routing devices. Travelling indication should be included for larger valves.

1.2 Modulating Control Valves

All operating valves for which intermediate positions are set by controller or keyed input require, as a minimum, limit switches for fully open and fully closed positions. A 4-20 mA DC signal for monitoring valve position between open and closed will generally be required, based on the process requirements.

Where specified, limit switches and position sensors are to be furnished by the manufacturer, as an integral part of the gate or valve unit.

Position monitoring, where possible, should not be based solely on the status of an intermediate mechanical or electrical connection (example: Spindle position on a Sluice Gate used to proved the gate's position). Position monitoring, where possible, should be based on confirmed, downstream conditions (Zero flow or level downstream of a gate may be interpreted as 'Gate Closed').

1.3 Monitored Valves

Hand operated valves should have limit switches for both fully open and fully closed positions, as a minimum.

Monitoring requirements for gates and valves, which are not part of the normal process or operation, will be a function of the amount the gate / valve is used. The threshold for valve use frequency will be established by the Primary Water Supply and is to be evaluated by the designer.

Those units used for maintenance or isolation (e.g. pump suction valves or routing isolation valves) should not be monitored, unless an improper position creates a safety hazard.

Monitoring requirements for gates and valves, which are used under emergency or non-standard conditions (Bypassing), should include monitoring of fully open, and fully closed.

2. Typical Electric Motors

The following physical parameters are to be monitored for all electric motors:

a. Overload Status
b. Out of Service Status
c. Motor Running
d. Any other Ministry of Labour Requirements

These additional parameters are to be monitored for larger electric motors over 100kW:

a. Bearing Temperature
b. Winding Temperature
c. Power Consumption
d. Vibration

Using engineering judgement the following parameters will be provided, based on specifics of equipment, for all process machines (e.g. pumps):

a. Unit Bearing Temperature
b. Casing Temperature (Larger Pumps)

Each piece of motor-driven equipment is to have a local 'Remote/Local' hand switch to override the computer. Each 'Remote/Local' hand switch should be provided with "Remote Position" contacts, to ensure the signal for remote operation is confirmed.

'Motor Running' and 'Motor Overload Status' should be monitored regardless of the position of the 'Remote/Local' hand switch.

Each motor starter shall have auxiliary contacts, to repeat overload heater and motor running conditions.

404 Field Instruments

1. General

1. The Primary Water Supply has standardized on a limited number of field instruments to reduce the ongoing instrument maintenance costs.

2. Instruments to be provided are to be proven of both high reliability & low maintenance.

3. Instruments to be provided are to be either currently in use in Ontario Plants or other similar sized facilities in North America. Documentation will be required from both a local supplier and the manufacturer.

4. Analog signals from instruments shall be 4-20mA DC and/or field bus. Two wire transmitters are to be used, where possible.

5. All transmitters are to have integrally mounted meter indicators.

6. Transmitters and transducers are to be installed as near to measuring point as practical, minimizing the need to address Confined Space Entry.

7. Instruments to be generally accessible (for both reading and cleaning) from grade level. Instruments not readily accessible to have permanent platforms/ladders, as a function of frequency of maintenance schedule/space availability.

2. Preferred Instrument Applications

1. The following table identifies the preferred instrument applications for reliable operation.

Application	**Preferred Technology**	**Acceptable Alternatives**
Level measurement for water reservoirs, water filters	Pressure Transmitter located at elevation of tank bottom	Ultrasonic
Level measurement for raw sewage wells, sludge tanks, chemical tanks	Ultrasonic	
Level switches in water applications, building flood alarms	Conductivity	Float (back-up only)
Level switches in sewage applications, chemical tanks	Ultrasonic	Float (back-up only)
Sludge blanket level	Ultrasonic	Series of light transmission rods
Pressurized pipe flow measurement in potable water, sewage, sludge, chemical	Ultrasonic Magmeter	
Open channel flow measurement	Parshall flume/Ultrasonic	Transit time
Gas flow measurement for air, digester gas	Thermal Mass Flowmeter	Orifice Plate/Differential Pressure
Potable water turbidity	Light Adsorption	
In-line sludge density	Light Adsorption	
Sludge Density in Aeration tanks, sludge tanks	Light Adsorption	
Aeration tank dissolved oxygen	Membrane type sensors	
Potable water chlorine residual	Amperometric	

