

City of London
Environmental Services



Consolidated
AUTOMATION AND CONTROL
VOLUME 1
DESIGN REQUIREMENTS

Version 3_9

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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 General

This document defines the City of London's base requirements for Water & Wastewater Automation Systems including minimum level of automation and how various components are to function and interact.

Unless documentation provided by the City of London along with a specific request for tender or request for proposal states specifically that a provision set forth has been waived, all provisions are to be satisfied. For example, if within a standard it is stated that specific monitoring is to be provided but this is not indicated on design drawings the requirements within these standards shall supersede unless the City has specifically stated that the specific monitoring requirements are not required on the project in question.

This document is part of a series of standards and as such should not be viewed in isolation of all other City of London standards. Associated standards may modify and/or clarify the requirements set forth within this document.

The requirements set forth within these standards are minimum requirements that shall be applied universally by all parties performing services for and/or providing equipment to the City of London. This includes, but is not limited to, all component parts that may form part of package systems.

PART 2 SYSTEM HIERARCHY

2.01 General

The control system hierarchy shall conform to a layered client server based model.

The IO Servers (IOS) shall provide a bridge between the real-time control environment, the CONTROL network segment in which the controllers operate, and the SCADA network segment. The only access to control information at the SCADA level shall be through these servers.

To ensure system integrity, and reliability, IOS nodes shall function strictly as servers and will not be used as operator interfaces. The systems shall be configured in such a manner that upon failure of an IOS OS stations will automatically reroute data flow through another IOS.

All operator stations (OS) within the SCADA system shall have the technical ability to access all information from all of the controllers through the IOS. Access control shall be restricted based on user network login and physical location. If a user does something that slows down or locks up an OS, this shall in no way limit or restrict the functionality or performance of any other OS.

Communication between OSs and IOSs will be over the SCADA segment of the City of London's Wide Area Network (WAN). The WAN is separated into different Virtual Local Area Networks (VLANs) for traffic control, one for administrative purposes and one for SCADA purposes. A separate real-time control segment shall be provided which is physically (i.e. at the hardware level) separated from the City of London's Administrative WAN. The routers will be configured to maintain complete separation between these segments such that the IOSs are the only data gateways between the two segments.

The RPU function shall be implemented using a Programmable Logic Controller (PLC) or Ultrasonic Level Controller (ULC). If field information is not required for real-time control, the devices shall be connected to the Ethernet network and polled directly by the IOS.

Polling shall be performed by not more than three IOSs at any point in time (the local IOS, the primary IOS and the backup IOS). If the information is required by other systems, information shall be passed over the SCADA network through these IOSs to the other nodes.

The approach to control will conform to one of the following methodology.

- PLCs shall be used for all control at plants and critical pumping stations. Ethernet will directly connect these PLCs to the IOSs over the dedicated Real-time network segment.

- At VFD & complex pumping stations (see City of London Pumping Station Philosophy for definitions) control will be provided by PLCs. Leased line serial modems will bridge these PLCs to the Real-time network segment at which point communication will be converted to Ethernet.
- At basic pumping stations Ultrasonic Level Controllers (ULC) will provide control. At these locations, the ULCs, along with all supplemental devices, shall be connected to a local serial RS-485 network. Leased line serial modems will bridge these “network” to the Real-time network segment at which point communication will be converted to Ethernet.

2.02 Programmable Controller

Controllers are to be kept relatively small for ease of programming and start-up, and for increased process reliability. When implementing control system, the following general design principals shall be followed.

- Under normal operating conditions, all automated control strategies shall be executed by the RPU.
- Control devices shall be connected in such a fashion that fail-safe operation is ensured in the case of Controller failure.
- The control system shall be designed in a manor that supports manual base loading of process equipment associated with a failed controller. While base loaded, controllers that are still operational will adjust the equipment under their control to compensate for process variations.
- 24Vdc discrete wiring or serial digital communication shall connect all digital I/O that is connected by new field wiring. All digital I/O that is connected using existing field wiring shall be 120 Vac. All field devices shall be connected without interposing relays.
- Control and timer relays shall only be used where required by regulation to provide hardwired critical safety and process interlocks.
- Interposing relays shall only be used were the load requirements exceed the rating of RPU I/O.

The following additional special conditions may also apply depending upon the nature of the process.

- For critical portions of the process, which are defined as those processes where process equipment redundancy is provided by design, redundancy shall also be designed into the control system.
- For critical processes with multiple process streams, multiple controllers are to be deployed splitting the control of the process such that at least one stream is maintained should a controller fail.

- A hot standby redundant control is required for those applications where the process will not always remain in a safe stable state until the controller is replaced.

2.03 Control Interface

The following four basic interface levels are to be provided to the control system.

- Local Control – Hard wired control panels
- Area Control – Direct communication with RPU
- OS Control – Interfaced through IOS
- Supervisory – Limited view function through WEB Server

These are described in detail in the following sections.

(a) Local Control

Local Control is the first level of interface to the control system. As a minimum, the field station will provide an override operation with lockout capability. No remote operation of the device shall be possible while in local mode.

The operator interface at this level shall be kept to a minimum. In those cases where the process requires field control actions in case of RPU failure, hand/off/remote selectors or local/remote switches and start/stop pushbuttons will be located at the Device, MCC or VSD. These controls shall function independent of the RPU.

Panels are not to be provided with status indicators (e.g. lamps & gauges) or mechanical control devices (e.g. switches & pots) except where associated with fail-safe control and are fully functional independent of the PLC.

(b) Area Control

Area control interfaces shall be provided for adjustment of control parameters such as pump queue, control limits (e.g. high and low control levels at pumps stations) and display of local alarms.

Control shall be provided by means of a graphical active matrix touch panel interfaced directly with the RTU controlling the process. The panel shall display key control parameters including current alarm conditions. The panel shall allow for local adjustment of control parameters and provide basic control.

At facilities with Ethernet connectivity, the area control panels shall be connected to the Real-time network.

(c) OS Control (SCADA)

OS control stations are the primary operator link to the process. The operator shall be able to start/stop equipment, change control set points, and monitor the process from these stations. These stations shall have complete access to all

information and shall be strategically located to ensure operators are able to quickly access the control system from all major sites.

As a minimum, the OS control stations will provide the functionality listed below.

- Annunciate and acknowledge alarms.
- Permit adjustments to event triggers for analog alarms, discrete alarms and events.
- Display status of process equipment and instrumentation information.
- Permit entry of control commands and track operational changes.
- Provide access to historical trends and event information.
- Generate both routine and custom reports.

In general, for maintenance, support and reliability reasons, OS stations shall be restricted to only those locations which have controlled office type environments and direct Ethernet connection to the City of London's WAN. Where it is necessary that OS systems be located in harsh environments, defined as any environment other than climate controlled office class environments, they shall be mounted in environmentally controlled cabinets such that the equipment is not exposed to conditions which may result in premature failure. Where exposure may be compromised due to an operator leaving keyboard trays or access openings open, these openings shall be monitored and when left open for prolonged periods alarmed.

(d) Supervisory View (WEB)

Supervisors and other key personnel within the City of London shall be provided with access to information via a standard WEB browser interface. The interface shall provide the ability to view and generate reports on information managed by the OS system, both real time and historical. In addition to access to information directly managed by the OS system, these individuals will also be provided with access to historical reports.

2.04 Servers

(a) Central Application Servers

Central Application Servers shall collect status and process data from field devices and controllers on a real-time base. In addition to making this information accessible to other systems on a real time basis, these systems shall store the information for historical analysis. These servers shall function in a redundant configuration.

The Central Application Server shall also maintain the master copy of the graphic application and transmit the application files to the area operator station as required to keep them up-to-date.

In addition to historian data from SCADA, the database on these servers shall also store manually entered operational data, lab transmitted data, maintenance management records, etc.

(b) Distributed Application Servers

Distributed application servers shall communicate with all PLC's within their span of control. In addition to making information accessible to other systems on a real time basis, these systems shall buffer the storage of historical information during communication interruptions with the Central Application Servers. In essence the primary purpose served are redundant communication portals.

(c) SCADA Web Server

The SCADA Web Server shall support controlled access to the real-time application graphics and historical data through the City of London intranet. This system shall be dedicated to performing solely this function.

The SCADA web server shall provide intranet support for browser access to the SCADA graphics screens and operational reports.

PART 3 GENERAL PHILOSOPHY

3.01 General

The primary function of process control systems is to provide a cohesive real-time interface allowing operators to interact with process operations under various operating conditions. A secondary function is to automate time consuming and/or routine tasks in order to allow staff to focus on other activities.

- Device run lamp & Hand/Off/Remote selector shall be located at the MCC.
- Control systems for critical processes shall be designed with 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. Decisions by the City shall be binding and final.
- Control system shall be designed such that in the event of a controller failure process equipment can still be operated manually. Equipment connected to other controllers, but related to the device controlled by the failed controller, will automatically compensate for all process variations.
- All process equipment operation shall be fully automated. For example, equipment shall automatically shut down when operating beyond safe limit. In addition, auxiliary safety equipment shall start automatically when needed; for example, ventilation fans shall start when high toxic gas concentrations are detected. One goal of automation (design, implementation and maintenance) is to operate with the number of pages per day kept to a minimum.

3.02 Instrumentation

- All instrumentation shall be monitored by the SCADA system and logged to the historian.
- 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.
- Instrumentation shall be provided as required for monitoring of all parameters not specifically listed above but set forth as a C of A reporting requirements.
- Automatic samplers shall be provided as required to satisfy “C of A” monitoring requirements.

- All instrumentation shall be designed for continuous online process monitoring and shall conform to all requirements set forth under the applicable City of London Standard for instrumentation.
- SEE AUTOMATION & CONTROL STANDARDS FOR BASE MONITORING REQUIREMENTS. The following classes of facility are defined:
 - 1) Sewage Treatment Facilities
 - 2) Sewage Pumping Stations
 - 3) Water Storage Facilities
 - 4) Water Pumping Stations
 - 5) Water Distribution Chambers

3.03 Gates and Valves

The following rules apply to determining the level of monitoring required for valve and gate positions.

- Full open-close type valves that are remotely controlled require limit switches for both the open and closed positions.
- Valves that are manually controlled require one limit switch for monitoring the normal operating position.
- Modulating valves and gates require limit switches for both full closed and full open positions. These valves shall also provide positive positional feedback (i.e. % open).
- Valves and sluice gates that are only used to isolate process equipment such as clarifiers, flumes and tanks for maintenance purposes shall be monitored where improper position may result in a health and safety risk, damage to equipment, and/or an environmental hazard. Limit switches shall confirm normal operating position (i.e. if the normal operating position is closed, limit switch shall monitor the fully closed position).