3. Preferred Instrument Vendor List

1. The following table identifies the preferred instrument vendors.

Company	Relevant Equipment	Web Site
ABB Magmaster	Magnetic Flowmeter	http://www.abb.com
Allen Bradley (Rockwell Automation)	Selector Switches, Pushbuttons and Indicating Lights Controls & Timing Relays	http://ab.rockwellautomation.com/
Ashcroft	Pressure Switch	http://www.dresserinstruments.com
Capital Controls	Chlorine Residual Analyzer	http://www.capitalcontrols.com
Control Concepts	Power Line Transient Protection	http://www.control-concepts.com
Cisco	Switches, Hubs, Routers	http://www.cisco.com
Entrelec	Signal Line Transient Protection DC Loop Power Supplies (24 Volt)	http://www.entrelec.com
Fluid Components International	Gas Flowmeter	http://wwwfluidcomponents.com
Flygt	Level Float Switches	http://www.ittflygt.ca
Allen Bradley (Rockwell Automation)	Processor, Rack and I/O Cards	http://ab.rockwellautomation.com/
General Monitors	Gas Monitoring	http://www.generalmonitors.com
Hach	Turbidity Meter Chlorine Residual	http://www.hach.com
Krohne	Magnetic Flowmeter	http://www.krohne.com
Kurz	Cost	http://wwwkurz-instruments.com
Nortel Networks	Switches, Hubs, Routers	http://www.nortelnetworks.com
Pepperl+ Fuchs	Safety Barriers	http://www.pepperl-fuchs.com
Phoenix	Signal Line Transient Protection DC Loop Power Supplies (24 Volt)	http://www.phoenixcontact.ca
Powerware	Motor Protection Relays Ups	http://www.powerware.com
ProMinent	Chlorine Analyzer pH Analyzer	http://www.prominent.ca
Rosemount	Pressure Transmitter Chlorine Residual Analyzers pH Analyzer Temperature Transmitter	http://www.rosemount.com
Royce	Sludge Blanket Level Dissolved Oxygen Analyzer	http://www.royceinst.com http://wwwblanketlevel.com
Royce	PH/ORP Transmitter	http://www.royceinst.com http://www.glint.com
Siemens Milltronics	Ultrasonic Level Transmitter Open Channel Flow Motion Switch	http://www.miltronics.com

Siemens Wallace and Tiernan	Chlorine Analyzer	http://www.siemens.com/wallace-tiernan
Trerice	Manual Pressure Gauges	http://www.trerice.com

3.1 Typical Field Device I/O

1. The following typical device I/O should be specified in the device specifications.

Application	Function	I/O
Typical Motor (FVNR - Full Voltage, Non-reversing)	Start/Stop Command Running Status Ready Status Fault Status	DO DI DI DI
Diesel Generator	Start Cmd Stop Cmd Running Status Hi Temperature LO Oil LO Fuel Overcrank Overspeed	DO DO DI DI DI DI DI DI
VFD	Start/Stop Cmd Running Status Fault Status Mode Speed Setpoint Speed Feedback	DO DI DI DI AO AI
Air Actuated Valve, Spring Return	Open/Close Open Status Close Status	DO D I D
Air Actuated Valve, maintain Last Position	Open Cmd Close Cmd Open Status Close Status	DO DO DI DI
Motorized Valve (Discrete)	Open Close Opened Closed Fault Mode	DO DO DI DI DI DI
Motorized Valve (Modulating)	Fault Mode Position Setpoint Position Feedback	DI DI AO AI
Smart Instruments	Analog Feedback Fault	AI DI

405 Field Indicating Lights

1. Field Indicating Lights

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

ITEM	COLOUR
Running, burner on, valve fully open, breaker closed	Red
Stopped, safe, burner on, valve fully closed, breaker open	Green
Intermediate position for valve	Half Red/Half Green
Overload/Alarm/Warning	Flashing Yellow
Acknowledged Alarm	Solid Yellow
Reset	No Colour

406 *Control Wiring*

1. Field Wiring Voltage Standards

1. The analog field wiring shall be 24 VDC, using 4-20 mA signals.

2. The DI and DO wiring shall be 120 VAC. DO signals shall be powered from the related field device circuit. The DI shall be powered from the PLC panel so that they can be placed on UPS power if needed.

2. Analog Signals

1. Analog signal wiring is to be twisted pair shielded (TPSH) wire. Individual signal conductors shall be stranded copper wire. A "pair" is defined as two insulated conductors covered in a 100% electrostatic shield plus a shield drain wire. When multi-pair cabling is provided, each pair must be individually shielded and an over-all cable shield must be included.

2. Each pair is to consist of one white and one black conductor. The convention is that the black conductor shall be of a higher potential (voltage) than the white conductor.

3. Each pair's shield drain wiring shall be terminated to the Isolated DC Ground point in the PLC panel. This shall be the only electrical connection to the shield. The shield must have its electrical isolation maintained through junction boxes, etc. by the use of insulating sleeves and dedicated terminal block assignments. The shield must be insulated and un-terminated at the field device.

4. All analog I/O points within a PLC or SCADA controller cabinet shall be terminated to uniquely numbered terminal blocks within the cabinet or to purpose-built remote termination assemblies (such as the Phoenix Universal PLC Wiring System). Field device wiring shall not be directly connected to I/O modules.

5. Successful operation of the 4-20 mA analog signal transmission convention requires there is only one series pathway for the signal: there must not be any parallel current pathways. The desired loop pathway is from the "+" terminal of a 24 (nominally) Vdc power supply, to a transistor load (the field transmitter), to a sense resistor (250 W), and finally to the "-" terminal of the power supply. The convention implemented in the SCADA system is that the low side of the 250 W resistor must be the only point of the loop connected to the SCADA Isolated DC Ground. Therefore it is critical that: (1) all elements in the loop are connected in a single series loop and (2) all elements in the loop must be isolated from ground. Refer to ISA S-50.1 for further discussion.

6. Field devices shall include electrical isolation as necessary to ensure accurate signal transmission from/to field device to/from the controller. Note that this is a particular requirement for the popular Milltronics MultiRanger ultrasonic level transmitters. Any analog signal connection to a VFD must be implemented with optical isolation.

7. The power supply shall be from the 24V power supply in the PLC panel. Connection for each individual field device circuit shall be routed though either a fuse or a current limiting series resistor to ensure that a wiring fault of one field device does not impair operation of other devices sharing the same power supply.

8. For 120V field instruments, the power supply shall be from the terminal blocks in the PLC panel. Connection for each individual field device circuit shall be routed though either a fuse or a current limiting series resistor to ensure that a wiring fault of one field device does not impair operation of other devices sharing the same power supply.

3. 24VDC Discrete Signals

1. For all field DI, the closed circuit shall represent the normal state and an open circuit shall indicate the process alarm state.

2. Low voltage DC Field Device signals (24VDC) are to be installed with stranded copper wire #16 AWG. If cable colour coding is black and white the convention shall be consistent with analog wiring: the black conductor shall be of a higher potential (voltage) than the white conductor.

3. Conductor colour for DC Discrete signal wiring which remains entirely within a single controller shall be orange.

4. Device change of state shall be actuated by powering and un-powering the + (positive) side of the 24 Vdc circuit. All of the 0 Vdc (-, negative) connections of the circuit shall be tied together. Switching elements on the return circuit is not permitted.

5. Whenever DC digital signals are transmitted between two controller systems the topology of solid-state output to solid-state input must be avoided. Therefore either the controller output must be a "hard contact" (relay) type output or, if a solid state output is used, it must drive an interposing relay which in turn provides the hard contact for connection to the solid state input. The use of "pull down" load resistors in place of the interposing relay is not acceptable.

4. 120VAC Discrete Signals

1. For all field DI, the closed circuit shall represent the normal state and an open circuit shall indicate the process alarm state.

2. The 120 VAC Discrete I/O field cabling is to be a minimum #14 AWG stranded copper wire.

3. AC Discrete Input device field cables shall use a minimum of three-conductor cable (with black, red and white conductors); two conductor cables shall not be used. AC Discrete Output device field cables may use two conductor cables.

4. The conductor colour designation is that green or bare conductors are always at ground.

5. White conductors of field cables are for use as neutral or control signal wires. If a white wire is used for a control signal (as in cables with less than 3 conductors) it shall be taped red or black for 50mm at its junction points.

6. Red conductors of field cables are for use as control signal wires.

7. Black conductors of field cables are for use as hot, or control signal wires. If a black wire is used for a neutral connection (as is common in cables with more than 3 conductors) it shall be taped white for a length of 50mm at its junction points.

8. Conductor sizes for 120 VAC control wiring which remains entirely within a single controller cabinet or junction box may be reduced in size to 16 AWG provided that the amperage requirements of Section 16 are met. These 120 VAC conductors shall be red, white or yellow in colour. Red coding is for 120 VAC and control wires which are powered from CDP circuits assigned to the cabinet; white colour coding is for the associated neutral. Yellow conductor coding is for all wiring which has an external 120 VAC supply (the most common occurrence is motor control wiring where each MCC bucket has its own control transformer).

9. Whenever AC digital signals are transmitted between two controller systems the topology of solid-state output to solid-state input must be avoided. The DO must drive an interposing relay which in turn provides the hard contact for connection to the solid state input. Use of "pull down" load resistors in place of the interposing relay is not acceptable.

10. The connection to a 120 Vac supply (typically a circuit breaker) for each individual field device circuit shall be routed though a fuse to ensure that a wiring fault of one field device does not impair operation of other devices sharing the same 120 Vac supply.

11. Field devices, which require a 120 VAC supply for operation shall use the same 120 VAC fused supply for status sensing.