Limit switches and position sensing transmitters are to be provided as an integral part of the valve assembly and shall be furnished by the manufacturer of the valve.

3.04 Package Systems

Process equipment is often procured as a subcontract under which a complete package is provided with self-contained controls and instrumentation.

- Package system, and all component parts thereof, must conform to all requirements set forth within the City of London Standards unless specifically exempted within this section.

- 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 incorporated.
- 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.
- Package systems with self-contained controllers shall connect by Ethernet (EGD or SRTP protocol) to the City's distributed control system.

3.05 OS Topology

The intent of this section is to provide a general conceptual understanding of the City of London's overall control architecture.

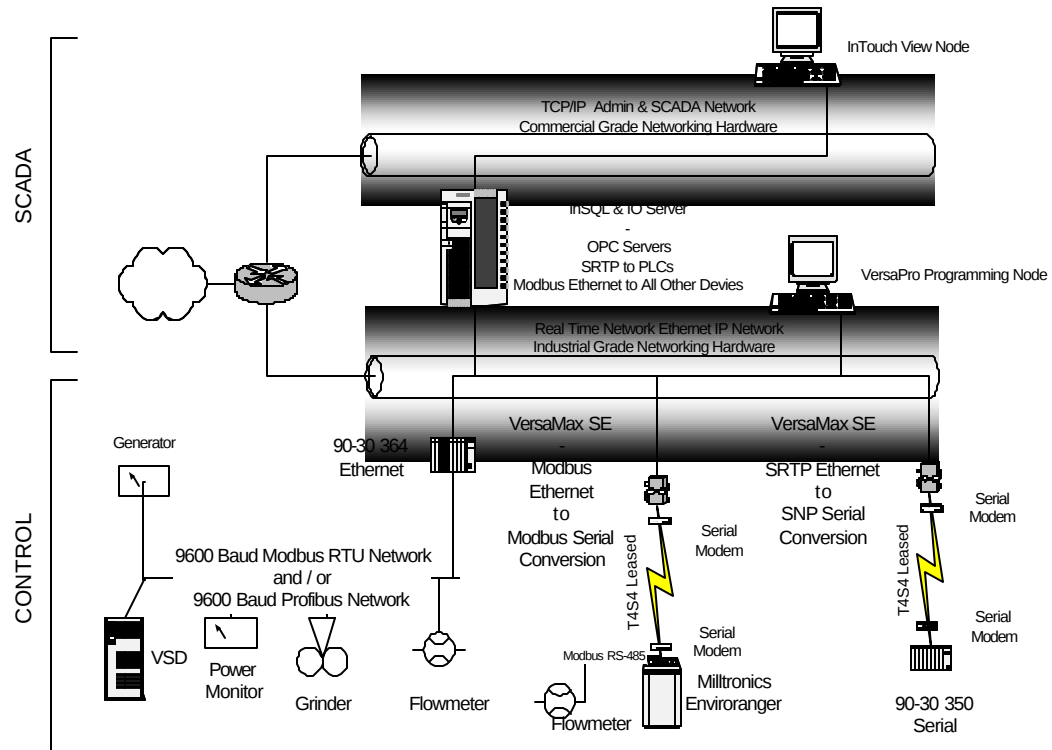
The following fundamental guidelines apply to all projects.

- All programmable controllers 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 between a PLC and analog devices, including but not limited to instrumentation, may use Ethernet SRTP, Modbus Ethernet, RS-485 Profibus and/or RS485 Modbus RTU.
- All Power Monitors & Programmable devices (e.g. VSD, PLC, Enviro Ranger, etc.) are to be directly connected to the City of London's "Real-Time" Ethernet control network and provide for remote program examination and modification over this network. The contractor shall provide complete details (including passwords and documented source code) regarding how to connect to and modify the configuration and program of all programmable devices over this network.
- For locations with direct Ethernet connectivity, UPS monitoring is to be provided by direct Ethernet connection to UPS.

Routers will be supplied and installed by Bell Canada as directed by the City of London's TSD group. All other communication equipment is to be provided by the Contractor. All equipment, including routers, shall be installed by the Contractor and/or under the contractor's supervision.

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. It is up to the Contractor to confirm exact components and configuration requirements with the City as this information may not necessarily be provided in the tender package. The Contractor is responsible for acquiring adequate information at time of tender

to avoid errors and/or omissions resulting from the provision of incomplete information within the tender package.



3.06 Device Communication Network

All devices (excluding new MCCs) providing analog data and/or multiple discrete inputs shall have either:

- RS-485 port supporting multi-drop communications (the protocol supported shall be Modbus RTU or Profibus);
- Ethernet port supporting GE SRTP or Modbus Ethernet (the port shall support both 10MB & 100MB data transmissions).

Typical devices that shall be connected by these means include:

- VSDs/VFDs (Variable Speed Drives);
- Flow Meters;
- Chemical Feed Pumps;
- Valve Actuators;
- Motor Protection Relays;
- Power Monitors;

- Generators;
- Online Instrumentation.

In the case of VSD motors, in addition to the serial link, a separate discrete hard-wired motor run status shall be provided.

MCCs shall be DeviceNet based providing full digital communication connectivity to the City of London Real Time Control Network.

If from a control perspective it is possible to subdivide the process into parallel process streams, the devices are to be distributed over separate communication buses such that with the loss of a single bus at least one process stream will remain fully operational. For example, at a four pump pumping station, bus one could monitor all devices associated with the control of pumps 1 & 3 and a second bus could monitor devices related to the control of pumps 2 & 4.

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. In addition to monitoring, the communications link shall also allow remote program modifications. 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.

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.

PART 4 PUMP STATION PHILOSOPHY

4.01 General

This standard provides a baseline for pumping station control and automation setting forth the minimum requirements for new pumping stations and the upgrading and expansion of existing facilities.

For the purposes of this document, Pumping stations are divided into the following general categories.

- Basic: This approach is only applicable to a limited number of locations and shall not be used if one or more of the following attributes apply: multiple wet wells, over three pumps, valves actuators and/or one or more pumps over 50 hp.
- VFD: All other locations shall be controlled by variable frequency drives (VFD). All new stations and retrofits with pumps 50 hp and over are to comply with these requirements.

Where upgrade costs are prohibitive, the City of London may, on a case-by-case basis, at the City's sole discretion, approve deviations from these standards.

4.02 Communication between SCADA & Pump Station

The Contractor shall be responsible for communications with the pump station up to and including the serial protocol converter connecting the pumping station to the City of London WAN. This includes, but is not restricted to, responsibility for all communication at the pumping station and the communication link between the pumping station and the point of connection to the WAN (Wide Area Network) by S4T4 (Bell Canada Schedule 4 Type 4) phone circuit.

With the exception of Basic pumping stations, all devices shall communicate with the PLC (Programmable Logic Controller) over RS485 Profibus communication links. In turn, the PLC shall communicate over phone lines by SNP (GEFanuc Series Ninety Protocol) which shall be converted to SRTP (GEFanuc Ethernet based Service Request Transfer Protocol) at the point of connection to the WAN.

At basic pumping stations all RS485 communication shall be by Modbus RTU protocol and all devices shall be directly accessible from the City of London WAN. The Ethernet converter in this case shall convert Modbus RTU to Modbus Ethernet.

The contractor is not responsible for changes required to the Central monitoring system used to remotely monitor the pumping stations. However, the contractor is responsible for all works at the pumping station including all local interface requirements.

4.03 Common Strategy

The following sections describe the operation of the key processes that shall be performed at each pump station. The focus is on describing automatic and backup modes of operation as these are the normal modes of operation.

Manual Control is not specifically discussed 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.

Unless parameters are specifically identified as derived, all monitored information is to be provided directly from field instrumentation (e.g. where rate of flow is listed, a flow meter which conforms with City of London Standards for Flow Meters must be provided and must provide this information directly).

Detailed pump monitoring, such as temperature and vibration, where stated as required, shall be interlocked with pump control by dedicated integrated electronic motor protection relay controller.

Pump run lamp & Hand/Off/Remote selector shall be located either at the MCC or the location of the backup interface panel – not both.

Local electronic touch screen operator interface data panels shall be provided for all pumping stations with PLCs. For basic pumping stations, an operator interface integral to the ultrasonic controller may be substituted.

The contractor shall have a process control engineer specializing in water and wastewater review the requirements set forth within this document. The engineer shall identify all deviations (if any) required to the control philosophy in order to address site specific operational restrictions. Suggested changes shall be submitted to the City for review – if in the City’s opinion the changes are required a change order shall be issued, otherwise the contractor shall conform to the requirements set forth in this standard.

4.04 Process Objectives & Performance Indicators

Process objectives define the basic framework for monitoring the efficiency and effectiveness. The following list of process objectives identifies the performance indicators which the control system shall monitor.

Effectiveness

1. Prevention of Sewage Spills
 - a) Frequency of Bypasses (Mean Time Between Bypasses)
 - b) Duration (Average Duration, Total Annual Duration)
 - c) Severity (Volumetric)
2. Transfer of Flow Toward Treatment
 - a) Pump Fail (MTBF (Mean Time Between Failure) for each pump)
3. Service Interruptions during Power Failure

- a) # of bypasses during power outages
- b) hours Generator online / hours power offline

Quality

- 1. Avoidance of Deposition in Networks
 - a) Discharge Pressure Increase without Increase in Flow
 - b) Grinder (MTBF)

Efficiency

- 1. Minimize operating costs
 - a) kW / ML pumped
 - b) Gallon Diesel / ML pumped on Standby
 - c) Mean Time between alarm events

4.05 Basic Pumpage

(a) Level Control & Flow Monitoring

RPU Automatic

- 1. 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.
- 2. 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.
- 3. At stations which have a possibility of bypassing, bypass pipes of sufficient size to handle bypass flows shall be provided complete with appropriately installed magnetic flow meters to monitor bypass flows. This requirement is irrespective as to whether the bypass will occur locally at the station or at a remote chamber.
- 4. The local controller shall provide for local buffering of the start time, duration and volume of bypasses. The design shall ensure that if a bypass should occur during a communication interruption that the event shall still be accurately recorded locally and shall then be transmitted to the central SCADA and recorded centrally upon reestablishment of communication.
- 5. Also, local UPS power shall be provided to all devices necessary for accurate estimation of bypass start time, duration and volume of bypasses during a communication interruption.

Backup Control

- 1. A low-level stop and high-level start float shall be provided.