5. SCADA Signal Grounding Practice

5.1 Isolated DC Ground

1. The analog DC and digital DC power supply "-" connection (0 Vdc) shall be connected to a single star ground point referred to as the "SCADA Isolated DC Ground Point" located within the PLC panel. This is typically implemented using a copper bus bar on insulated stand-offs located near the bottom of the controller cabinet. This bus bar shall be identified as the "Isolated DC Ground". This bus shall be tied by one and only one ground wire which runs directly from the bus bar to the lowest potential building or system ground available

(typically the building frame or buried grounding grid. Simply tying this ground via the AC System Ground bus bar should be avoided. The grounding cable from the Isolated Ground DC bus bar to this ground point shall not serve any other purpose.

2. Field device enclosures must not be connected to the Isolated DC Ground.

3. Wiring conductors connected to the Isolated DC ground shall be labeled and coloured in accordance with its loop function (i.e., with a "-" suffix as described below) or shall be green in colour and labeled as "DC GND".

5.2 AC System Ground

1. The AC System ground is the principle ground for the SCADA system. It originates from the supply transformer neutral.

2. This is typically implemented using a copper bus bar on non-insulated stand-offs located near the bottom of the controller cabinet.

3. All cabinets, bonding, AC powered field devices, AC digital field devices and AC field wiring shall be grounded to the AC system ground.

4. Wiring conductors connected to the AC System Ground shall be labeled and coloured in accordance with its loop function (i.e. with a "G" suffix as described below) or shall be green in colour and labeled as "AC GND".

5.3 AC Isolated Ground

1. The AC Isolated Ground is a short dedicated ground that only occurs with UPS and series topology power conditioners (i.e., Tycor) which have a supply side ground connection (which is tied to the AC System Ground) and a separate load side ground connection. The load side ground connection becomes the AC Isolated Ground. This ground shall be connected to all loads from the device connection point and shall not be connected to a bus bar.

2. The AC Isolated Ground shall be reserved for connection to data processing equipment (SCADA and PLC CPUs) in close physical proximity. Field device enclosures must not be tied to the AC Isolated Ground. If a field device is powered from a UPS (which requires an AC Isolated Ground) then the device shall be bonded through its field wiring cable shielding to the AC Isolated Ground.

3. Wiring conductors connected to the AC Isolated Ground shall be labeled and coloured in accordance with its loop function (i.e. with a "G" suffix as described below) or shall be green in colour and labeled as "AC ISO GND".

4. Use of an AC Isolated Ground should be avoided unless the UPS or power conditioner manufacturer installation instructions require it.

5.4 Communication System Wiring Practice

1. Network communication cables shall be specified as required by the application. Whenever such cable is used it shall be the of the premium model available and must include such features as individual shielding, stranded conductor construction, plenum rated fire jacketing, premium connector strain relief. Communication cables shall be supplied as factory assembled whenever possible. Field assembled cables may be used where required to facilitate long cable run installations, however each and every such cable must be tested for DC insulation, DC conductivity and for representative data transmission using a recommended data test set.

2. All elements of data network cabling system including cables, connectors, patch cords, termination methods and testing methods must be completed to a consistent standard.

407 *Control Panels*

1. General

1.1 Introduction

1. Control panels house the control system at each of the basic levels of operator interface. In general, control panels at the PLC level are not used as hardwired operator control stations. With a few exceptions, operator interface is concentrated at the area or plant level and at the local hand stations.

2. Panel Fabrication

1. Panel must carry applicable CSA/UL label and Ontario Hydro approval sticker.

2. Use enclosures, which conform to the requirements of the EEMAC/NEMA type specified in the schedule or panel drawing.

3. Provide structural reinforcements within enclosures to ensure a plane surface, to limit vibration, and to provide rigidity during shipment, installation, and operation without distortion or damage to the panel or to any instrument.

4. Place knockouts for the wiring of freestanding panels either at bottom or sides of the panel. Cover holes for future devices with a plastic plate.

5. Bonderize steel enclosures. Prime and finish with 2 coats of factory finished ANSI baked enamel. Paint the panel interior white. The exterior colour will be selected by the Owner.

6. Provide steel stiffeners on the back of the panel face as may be required to prevent deflection due to instruments, operation of equipment, or opening/closing of doors. Use 0.64 cm high by 2.54 cm wide by 1.27 cm deep minimum stiffeners and tack welded to the panel.

7. Provide internal condensation and freezing protection with thermostat controlled heater on outdoor enclosures.

8. Provide a 25 mm deep print pocket within enclosures.

9. Fabricate panels, install instruments, plumb, and wire in the factory. Test wiring and plumbing prior to shipment. Use numbered terminal blocks for external connections.

10. Use panel fabrication techniques that allow for removal and maintenance of all equipment after installation.

11. Provide panels with switched full length fluorescent interior lights and mount near the top, where required by size of panel (larger than 24 x 24") or location (outstation) or equivalent area.

12. Provide panels with a 15 A, 115 VAC service outlet circuit with surge suppressor within the interior. Provide the circuit with 3 wire, duplex receptacles, one for every 1.0 m of width (one minimum per enclosure) and space evenly along the back-of-enclosure area. Provide ground fault interrupter type outlet in outdoor panels.

13. Install panel lighting, service outlets and heater on separate 120 VAC breaker. Do not mix with internal panel circuits or loads.

14. Provide louvers, forced ventilation, or air conditioners as required to prevent temperature build-up to protect equipment with ambient temperatures of up to 400 C.

15. Provide clean instrument air purging arrangement with filter regulator and shut-off valve, where required

3. Signals and Interfaces

1. Analog signals are 4 to 20 mADC and conform to the compatibility requirements of ISA Standard 50.1. Provide the signal conversion necessary for compatibility with panel mounted instruments and the interface to the digital controllers.

2. Provide interposing relays or opto-isolators, if required, for retransmission of isolated discrete (digital) signals to digital controllers. Relays shall be 10 Amp, 120 VAC, SPDT or DPDT, pin-base, plug-in style with neon indicator.

3. 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 type of control circuit function applicable to a particular final control element. Use sealed and plug-in type components.

4. Panel Wiring and Terminations

4.1 Wiring

1. Use flexible, stranded, copper TEW wiring. Run wires in continuous lengths from terminal to terminal. Do not splice wires.

2. For analog signal wiring, use uniformly twisted shielded pairs not smaller than 18 AWG with a minimum of six twists per foot. Separate analog signal wiring at least six inches from power wiring. Provide continuous foil or metalized plastic shields with 100 percent coverage. Include a drain wire in continuous contact with the shield. Multiple cables must have an overall shield and individual shields for each signal cable.

3. Use 16 AWG if approved under the local electrical authority or larger for control signal wiring.

4. Use power wiring with insulation rated at 600 V. Use 12 AWG or larger for power wiring.

5. Segregate signal wiring from control power wiring, group functionally, and arrange neatly to facilitate tracing of circuits.

6. Use plastic wiring wraps to bundle wires, outside of wiring ducts. Securely fasten the bundles to the steel structure at intervals not exceeding 12 inches. Each bundle contains 30 conductors maximum. Use Panduit, or equal wiring ducts and size to provide a minimum of 20 percent spare space.

7. Do not intermix signals within the same bundle or duct.

8. Use twisted unshielded wire for other DC signals and segregate from wire conducting AC signals.

9. Use PVC crimped sleeve type wire tag identifications.

4.2 Terminal Blocks

1. Provide DIN style terminal blocks mounted on DIN rails, such as Entrelac or Phoenix. Space terminal block strips no closer than 15 cm centre to centre.

2. Provide a continuous marking strip with the terminals. Provide a separate terminal for terminating each shield wire.

3. 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. Terminate no more than two wires at any one terminal.

4. Provide a minimum of 25 percent spare terminals, mounted separately.

5. Provide analog loops positive side metering circuits plug in type terminals.

4.3 Grounding

1. Provide 2 ground buses in each cabinet or panel, one for shield and cabinet grounding and one for signal grounding.

2. Provide grounding lugs for connection to the external grounding system.

3. Provide # 6 AWG stranded copper grounding conductor for DC signals.

5. Wire Colour Standard

1. The purpose of defining field wiring standards for SCADA systems is to assist the Operations and Maintenance staff to easily identify and troubleshoot wiring issues and to ensure a safe and compliant SCADA system installation consistent with good workmanship practices.

Control Panel Wire Colours

Wire Usage	Colour	
120 VAC panel feeders and internal power wiring	Power (1) Power (2) Neutral	-Blue -Red -White
120 VAC DO or DI power from outside panel	Power Neutral	-Yellow -Yellow/white stripes
24 VAC DO powered from outside panel	Power (+) Power (-)	-Blue -Blue/white stripes
120 VAC DO or DI powered from within the control panel	Power Power (Return)	-Orange -Orange/white stripes
24 VDC AI or AO powered from outside the control panel	Cable Power Strand (+) Power Strand (-)	-Black with 6” of yellow tape at each end -Black -White
24 VDC AI or AO power from within the control panel	Cable Power Strand (+) Power Strand (-)	-Black -Black -White
Ground wires	Green	

6. Power Distribution

1. Provide a main circuit breaker and branch circuit breakers for each individual circuit distributed from the panel. Group the circuit breakers on a single subpanel. Place subpanel so that there is a clear view of and access to the breakers when the door is open. Use branch circuit breakers rated as required.