(b) Pump Control

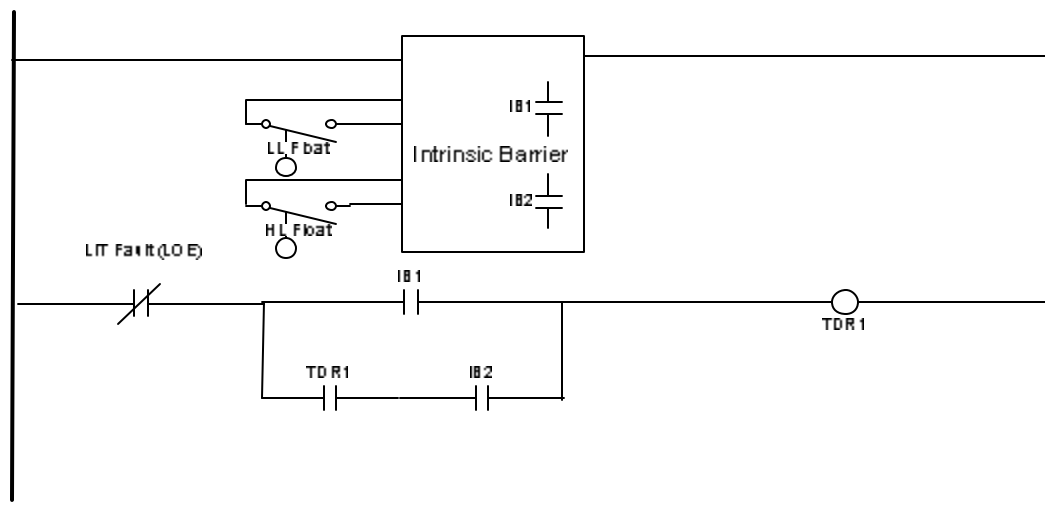
RPU Automatic

1. The ultrasonic controller shall perform pump control, event monitoring, and remote communications. The control algorithm selected shall as closely as possible match the control algorithm described for complex pumps.

Backup Control

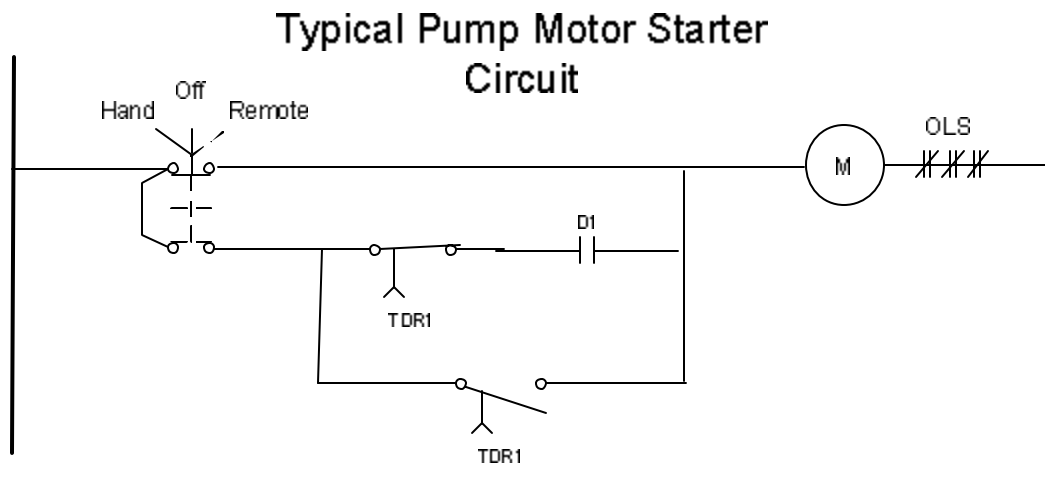
1. Upon loss of echo, relay based backup pump control will automatically

Ultrasonic Control - Two Backup Floats



enable.

2. When enabled for backup pump control, if the backup high-level start is exceeded for more than a predefined time interval (independent timer relays shall be provided for each pump) the pump will start.
3. If the level falls below the backup level, all pumps selected as backup pumps will stop irrespective as to what the Ultrasonic is calling for.
4. Under normal operation pumps with backup control enabled will be controlled by the RPU. Unless a fault is detected, ultrasonic pump control will not be overridden by relay control.
5. The following diagram is intended to demonstrate the general concept. The contractor is responsible for engineering the actual control circuit to provide the described functionality, irrespective as to errors and/or omissions (if any) in these diagrams.



(c) Enviroranger IO Assignment

See Automation & Control – Volume 2 - Standards

(d) Control Interface

The following defines the minimum acceptable I/O requirements.

Hard-wired Interface

1. Lamps:
 - a) Bypass Level / Bypass Flow Detected
 - b) Backup Circuit High-level Start
 - c) Backup Circuit Low-level Stop
 - d) Hardwired Interlock status for each interlock
 - e) Backup Control Start Commanded for each Pump
 - f) Pump Run Status for each Pump
2. Switches:
 - a) Normal/Test Switch, spring return with latch to hold switch in either position.
 - b) Hand/Off/Remote Selector for each Pump

SCADA to Controller

1. Pump start/stop control levels (for each pump)
2. Pump duty selection (duty / standby)
3. Pump Auto / Manual (for each pump)
 - Auto – control provided by ultrasonic control algorithm

- Manual – pump operation manually controlled by operator at SCADA

4. Pump Start / Stop (for each pump)

Controller to SCADA

1. Status of all IO defined under section 2.03
2. Wet well level
3. Loss of echo
4. Total station flow (RS-485 connection to discharge flow meter)
5. Pump Discharge Header Pressure (RS-485 connection, but only applies to pump stations pumping into force mains)
6. Pump Mode (Auto / Manual – repeated for each pump)
7. General Pump Fail (Common for all pumps)
8. Backup Control Enabled (Common for all pumps)
9. Total Station Power (kWh) derived from pulse connection to revenue meter

SCADA Derived Values

1. Pump run status – Uncommanded Stop
2. Pump run status – Uncommanded Start
3. Bypass flow – estimated by SCADA based upon level and flow velocity provided by ultrasonic.

4.06 VFD Pumpage

(a) Level Control & Flow Monitoring

RPU Automatic

1. Each pump well will be equipped with a separate ultrasonic level monitor and separate transceivers.
2. For locations with multiple ultrasonic, the operators shall be able to select between duty, standby and offline for each transceiver. If the duty transceiver reports a fault, and a standby unit is defined, the PLC will automatically switch control to the standby unit.
3. When a pump well has been taken out of service for maintenance, the monitor for the well that is out of service will be locked out of service based on gate position limit switches on the interconnection and inlet gates.
4. If the overflow/bypass is located above the level monitored by the transducers used for control, additional transducers will be mounted to monitor high levels.
5. A bypass/overflow float will be provided as a backup to the ultrasonic based level monitoring system.
6. Individual magnetic flow meters will be provided for each pump.

7. At stations which have a possibility of bypassing, bypass pipes of sufficient size to handle bypass flows shall be provided complete with appropriately installed magnetic flow meters to monitor bypass flows. This requirement is irrespective as to whether the bypass will occur locally at the station or at a remote chamber.
8. The local controller shall provide for local buffering of the start time, duration and volume of bypasses. The design shall ensure that if a bypass should occur during a communication interruption that the event shall still be accurately recorded locally and shall then be transmitted to the central SCADA and recorded centrally upon reestablishment of communication.
9. Also, local UPS power shall be provided to all devices necessary for accurate estimation of bypass start time, duration and volume of bypasses during a communication interruption.

Backup Control Level

1. For stations with only one ultrasonic, each pump well will be equipped with two control floats – low-level stop, high-level start.
2. For stations with two or more ultrasonic, the relay contacts on the ultrasonic level transmitter will be used for backup control.

(b) Pump Control

RPU Automatic

1. The following strategy describes the normal mode of operation for VFD based pumps. The actual PLC control algorithm shall provide for greater variation in pump control in order to address site specific requirements. Contact the City of London for details regarding additional functional requirements if not using the City of London's standard PLC pump control algorithm block.
2. It is the responsibility of the design engineer to review the standard control strategy and advise the contractor of any specific local requirements which may require changes to the standard control strategy.
3. The following control parameters apply to RPU automatic mode of operation.
 - 1) MES - Minimum Efficient Speed for each pump (not adjustable to less than the MOS - Minimum Operating Design Speed)
 - 2) MaxS – Maximum control speed for each pump (in most cases this will be 100%)
 - 3) Upper Control Level
 - 4) Pump Start Level - for each pump
 - 5) Pump Start Time Delay
 - 6) Pump Stop Level
 - 7) Pump Stop Time Delay

- 8) Duty Queue Position - For each pump
- 9) Duty Queue Rotation - Auto / Manual
4. The following algorithm applies to the starting of pumps and ramping of the speed of the pumps while in RPU Automatic.
 - 1) As the well level increases above the Pump 1 start level, Pump 1 starts and is ramped by the VFD up to the MOS.
 - 2) The PLC then increases the speed to the MES.
 - 3) As the well level increases, the speed of the pump increases linearly from the MES to the MaxS at the Pump 2 start level.
 - 4) If the level is still increasing after the Pump Start Delay, Pump 2 will start.
 - 5) Once Pump 1 is at MaxS, if the level is still increasing Pump 2 starts and is ramped by the VFD to the MOS.
 - 6) The PLC then increases the speed of the second pump while decreasing the speed of the first pump until the speed of both pumps are the same.
 - 7) Once reaching this level, the pump speed will adjust linearly between the Upper Control Limit (the Upper Control Level if all pumps are running or the next pump start level if all pumps are not running) and the start level for the first pump.
 - 8) The speed set point will be calculated for each pump by the following general equation.

$$y = mx + b \quad \text{where}$$

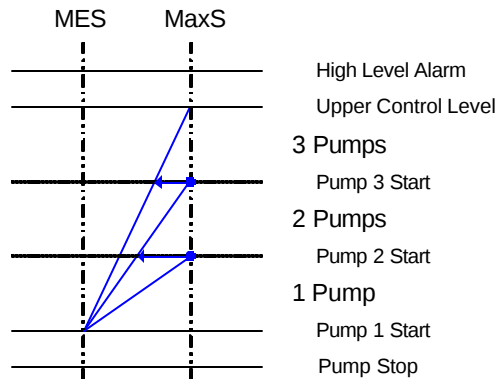
y = speed set point

x = current pump well level

m = (Upper Control Limit – Lower Control Limit) / (MaxS - MES)

b = (MES – MOS) / (MaxS – MOS)

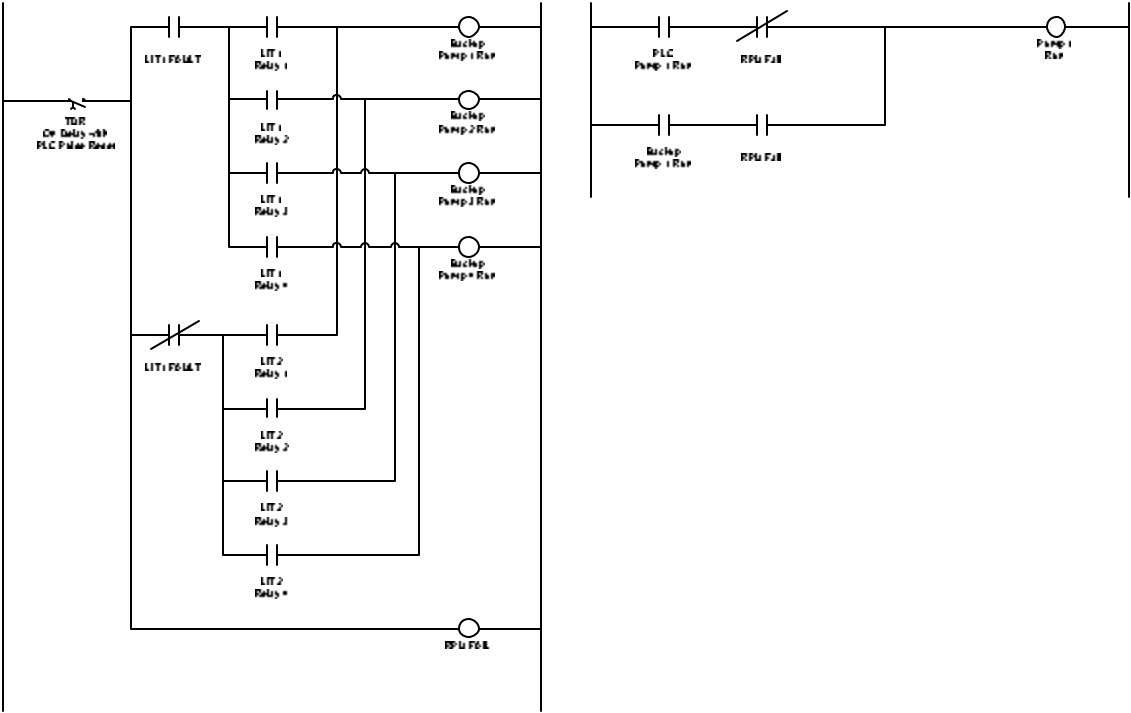
- 9) The same pattern is repeated for each subsequent available pump.
- 10) If a duty pumps fails to start, if a standby pump is designated, the standby pump will be called to start. The standby pump will not start unless at least one duty pump has failed to start. Note that pumps not included in the duty queue will not start.



5. The following algorithm applies to the stopping of pumps while in RPU Automatic.
 - 1) Once all the pumps have all slowed down to the MES, if the level drops below the "All Pump Stop" level for more than the Pump Stop Delay one pump will stop. If in Auto Duty Queue Mode, pumps will stop on a FIFO basis (and the duty's will automatically rotate) while pumps will stop based on queue position if in Manual Duty Queue Mode.
 - 2) As each pump stops, the Upper Control Limit will adjust accordingly such that the ramp is between the Pump 1 Start level and the Start Level for the next duty pump to be started as the level increases.

Backup Control

1. Backup control will automatically enable upon failure of the PLC. PLC failure shall be detected based upon a PLC pulse not being received by the backup circuit for a period of 1 minute.
2. When enabled for backup pump control, if the backup high-level start is exceeded for more than a predefined time interval (local timer relay for each pump) the pump will start and ramp to 100% speed irrespective as to what the RPU is calling for.
3. Thus, since the pump run is actually driven by a Time Delay relay, it is possible to sequence the pumps such that one pump starts immediately and subsequent pumps after an adjustable time period start if the level does not drop below the start level.
4. If the level falls below the backup level, all pumps selected as backup pumps will stop irrespective as to what the RPU is calling for.
5. The following diagram is intended to demonstrate the general concept for a station with two well. The contractor is responsible for engineering the actual control circuit to provide the described functionality, irrespective as to errors and/or omissions (if any) in these diagrams.



- e) Pump Start Time Delay
 - f) Pump Stop Level
 - g) Pump Stop Time Delay
 - h) Duty Queue Position - For each pump
 - i) Duty Queue Rotation - Auto / Manual
2. Ultrasonic duty selection (Duty, Standby) – If applicable
 3. Auto / Manual for each pump
 - Auto – control provided by PLC control algorithm
 - Manual – pump operation manually controlled by operator at SCADA
 4. Start / Stop for each pump
 5. Manual Speed set point for each pump
 6. Alarm System Rearm

Controller to SCADA

1. Running status for each pump
2. Speed for each pump
3. Wet well level (for each ultrasonic)
4. Loss of echo (for each ultrasonic)
5. Overflow/bypass float (for each wet well)
6. High wet well level float (for locations with only one ultrasonic)
7. Low wet well level float (for locations with only one ultrasonic)
8. PID Tuning Parameters for each PID loop
9. Pump flows (for each pump)
10. Bypass flow
11. Pump Discharge Header Pressure (only applies to force mains)
12. All site specific interlocks (e.g. emergency stop, interconnection gate closed status)
13. Pump Alarms
 - 1) General pump fail (for each pump)
 - 2) Moisture detection (for each submerged pump)
 - 3) High Casing Temperature
 - 4) Excessive Vibration
 - 5) High Bearing Temperature (inboard and outboard)
 - 6) High Stator Temperature
 - 7) Motor Overload

4.07 Grinders

(a) General

All pumping stations 50 hp and over will be equipped with in channel grinders upstream of the pumps. These grinders shall be installed in such a fashion that flow automatically bypasses the grinders and passes through coarse screening in the event the grinders should fail.

All pumping stations 50 hp and under where traditionally screens would have been installed shall be equipped with either chopper pumps or inline grinders. This equipment shall match the model and manufacturer of equipment currently installed within the City's collection system.

All other locations shall be equipped with non-clog style pumps.

4.08 Standby GENERATOR

(a) General

All new pumping stations shall include a permanent standby generator which shall provide alternate power in the case of power interruptions unless the City of London states otherwise for a specific station.

Where it is deemed by the City that a permanent generator is not currently warranted the pumping station design shall still provide for the future installation of a permanent generator. In addition, the station shall be designed with transfer switch and standby power socket which will accommodate the City of London's portable generators.

(b) Process Control Strategy

The control system for standby generation and transfer switch shall be provided by a single supplier as a complete package. Although the detailed control strategy shall be developed by the manufacturer of the generator, the following general strategy shall apply.

1. Generator to start on loss of grid supply. Once generator operating in a steady state, load to be transferred to the generator.
2. After transferring to the Generator, the load shall not be transferred back to the Grid until grid power has remained on for a period of 5 minutes.
3. The Generator shall not stop until the load has been successfully transferred back to the grid.
4. Changeover-switch control shall be integrated with control circuit for standby power generator.

(c) Control Interface

See Automation & Control – Volume 2 - Standards

4.09 Site Monitoring

(a) Process Description

Building and site monitoring pertains to support systems such as heating, ventilation and air conditioning (HVAC), sump pumping, building drainage, fire detection and security.

The following general guidelines apply to all pumping stations, however more comprehensive strategies may be required depending upon location specific details.

All additional monitoring required to meet applicable regulatory requirements including but not limited to building codes, health & safety guidelines and MOEE C of A requirements shall be provided. It is the responsibility of the contractor to determine all such requirements before bid submission.

(b) Process Control Strategy

Entry Alarms

Pump stations are to be provided with keypad based security systems. The keypads are to automatically rearm after a programmable time delay. The keypad shall locally display which specific contact switch has been tripped.

When the administrator code is entered, the keypad shall display a detailed history of the past 1000 events including who entered the building and at what time.

The controller shall monitor a single NO alarm contact and a single NC alarm disabled contact both provided at the keypad. A relay output from the controller shall be connected to the keypad in order to allow the security system to be rearmed remotely by SCADA.

If site alarms have been disabled for a period of 60 minutes an alarm shall be triggered indicating that the system has been disabled.

Alarm Test Mode

Each pumping station panel will have a key lock, spring return selector switch to select between Test & Normal mode of operation. In Test mode the system shall behave as follows:

1. When momentarily switched to the “Test” position all normal alarms from the station will be acknowledged and disabled for 15 minutes.
2. In addition, a test alarm shall be triggered which will be treated as a low priority alarm at the SCADA but will trigger an immediate page to the appropriate pump crew.
3. Once the page is acknowledged, the alarm will clear.
4. If the switch is latched in the Test position, every 60 minutes an alarm will be triggered indicating that the pump station alarm system is in test mode.

(c) Control Interface

See Automation & Control – Volume 2 - Standards

PART 5 P&I DRAWINGS

5.01 Introduction

This standard defines the City of London requirements regarding the development of P&I drawings. This standard is based on the Instrumentation Society of America (ISA) standard ISA-S5.1-1984, “Instrumentation Symbols and Identification.” This material has been reformatted to be directly applicable to the water and wastewater industry.

Although this section is based on ISA, it is not constrained by it and hence some deviations do exist.

All P&I Drawings are to be generated in Microsoft Visio as native Visio Drawings. AutoCAD generated drawings are not acceptable.

5.02 Purpose of Standard

- This standard is intended to ensure that information is shown in a consistent fashion on all drawings generated for the City. Consistent presentation speeds staffs’ ability to review and understanding diagrams. Consistent preparation of the diagrams will also enable the use of data base access to and from information on the diagrams.
- This standard applies to all design project and construction contracts that prepares or modifies P&IDs.
- The contractor is responsible for converting all existing diagrams already prepared related to the works covered under this contract which are inconsistent with this standard to this standard.

5.03 ISA Reference Standard

- Duplication and conflict may exist between standards set by ISA and by other agencies or standards setting organizations such as Canadian Gas Association (CGA), National Fire Protection Association (NFPA), and International Standards Organisation (ISO).
- P&IDs are to be produced which are consistent with ISA in order to have documentation readily understood by as wide an audience as practical. Symbols and nomenclature not defined within the ISA standards will only be used with the written consent of the City of London except where already defined within City of London standards.
- The electrical symbol sheet (not ISA), shall be included in each drawing set containing panel control diagrams.

5.04 Purpose of P&ID

- P&IDs shall convey process, instrument and control equipment information. It shall be possible from the P&IDs for an individual who has a reasonable

knowledge of sewage and water treatment to understand the means of measurement and control of the process.