2. Place no more than 16 devices on any single circuit breaker, as required. Avoid common mode power loss. Subject to operational impact review.

3. Where multiple units perform parallel operations, do not group all devices on the same branch circuit.

4. Do not exceed 12 amperes on a 15A branch circuit.

5. Provide DIN-style fuse with LED failure indicator, Entrelac or Phoenix, for each control loop.

7. DC Loop Power Supplies

1. Enclose each power supply in an EEMAC type 1 enclosure, vertical surface mounting type, with surface barrier screw terminals for load connection. Equip each power supply with a power on/off circuit breaker.

2. Meet the following:
   a. Input Power: 115 VAC + 10 percent, 60 Hz.
   b. Output Voltage: 24 VDC regulated.
   c. Output Voltage Adjustment: 5 percent.
   d. Line Regulation: 0.05 percent for 10 volt line change.
   e. Load Regulation: 0.15 percent no load to full load.
   f. Ripple: 3 mV RMS.
   g. Operating Temperature: 0 to 600 C.

3. DIN rail mounted.

4. In general, use single or dual loop power supply.

5. Mount power supplies such that dissipated heat does not adversely affect other components. Install output fused terminal blocks, mounted alongside terminal blocks.

8. Panel Mounted Devices

1. Use face-of-panel mounted devices which are semi-flush mounting and which present a uniform appearance.

2. For EEMAC type 3R and type 4 panels, mount face-of-panel mounted devices such as indicating meters, controllers, etc. that are not weatherproof on a hinged inner door. Provide an EEMAC/NEMA rated viewing window on the enclosure door.

3. Locate face-of-panel mounted device higher than 0.8 m and lower than 2.0 m from the floor.

4. Arrange back-of-panel devices in a neat and orderly fashion. Allow 20% continuous space for future additions. Use mounting plant for mounting all components.

5. Furnish face-of-panel mounted nameplates to identify systems and equipment. Use engraved gravoply laminate nameplates having white letters on black background. Include device identification number as well as a descriptive name. Centre lettering on each line. Use minimum 3 mm high characters. Mount nameplates with quantity 2 stainless steel machine screws.

6. Use engraved gravoply laminated nameplates with white letters on a black background in the panel interior to identify each device mounted on the panel exterior and interior. Place the tags above, but not on, the device. Do not obstruct visibility by wire bundles or other equipment. Include device identification number as well as a descriptive name to match identification shown on drawings. Mount nameplates with quantity 2 stainless steel machine screws.

7. Follow ISA-RP60.6-1984, Recommended Practice for Nameplates, Labels and Tags for Control Centres.

8. Use SCADA colour convention, unless otherwise noted.

9. Selector Switches, Pushbuttons, And Indicating Lights

1. Provide EEMAC oil-tight selector switches, pushbuttons, mushroom head pushbuttons for emergency stop, and indicating lights. Provide units that will accommodate panel thicknesses from .423 cm to .476 cm. Provide units that occupy approximately 6.5 cm to 10 cm square face-of-panel space.

2. Include operator mechanisms and contact blocks on selector switches and pushbuttons. Label contact block terminals for identification purposes and provide at least 1 single pole, double throw contact. Use heavy duty type contact blocks rated 10 A at 115 VAC breaking current.

3. Where the contact blocks handle analog (4 to 20 mA) and 24 VDC or less contact closure signals, provide contact material of gold or gold flashing over silver and rated 0.5 A at 115 VAC.

4. Provide flush head type pushbuttons with momentary operation.

5. Provide 2, 3, and 4 position maintained contact selector switches. Provide springs return selector switches as indicated on the drawings.

6. Provide LED indicating light units, which allow light removal and replacement through the front of the unit, such as Entrelac.

7. Provide a pushbutton with suitable diodes to test all indicating LED light units.

8. For key-operated selector switch, use standard Allen Bradley DO-18 key or equivalent.

10. Enclosures

10.1 Free-standing Enclosures — Steel

1. Fabricate enclosures from sheet steel.

a. Provide single door EEMAC type 4 and 12 enclosures with 12 gauge sides, top, and back. Provide double door enclosure with a 10 gauge back with 12 gauge top and sides.
b. Provide multi-door enclosures with 10 gauge sides, top, and back.

2. Internally, supply the enclosures with a structural steel framework or bracing for equipment support and enclosure bracing. Permit lifting without racking or distortion. Provide removable lifting rings designed to facilitate rigging and lifting of the enclosure during installation. Provide plugs, which fill the lifting ring holes after installation is complete. Where two or more enclosures are shown mounted immediately adjacent to one another, bolt them securely together with their front faces parallel.

3. Provide each enclosure with full height, fully gasketed access doors where shown. Provide doors with three-point latches. Provide for padlocking.