- The P&ID must be an accurate representation of the physical process or system and shall show equipment in the proper functional relation. P&IDs shall include the following:
 - Process piping, tanks, structures, and equipment;
 - Primary elements, transducers, and analyzers;
 - Actuators and final control elements;
 - Panels and controls;
 - Input/output signals to digital controllers;
 - Schematic representations of control signal interconnections.
- P&IDs shall be used during the design phase for:
 - Computer control strategy design;
 - Computer input/output point list development;
 - Field instrument schedule development;
 - Control panel design;
 - Electrical interface definition;
 - Mechanical and electrical equipment tagging;
 - Overall design coordination.
- During construction and start-up P&IDs shall be used for:
 - Shop drawing review of computer controls, panel and loop submittals;
 - Electrical interface coordination;
 - Graphic display development/approval;
 - Process control operational checkout;
 - Developing as built drawings;
 - Developing operation and maintenance manuals;
 - Training.

5.05 Scope of Drawings

- A set of P&IDs for a process or sub-process shall include all aspects of the process or sub-process. That is, all of the piping, equipment, instrumentation and controls in the process or sub-process must be included on the drawing set. For example, the set of P&IDs for a pumping sub-process would include the main system, e.g. waste sludge or wash water pumping and all auxiliary systems such as sample system, drainage system, service water, city (potable) water, instrument air, power distribution, gas monitoring, hydraulic and pneumatic systems, security, fire alarm and suppression, safety systems and heating, ventilation and air conditioning.
- P&IDs must show:
 - All automated and non-automated systems;

- o Current project additions, deletions and modifications;
 - o Existing conditions and future provisions if known;
 - o All hardwired interlocks, totalizers and signal converters;
 - o All software controllers and software interlocks.
 - o All inputs and outputs of the Process Control System and the instruments and equipment that provide the inputs and receive the outputs.
- The P&IDs shall show virtual points where needed to clarify control logic.
 - The P&IDs do not include equipment that is not associated with operation of the process or sub-process. That is, the drawing set does not include such equipment as elevators, cranes, lights, vehicles, phones, fire extinguishers or computers.
 - Information shall only be shown once. Do not repeat symbols for the same I/O point, instrument or piece of equipment on more than one drawing.

5.06 Drawing Phases

- The P&IDs are to be developed in stages in order to add information at the appropriate time. The required P&ID development stages at which point these drawings are to be reviewed by the City are shown in the following table.

Major Item	Preliminary Design	Final Design	As Built
Piping, tanks, equipment and valves for process and auxiliary processes	-	Required	Required
Sensors, transmitters, switches	Required	Required	Required
Actuator type with pneumatic and hydraulic instrumentation	Required	Required	Required
Panel – Face mounted instrumentation - New / Modified custom panels - Existing custom panels - Equipment package panels - Specialty package panels	Required - - -	Required Required - Required	Required Required Required Required
Panel – Internal instrumentation - New / Modified custom panels - Existing custom panels - Equipment package panels - Specialty package panels	- - - -	Required Required - Required	Required Required Required Required
Control loops – hardwired	Required	Required	Required
Control loops – software	-	Required	Required
Control parameters – Setpoints, limits	-	-	Required
Use of Typical Allowed?	Yes	No	No

5.07 Control Levels

- Use a layered approach to distinguish the various levels of control.
 - o Place field instrument and equipment balloons above or next to the devices.

- Locate field controls, motor controls, and area control panels above the field devices at separate levels.
- Where applicable, the highest level shall show program logic controller (PLC), remote terminal unit (RTU), distributed process controller (DPC) and remote station controller (RSC) identification.
- Identification tagnames shall conform to the City of London Standard for Identification.

5.08 Interlocks

Process interlocks are control connections wired between two separate equipment items. For example, a hard-wired control connection that causes an electro-hydraulic check valve to operate whenever a pump starts and stops is a process interlock.

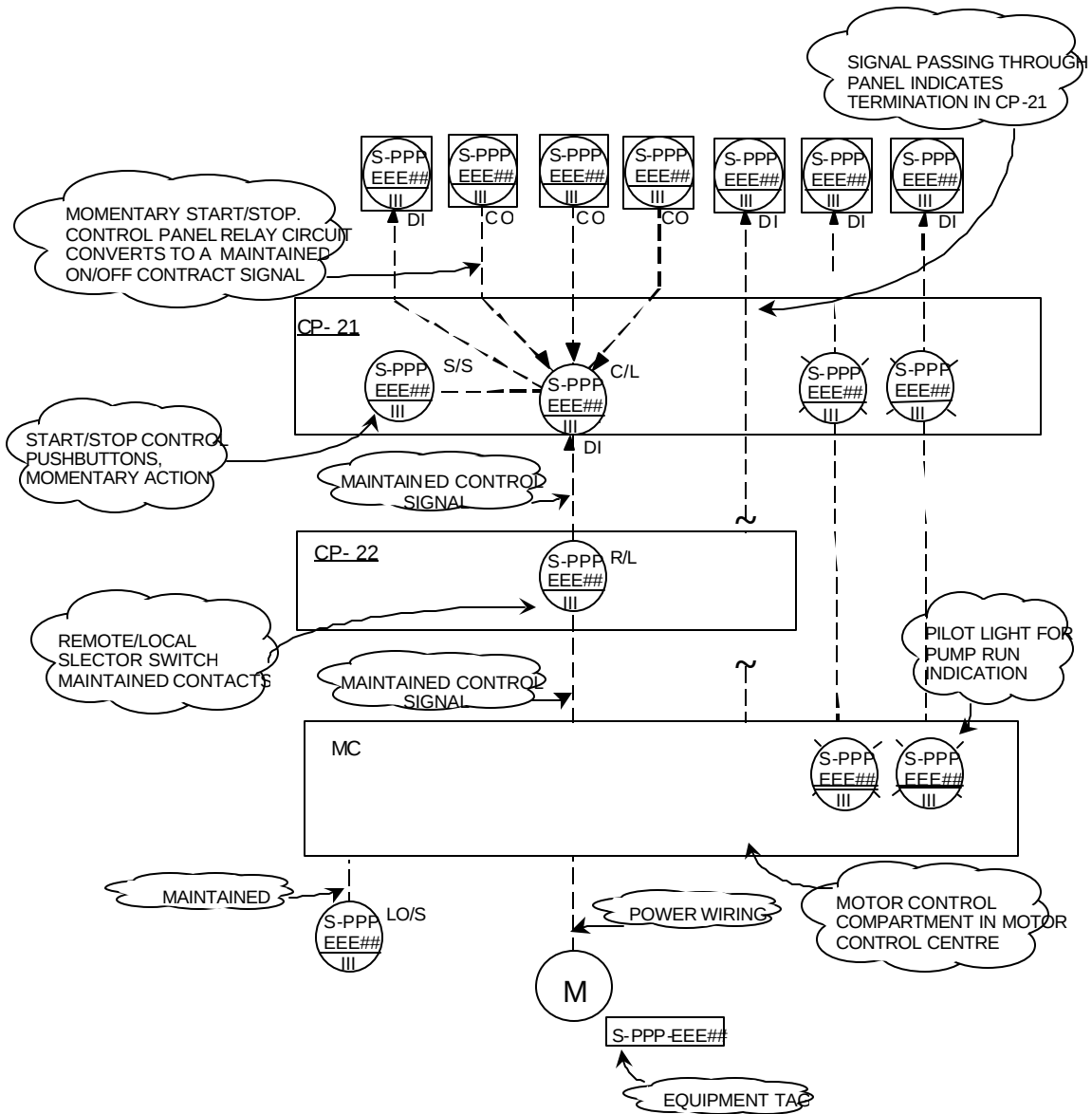
- Show all process interlocks. Process interlock details are also to be shown on electrical drawings. Notes on the drawings should describe the function of all interlocks and cross-reference to electrical drawings and the operations manual.
- All device protective interlock symbols shall be shown including internal device protection interlocks (e.g. motor overload protection).

5.09 Control Panels

- For panels, face mounted instruments have a single, solid line across the instrument balloon. Interior mounted instruments have a single, dashed line across the instrument balloon. Show balloon interconnections and electrical interlocks.
- Package system panels shall be shown on process and sub-process P&IDs as boxes with face of panel mounted instruments and external I/O connections only. Do not show interconnections, interlocks, interior signal function balloons, or signal function codes within the box that are internal to the package system. Provide separate P&IDs specific to each package providing all additional details.

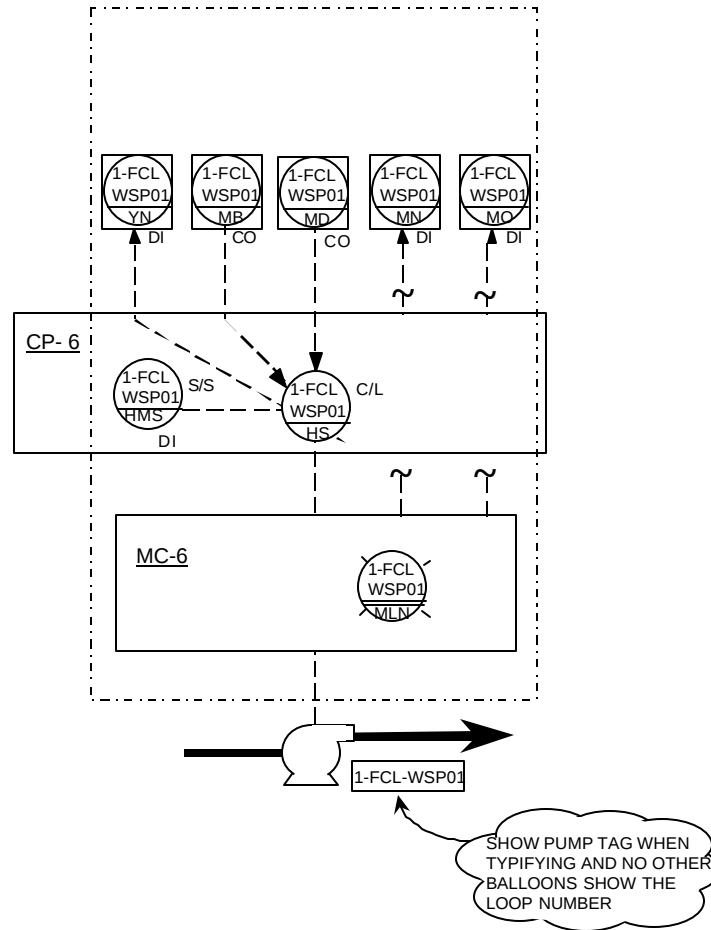
5.10 Control Signals

- Run computer output signal lines to computer-manual selector switches to indicate that the switch selects between computer control and an alternate source of control.
- Show signals which are to be terminated within a panel by running the signal line up to the package panel border or through the custom panel. If the signal does not require termination in the panel, run the signal around the panel or use the break symbol (see example on following page).
- Label signal lines any time the function of the signal may be unclear. The label should be enclosed in quotation marks.



5.11 Typifying

- Typical drawings are only allowed during the preliminary design phase of P&ID development.
- When typifying controls, the following rules apply (see following sample drawing):
 - Show all signals to and from balloons, control devices or primary elements.
 - Include equipment tags whenever there are no other balloons which indicate the loop number.
 - Show the loop numbers, panel designations, and equipment tags of all devices represented by the typical box. List the loop number which is shown on the drawing.
- Typified controls must be functionally process related. Do not typify based on control interface only. For example, do not use one typical to show both return and waste sludge pump control.
- Do not sacrifice clarity — when in doubt, do not typify even if additional drawings will be needed.



5.12 Plant or System Overview

- Prepare a P&I plant or system overview drawing on all projects involving several unit processes, plants, or process areas. The overview should be prepared after the individual P&IDs are near complete and shall precede the P&IDs in the drawing set.
- The overview shall show:
 - Each unit process, plant or process area by name and number;
 - Flow streams between processes;
 - Information common to multiple P&ID drawings;
 - Dashed boxes to show division between P&ID drawing numbers.
- The overview shall be oriented with north toward the upper part of the drawing. Show process stream connections to other areas or unit processes.

5.13 Device Details

- Large or complex devices may be shown as an overview symbol on a P&ID and then detailed on a separate drawing. The overview shall identify the

device, detail reference number and which panels contain instrumentation related to the detail. If a panel is dedicated to the device it should only be shown on the device detail.

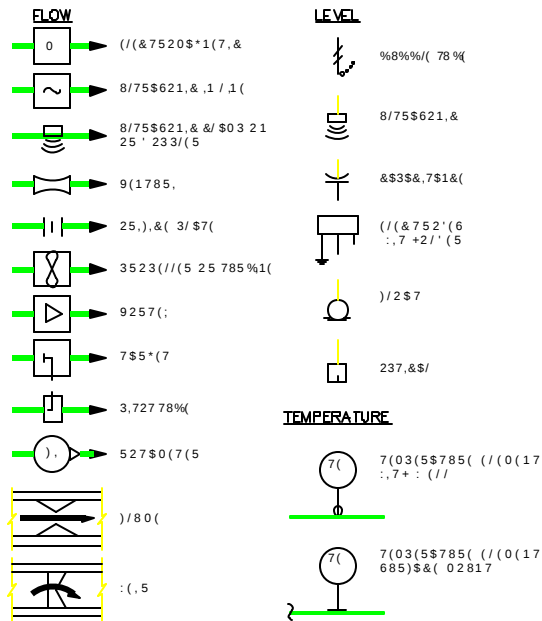
- Frequently occurring devices may be shown as an overview symbol on a P&ID and detailed on another drawing as standard devices. Restrict this practice to only those areas where required for clarity and or to ensure consistency.

5.14 Process Detail

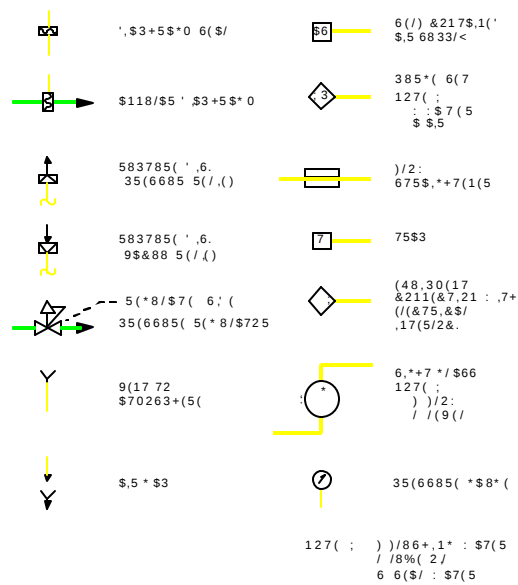
- This diagram shows full detail of the process and may reference P&ID layouts for standard devices.
- Information shown on this drawing includes:
 - Flow meter size, tank size and capacity;
 - Trip points for level, pressure, temperature and similar switches which are set at a fixed point in the field;
 - Process parameters and set points, except those which are operator adjustable from SCADA;
 - Pipe sizes.

5.15 Standard Drawing Legends

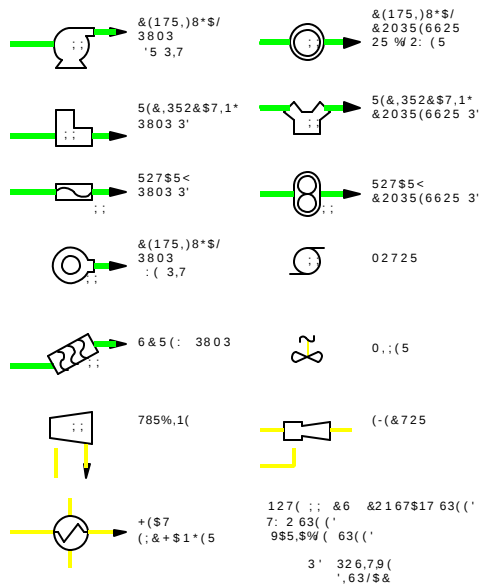
PRIMARY ELEMENT SYMBOLS



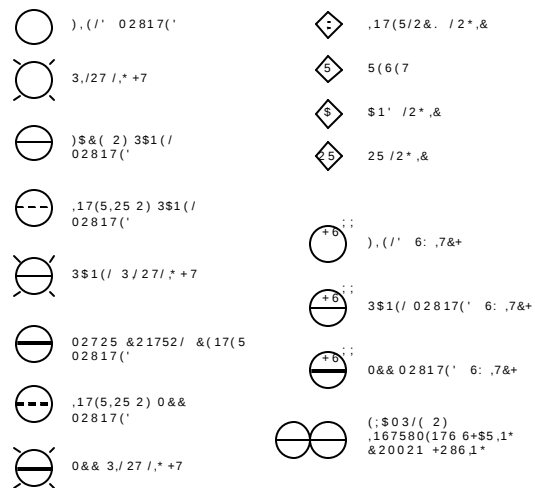
MISCELLANEOUS SYMBOLS



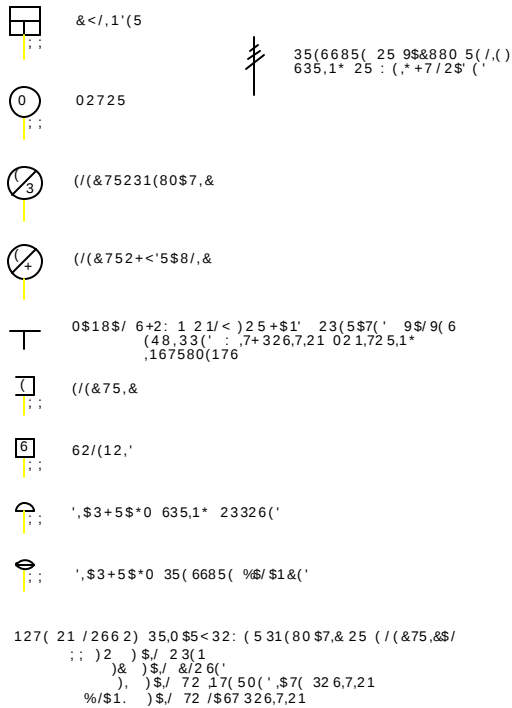
EQUIPMENT SYMBOLS



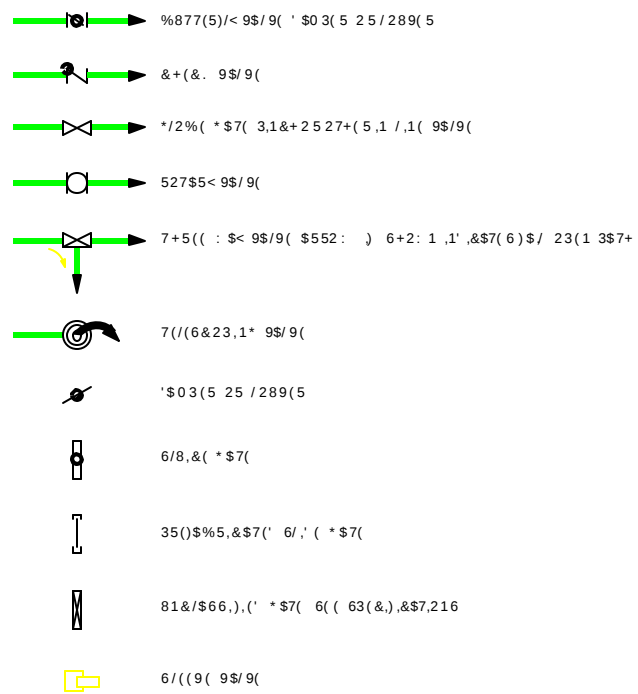
INSTRUMENT & FUNCTION SYMBOLS



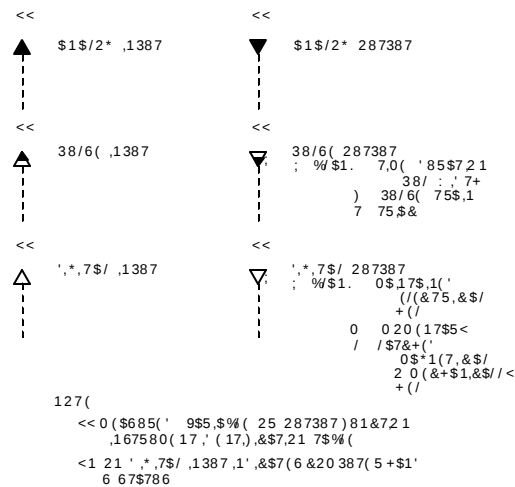
ACTUATOR SYMBOLS



VALVE & GATE SYMBOLS



INPUTS & OUTPUTS TO SHARED OR PROGRAMMABLE LOGIC CONTROLLER



GENERAL NOTES

General Notes:

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INSTRUMENT IDENTIFICATION TABLE

TABLE 1-1

LETTER	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS (C)		ALARM		
B	BURNER, COMBUSTION			CLOSE, STOP, DECREASE (1)	
C				CONTROL	
D		DIFFERENTIAL		OPEN, START, INCREASE (1)	
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			FAIL (1)
G			GLASS, VIBRATING DEVICE		
H	HAND				HIGH (OPENED)
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TEMPERATURE CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW (CLOSED)
M	MOTOR, MOTION (1)	MOMENTARY		MOTOR (1)	MIDDLE RINTERMEDIATE
N					OVERLOAD (1)
O			ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION	PUMP (1)	
Q	QUANTITY (C)	INTEGRATE, TO TOLUE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE (C)		MULTIFUNCTION (C)	MULTIFUNCTION (C)	MULTIFUNCTION (C)
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, DOOR	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED (C)		UNCLASSIFIED (C)		UNCLASSIFIED (C)
Y	EVENT, STATE, PRESENCE			RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION			DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

(1) USER'S CHOICE

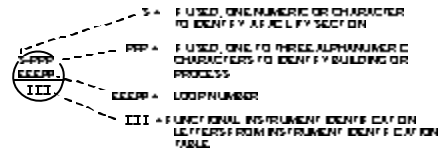
(C) WHEN USED, SYMBOL OR SIGNAL LINE IS ANNOTATED.