4. Arrange rear access doors and size such that they extend no further than 60.0 cm beyond the enclosure when opened to the 90-degree position. Provide access doors with full length, continuous, piano type, steel hinges with stainless steel pins. Provide for padlocking.

5. Provide enclosures with louvers, forced ventilation, or air conditioners as required to prevent temperature build-up. Except for enclosures mounted with their backs directly adjacent to a wall, place louvres 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.

10.2 Free-standing Enclosures — Fibrerglass

1. Use EEMAC type 4X fiberglass reinforced polyester enclosures. Construct the enclosures so that no metal parts are exposed.

2. Provide steel reinforced tops, bottoms, and sides. Provide an internal steel framework to support equipment, brace the enclosure, and permit lifting.

3. Provide removable lifting rings, interior lights, and receptacles as for steel enclosures.

10.3 Wall Mounted Enclosures — Steel

1. In addition to the EEMAC standards, meet the following requirements:
   a. 14-gauge minimum metal thickness.
   b. Doors shall be rubber-gasketed with continuous hinge.

Where enclosures are mounted outside or in unheated areas, provide them with thermostatically controlled heaters that will maintain the inside temperature above 40 C.

10.4 Wall Mounted Enclosures — Fibreglass

1. In addition to the EEMAC standards, meet the following requirements:
   a. Hinge doors on the left side and equip with quick release latches. Provide fibreglass reinforced polyester latches and hinges.
   b. Provide heaters as for wall mounted steel enclosures.

11. Enclosure Options — If Required

11.1 Window Kits:

1. Provide window kits suitable for EEMAC type 4 and type 12 enclosures as specified in the schedule or panel drawing.

2. Provide windows with 0.6 cm clear acrylic with steel frames. Use stainless steel frames and polycarbonate window for EEMAC type 4X enclosures.

3. Provide an oil resistant gasket to ensure a watertight seal around the window and window frame.

4. Provide window kits in a variety of sizes ranging from 7.5 cm by 12.5 cm, to 60 cm by 91 cm.

11.2 Louvres:

1. Include washable aluminum air filters with louvres used for ventilation.

11.3 Fans:

1. Provide forced ventilation fans, where used, with washable, aluminum air filters and finger guards.

2. Operate fan motors on 115 VAC, 60 Hz power. Include thermal protection. Use motors rated for 20,000 hours of continuous operations without lubrication or service.

3. Provide exhaust grilles with filters.

11.4 Closed Loop Air Conditioners:

1. Provide closed loop cabinet air conditioners as specified in the schedule or panel drawing.

2. Meet the following requirements:
   a. Power: 115 VAC, 60 Hz.
   b. Mounting: Vertical on side or back.
   c. Capacity: 1,200 to 10,000 BTU per hour as required by the cabinet equipment.

3. Provide special coatings on coils and copper lines to reduce corrosion damage.

11.5 Heaters for Condensation Control

1. Provide thermostatically controlled, fan-driven heaters for all outdoor enclosures for condensation control unless otherwise specified.

2. Meet the following requirements:
   a. Power: 115, VAC, 60 Hz.
   b. Rating: 100 Watts for panels smaller than 61 cm by 122 cm.
   c. 200 Watts for larger panels.

Provide thermostats that sense air temperature in the panel and are adjustable from 4 to 250 C.

1. Mount heaters near the bottom centre of the enclosure. Do not mount electronic components closer than 15 cm to the heater.

11.6 Heaters for Freeze Protection

1. Provide thermostatically controlled heaters for freeze protection as specified in the schedule or panel drawing.

2. Meet the following requirements:
   a. Power: 115 VAC, 60 Hz.
   b. Rating: 100 Watts for panels smaller than 25 cm by 41 cm.
   c. 150 Watts for panels smaller than 31 cm by 62 cm.
   d. 250 Watts for panels smaller than 46 cm by 76 cm.
   e. 500 Watts for panels smaller than 61 cm by 122 cm.

11.7 Moisture Protection

1. Self-regenerating desiccant, or equivalent, in heat-sealed, semi-permeable packet, Humidisorb by A+ Corporation. Provide the size and number of packets needed to protect the size of panel.

2. Self-regenerating desiccant, or equivalent, with vapour corrosion inhibitor in heat-sealed, semi-permeable packet, Humidisorb Plus X-Corrode by A+ Corporation. Provide the size and number of packets needed to protect the size of panel.

408 PLC Hardware & Software

1. General Requirements

1. The following table identifies the standard PLC hardware for use in any installation. **(No Other PLC Vendor Will Be Accepted)**.