FLOW STREAM IDENTIFICATION

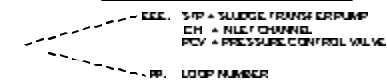
— ACS — ACTIVATED CARBON SOLUTION	— OR — OIL	— SLO — SLUDGE
— AHP — AIR, HIGH PRESSURE PROCESS	— ORS — GREASE	— SA — SODA ASH
— AHY — AIR, HIGH HYDROGEN		— SAS — SODA ASH SOLUTION
— AIS — AIR, INSTRUMENT SUPPLY	— HO — HYDROCHLORITE	— SCM — SCUM
— ALM — ALUM	— HO — HYDROGEN GAS	— SOG — SULFUR DIOXIDE GAS
— ALP — AIR, LOW PRESSURE PROCESS	— HL — LIQUID HYDROGEN	— SOL — SULFUR DIOXIDE LIQUID
— ASH — ASH	— HPC — HIGH PRESSURE CONDENSATE	— SOS — SULFUR DIOXIDE SOLUTION
	— HPS — HIGH PRESSURE STEAM	— SE — SECONDARY EFFLUENT
— BFE — BIO-FILTER EFFLUENT	— HWB — HEATING WATER RETURN	— SEW — SETTLED WATER
— BFR — BIO-FILTER RECYCLE	— HWS — HEATING WATER SUPPLY	— SMP — SAMPLE
— BLS — BLENDED SLUDGE		— SSL — SECONDARY SLUDGE
— BR — BRINE	— INF — INFILTRANT	— STW — STORM WATER
— BAS — BAKED SLUDGE		— SUP — SUPERATANT
— BRSP — BRINE SPENT	— IM — LIME DRY	
— BSL — BLENDED SLUDGE	— LMS — LIMESLURRY	— TAS — THICKENED ACTIVATED SLUDGE
— BWS — BAKED WASTE SUPPLY	— LMSD — LIMESLUDGE	— TBS — THICKENED BOTTOM SLUDGE
— BWW — BAKED WASTE	— LO — LUBRICATION OIL	— TO — THICKENED OVERFLOW
— BWP — BYPASS	— LPC — LOW PRESSURE CONDENSATE	— TPS — THICKENED PRIMARY SLUDGE
	— LPS — LOW PRESSURE STEAM	— TR — THICKENED RECYCLE
— CDO — CARBON DIOXIDE GAS		— TS — THICKENED SLUDGE
— CDL — CARBON DIOXIDE LIQUID	— MG — METHANOL GAS	— TUF — THICKENED UNDERFLOW
— CEN — CENTRATE	— ML — MUDDED LIQUOR	
— CH — CHEMICAL		— UD — UNDERDRAIN
— CLO — CHLORINE GAS	— NAW — SODIUM HYDROXIDE	
— CLU — CHLORINE LIQUID	— NO — NATURAL GAS	— VT — VENT
— CS — CHLORINE SOLUTION		
— CSL — CARBON SLURRY	— OF — OVERFLOW	— WW — WASH WATER
— CWR — COOLING WATER RETURN	— OG — OXYGEN GAS	— WWS — WASTE ACTIVATED SLUDGE
— CWS — COOLING WATER SUPPLY	— OL — LIQUID OXYGEN	— WCL — WATER, CHLORINATED PLANT EFFLUENT
		— WD — WATER, DISTILLED
— DCT — DECANT	— PFA — POLYMER FILTER AID	— WML — WASTEWATER LIQUOR
— DG — DIBESTER GAS	— PG — PROPANE GAS	— WSL — WASTE (ACTIVATED) SLUDGE
— DRN — DRAIN	— PP — POTASSIUM PERMANGANATE	— WO — WATER, OZONEATED
— DS — DIBESTED SLUDGE	— PRE — PRIMARY EFFLUENT	— WP — WATER, POTABLE
— DWS — DEWATERED SLUDGE	— PRI — PRIMARY INFILTRANT	— WPS — WATER, PLANT SERVICE
	— PRS — PRIMARY SLUDGE	— WW — WATER, NON-POTABLE
— EFF — EFFLUENT	— PSL — PRIMARY SLUDGE	— WSE — WATER, SEWAGE EFFLUENT
— EGO — EXHAUST GAS	— PYD — POLYMER DRY	— WWW — WELLS WATER
	— PYL — POLYMER LIQUID	
— FC — FERRIC CHLORIDE	— PYS — POLYMER SOLUTION	
— FCPL — FERRIC CHLORIDE LIQUOR		
— FES — FERRIC SULFATE	— RAS — RETURN ACTIVATED SLUDGE	
— FFW — FINISHED WATER	— RAW — RAW WATER	
— FLE — FILTER EFFLUENT (FILTERED WATER)	— RBE — REACTION BASIN EFFLUENT	
— FLT — FILTRATE	— RCY — RECYCLE	
— FWW — FILTER WASH WATER	— RSL — RETURN (ACTIVATED) SLUDGE	
— FOR — FUEL OIL RETURN		
— FOS — FUEL OIL SUPPLY		

* IDENTIFICATION MAY BE FOLLOWED BY A NUMBER TO DIFFERENTIATE AMONG SIMILAR FLOW STREAMS. FOR EXAMPLE, CH1.5 CHLORINATED REPRESENT TWO DIFFERENT CHEMICAL FLOW STREAMS.

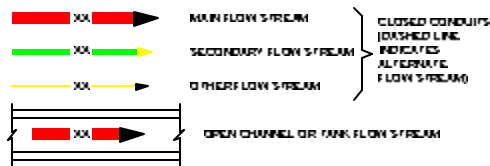
EXPLANATORY NOTATIONS



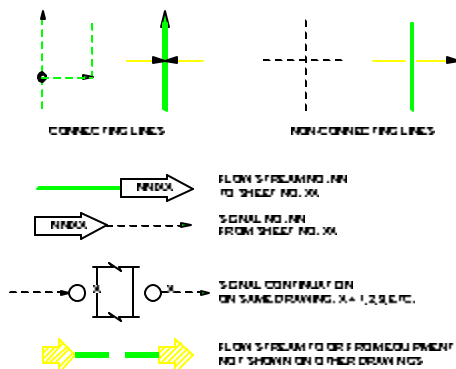
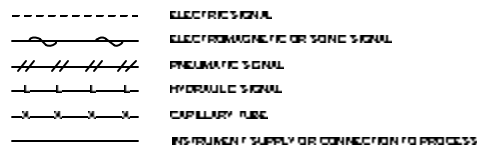
EQUIPMENT TAGGING



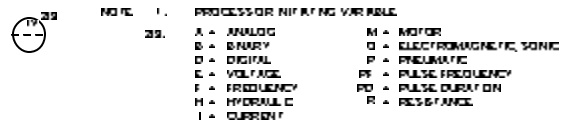
FLOW STREAM & INSTRUMENT LINE SYMBOLS



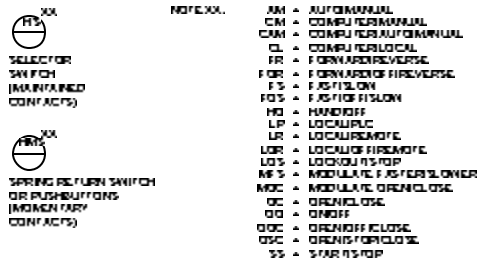
NOTE XX. FLOW STREAM IDENTIFICATION



SIGNAL CONVERTERS

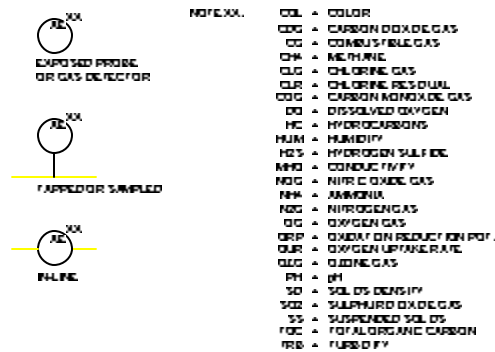


HAND SWITCHES



1. "A", WHEN ADDED TO NOTATION, INDICATES AUTO.
EXAMPLE: HQR + HANDOFF AUTO
2. "R", WHEN ADDED TO NOTATION, INDICATES REMOTE.
EXAMPLE: HQR + HANDOFF REMOTE

ANALYSIS INSTRUMENTS



GENERAL NOTES

1. THIS IS A GENERAL P & ID LEGEND SHEET. SOME SYMBOLS OR NOTATION'S MAY NOT BE USED ON THIS PROJECT.

TERMINALS

	TERMINAL ET1
	TERMINAL FOR DEVICES LOCATED INTERNALLY/EXTERNALLY AS NOTED. ET2

COIL CONTACTS

	NORMALLY OPEN CONTACT EC1
	NORMALLY CLOSED CONTACT EC2
	NORMALLY OPEN CONTACT TIMED DELAY CLOSING EC3
	NORMALLY CLOSED CONTACT TIMED DELAY OPENING EC4
	NORMALLY OPEN CONTACT TIMED DELAY OPENING EC5
	NORMALLY CLOSED CONTACT TIMED DELAY CLOSING EC6

RELAY COILS

	CONTROL RELAY EC7
	MOTOR STARTER EC12
	PNEUMATIC TIMER WITH ADJUSTABLE TIMING RANGE AS SHOWN EC8
	ELECTRIC TIMER WITH ADJUSTABLE TIMING RANGE AS SHOWN EC10
	SOLENOID EC11
	LATCHING RELAY EC14
	THERMAL OVERLOAD BM12