Elgin Area and Lake Huron Primary Water System Supply

Component	Manufacturer	Model
PLC		
1. PLC Rack	Allen Bradley (Rockwell Automation)	1756-A7
2. Processor (ControLogix)	Allen Bradley (Rockwell Automation)	1756-L63
3. Power Supply	Allen Bradley (Rockwell Automation)	1756-PA72
4. Ethernet Module	Allen Bradley (Rockwell Automation)	1756-ENBT
5. ControlNet Module	Allen Bradley (Rockwell Automation)	1756-CNB
6. Redundant Control Module	Allen Bradley (Rockwell Automation)	1757-SRM
7. Modbus Master/Slave Module	ProSoft Technology	MVI56-MCM
8. Redundant Module Cable	Allen Bradley (Rockwell Automation)	1757-SRM
9. Media Adapter for ControlNet	Allen Bradley (Rockwell Automation)	1794-ACN15
Remote I/O Racks		
1. Media Adapter for ControlNet	Allen Bradley (Rockwell Automation)	1794-ACN15
2. Digital Input Module	Allen Bradley (Rockwell Automation)	1794-IA16
3. Digital Output Module	Allen Bradley (Rockwell Automation)	1794-OA16
4. Analog Output Module	Allen Bradley (Rockwell Automation)	1794-OE4
5. Analog Input Module	Allen Bradley (Rockwell Automation)	1794-IE8
6. ControlNet Modular Repeater Adapter	Allen Bradley (Rockwell Automation)	1786-RPA
7. ControlNet Fibre Repeater Medium	Allen Bradley (Rockwell Automation)	1786-RPFM
8. ControlNet Fibre Repeater-Long	Allen Bradley (Rockwell Automation)	1786-RPFL
Remote Sites		
1. CompactLogix Processor	Allen Bradley (Rockwell Automation)	1769-L32E
2. Power Supply	Allen Bradley (Rockwell Automation)	1769-PA4
3. Digital Input Module	Allen Bradley (Rockwell Automation)	1769-IQ16
4. Digital Output Module	Allen Bradley (Rockwell Automation)	1769-OB8
5. Digital Output Module, Relay	Allen Bradley (Rockwell Automation)	1769-OW16
6. Analog Input Module	Allen Bradley (Rockwell Automation)	1769-IF8
7. Analog Output Module	Allen Bradley (Rockwell Automation)	1769-OF4C
8. Left End Cap/Terminator	Allen Bradley (Rockwell Automation)	1769-ECL
9. Right End Cap/Terminator	Allen Bradley (Rockwell Automation)	1769-ECR

Central Elgin, St. Thomas and APAM

Component	Manufacturer	Model
PLC		
1. Processor (MicroLogix 1100)	Allen Bradley (Rockwell Automation)	1763-L16BWA
2. Digital Input Module	Allen Bradley (Rockwell Automation)	1762-IQ16
3. Digital Output Module	Allen Bradley (Rockwell Automation)	1762-OW8
4. Analog Input Module	Allen Bradley (Rockwell Automation)	1762-IF4
5. Analog Output Module	Allen Bradley (Rockwell Automation)	1762-OF4

2. The standard PLC/HMI Software includes the following
   a. Programming- RSLogix 5000
   b. Programming FT View SE

409 Communication Networks

1. General

1. The following table identifies the network communication standards for LANs and WANs.

Medium	Comments	Acceptable Manufacturers/Products
Ethernet Hub		Cisco 2900 series
Ethernet Routers & Firewalls		Cisco
Ethernet Media Converter	When required, provide Ethernet media converter from 100baset to duplex multimode optic fibre media. Converter shall have RJ-45 and ST connectors and shall include rack-mounting accessories.	Allen Bradley (Rockwell Automation) Ethercom – EFM-12T Blackbox – LHC001A
Network Connection Modems	When required, provide network interconnection modems for use on dial-up services.	3COM (quickest available speed)
Ethernet Jacks	When required, provide Ethernet jacks to CAT 5E and 6 standards complete with mounting plates. Jacks shall be non-keyed RJ-45 style and connections shall be by “110 Style” punch down connectors.	Hubbell Thomas & Betts Panduit
Ethernet Patch Panel	When required, provide Ethernet patch panel to CAT 5 standards in 19” rack mounting configuration and with not less than 16 ports. Rear mounted punch down connectors shall be “110 Style”. Front mounted connections shall be RJ-45 jacks.	Hubbell Thomas & Betts Panduit
Network Equipment Rack	When required, provide network equipment rack.	Rack shall have the following features: 19” rack standard (EIA 310) Minimum rack height of 17.5” (10 units) Minimum rack depth of 10” EEMAC 1 construction

410 SCADA Servers, Other Servers, and Workstations

1. General

1. All servers shall be dual, designed to suit the application.

2. All servers to include dual, removable hard drives operating in a RAID style configuration.