PUSHBUTTONS & SWITCHES

	NORMALLY OPEN PUSHBUTTON EP3
	NORMALLY CLOSED PUSHBUTTON EP4
	NORMALLY CLOSED MUSHROOM HEAD PUSHBUTTON EP5
	MECHANICAL CONNECTION WITH INTERLOCK EP10
	FOOT SWITCH NORMALLY OPEN EP11
	FOOT SWITCH NORMALLY CLOSED EP12
	TOGGLE SWITCH EP13
	LIMIT SWITCH NORMALLY CLOSED EP20
	TWO POSITION SELECTOR SWITCH OPENED EP7
	TWO POSITION SELECTOR SWITCH CLOSED EP17
	SPRING RETURN SELECTOR SWITCH OPENED EP8
	SPRING RETURN SELECTOR SWITCH CLOSED EP18
	THREE POSITION SELECTOR SWITCH OPENED EP9
	THREE POSITION SELECTOR SWITCH CLOSED EP19
	NORMALLY OPEN CONTACT OF SELECTOR SWITCH EP14
	NORMALLY CLOSED CONTACT OF SELECTOR SWITCH EP15

LIMIT SWITCHES

	NORMALLY OPEN ES1
	NORMALLY CLOSED ES2
	HELD CLOSED NORMALLY OPEN ES3
	HELD OPEN NORMALLY CLOSED ES4
	MAINTAINED OPEN ES5
	MAINTAINED CLOSED ES6

MISCELLANEOUS

	CIRCUIT BREAKER BM1
	FUSE BM2
	TRANSFORMER SECONDARY VOLTAGES RATING INDICATED AS APPLICABLE BM3
	BATTERY BM4
	LIGHTNING ARRESTER (GAP PROTECTIVE) BM5
	AUDIBLE DEVICE BM6
	WIRELESS INDICATOR BM10
	ELAPSED TIME METER BM11
	RESISTOR WITH OHMS INDICATOR BM13
	RECTIFIER, D.O.D.E. BM14
	RECTIFIER, D.O.D.E. BM15
	CAPACITOR, GENERAL BM16
	CAPACITOR, GENERAL BM17
	CAMERA BM18
	PASSIVE INFRARED DETECTOR (NIGHT VISION) BM19
	BROKEN GLASS DETECTOR BM20
	DOOR INTRUDED IN CONTACT BM21

INPUT/OUTPUT STATIC DEVICES

	1250\$/< 23(1 ,62/\$7('
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TEMPERATURE ELEMENTS

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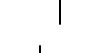
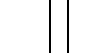
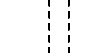
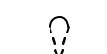
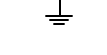
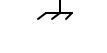
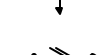
PROCESS SWITCHES

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PILOT LIGHTS & METERS

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CONDUCTORS

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NOTE(S)

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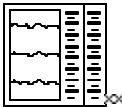
SWITCHBOARD
INDICATOR
(4 1/2" X 1 1/2")
PNLS0



PEN
RECORDER
(3" X 6")
PNLS0



PANEL METER
(4 1/2" X 1 1/2")
PNLS1



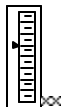
PEN
RECORDER
(6" X 6")
PNLS1



LARGE GAUGE
PNLS2



HORN (AUDIBLE)
PNL70



EDGOMETER
(1 1/2" X 6")
PNLS3



ROTAMETER
PNL71



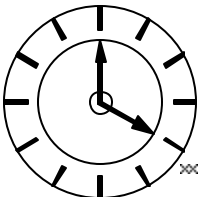
DIGITAL
INDICATOR
(2" X 4")
PNLS4



STANDARD HANDLE
PNL72



ELAPSED
TIME TO T
(1 1/2" X 2 5/8")
PNLS5



CLOCK
(9")
PNLS6

ITEM	COMMENT
LINE 01	
LINE 02	
LINE 03	
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ITEM	COMMENT
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LINE 100	

XXX

LINE 01

LINE 02

PNLS0

PART 6 DEVICE INTERFACES

6.01 Introduction

This standard defines the City of London requirements regarding device interface requirements.

- The intent of this standard is to ensure that the level of device monitoring is applied consistently across the City. The requirements do not differentiate between analog / discrete I/O and information provided by serial communication links except where specifically stated.

Details regarding IO requirements are addressed in “Automation & Control – Volume 2 – Standards”.

6.02 Safety and Permissive Interlocks

Interlocks are to be used to prevent equipment from running under undesirable conditions (e.g. low pump well level locking a pump out). The following general requirements apply to all equipment.

- All interlocks, except those that are integral to devices (e.g. motor overload protection) and device disconnects, are to 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.

6.03 Field Control

The following information defines the requirements for field control wiring for equipment. It is recognized that exceptions may need to be granted, however where possible the following guidelines are to be followed. Any deviations must

be reviewed and approved by the City before field implementation to verify that the deviation is required.

- Devices (unless otherwise stated within this section) are to be provided with Hand/Off/Remote selector switches. The PLC is to 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 to be used for maintenance purposes.
- Where the ability to switch the devices between local and remote in a bump-less fashion is required, Start/Stop Pushbuttons with a separate Local/Remote Selector shall be provided. An example where this type control applies is to aeration blowers.
- Where the device is to 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 as required.
- 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 deenergized) 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 is to stop and the operational procedure shall be that in order to restart the device the selector must be switched off of Remote.
- 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.

PART 7 DOCUMENTATION

7.01 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 to be submitted 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 are to be submitted of all information intended for review and/or approval. Sheet size is not to exceed 280 x 432 mm
- Electronic copies of all final drawings and documents are to be submitted on CD-Rom. The CD-Rom shall contain copies both in electronically editable format (i.e. native AutoCAD, Microsoft Visio, Microsoft Excel, or Microsoft Word format) and in Adobe PDF format. Provide a total of 5 copies of the CD-Rom.
- All document submissions, unless otherwise directed by the City of London, are to 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 2000, Word Perfect Suite 2000, Microsoft Visio, AutoDesk AutoCAD 2000 or Bentley Microstation 7.01.
- Documents are not to use external references or customized file extensions (e.g. drawings are to contain title blocks, documents are to contain all graphics). Submissions are to be provided in native file format (e.g. if created with AutoCAD in DWG format) without password protection.

7.02 Drawings - General

The following general requirements apply.

- Construction drawings are to provide complete standalone documentation of the systems provided under the contract and related existing equipment. In the case of instrumentation work, this includes not only field devices and control but also local area networks, and security systems.
- Drawings are to be completed in accordance to the City of London Drafting Standards, City of London P&ID Standards and City of London Identification Standards. This includes but is not limited to the use of layers, line types, title block, symbols and device identification.
- Title blocks are to include City of London Contract Number, Engineer's Project Number, Contractor Project Number, Contractor Logo, Project Title (as stated in the contract documents), Drawing Title, Drawing Number and File Name. Tabular columns shall be used to record the original submission

date, a revision number, date and reason for subsequent revisions, and signature of individual authorizing the release of the drawing.

- As a minimum, drawing revisions to be generated shall include preliminary design (by engineer), final design (by engineer), construction mark-up (by contractor), and as built (by engineer). Until acceptable “construction mark-up” drawings have been submitted and approved, the contractor shall not be eligible to claim for substantial completion.
- All existing facility drawings that are affected by the scope of works are to be digitized in vector format and updated accordingly.
- The contractor shall maintain two (2) sets of project record drawings upon which the contractor will record accurately record 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 following drawing details shall be provided and will include the information as described. All additional drawings requested by the City shall also be provided.
- Each drawing detail shall consist of not less than one drawing, or such number greater than one to ensure that the information on the drawings can be easily interpreted when the drawings are plotted as an A3 drawing. Unless otherwise approved, drawings are to be submitted either concurrently or in the order listed at the option of the contractor.
- Note that under some contracts many of the drawings listed already exist and will be provided to the contractor. It is the responsibility of the contractor to ensure they are fully aware of which drawings they are responsible for generating and which drawings they are responsible for updating such that they include all associated costs within their tender bid.

(a) Site Plan

- Show the overall layout of the site, special site access for construction, contractor storage areas and contractor parking to scale.

(b) Plan Drawing(s)

- Show the location of system components including RPU's, computers, printers, hubs (routers, bridges and modems may be shown separately or as part of the hub), speakers, cameras and horns.

- Show major process piping, channels, tanks and other major process structures.
- Indicate both existing equipment and work to be done.

(c) Device Removal Plan(s)

- Show all wiring and devices to be removed. Include a cross-reference to the control schematics.

(d) Process and Instrumentation Drawing(s)

- Show all instrumentation and equipment (new and existing where affected).
- Include all coding and tagging information.
- Provide control schematics (equipment interface diagrams), control logic, panel lights and I/O wiring details.

(e) Loop Drawing(s)

- Develop in accordance with ISA S5.4 format and show the information called for in Sections 4.1 through 4.15 of the Standard.
- Include itemized instrument wiring arm drawings for all analogue process loops and discrete connections. As a minimum incorporating 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.

(f) Single line Diagram(s)

- Show power from MCC panels to equipment, lighting panels and other electrical loads.
- Show power coming into the site and distribution to MCCs.
- Show all power monitors, transformers, breakers, switches and fuses.

(g) Wiring & Electrical Plan(s)

- Show locations of items that require electrical installation.
- Show wiring furnished and installed under this Contract including all instances of the following items:

- Inter-cabinet cabling.
 - Wiring from control rooms to each panel or termination cabinet.
 - Wiring from each panel or termination cabinet to each motor control centre, instrument and control device.
 - Panel or termination cabinet internal wiring.
 - Power wiring to all hardware.
 - Communication cables.
 - Wiring termination in junction boxes and panels.
 - Control networks, instrument signal, control loop, and I/O wiring.
 - MCCs, panels, conduit, junction boxes, instruments, control devices and electronic devices.
 - Circuit breakers, fuses, power supplies and power conditioners.
- Show termination identification at each item of equipment, inter-wiring and cable numbering, including network connections between SCADA system components, all peripheral equipment, PLC module configuration information (including DIP switch settings and software configuration), pin assignments for D-shell connectors, plugs and jacks, and instrument/equipment tag numbers
 - Show conduit size, wire numbers, cables, cable wires and colours, terminal strips, terminal numbers, grounds, shielding and input/output point power sources.
 - Show cross-reference installation details for conduit and cable tray supports and wall penetrations.
 - If the required information is too much to fit on one drawing, split by type of cable.

(h) Cable and Device Schedule(s)

- Indicate cable number, cable type, wire numbers, wire type, cable tray/conduit numbers, length and plan drawing reference(s).
- Document electronic systems using cable diagrams, plan drawings and cable schedules.
- Detail electronic systems include paging system, local area networks, security systems and control systems.

(i) Mechanical Plan Drawing(s)

- Show locations of all equipment requiring mechanical installation and/or modification.

- Provide installation details for instruments, conduits, cable trays, panels, valves and pumps as separate drawings or drawing insets.
- Show how items are to be physically installed including orientation, mounting brackets, supports, mounting bolts, grouting, seals, piping, valves, unions, tees, other plumbing fixtures and grounding.
- Include tag identifier, service, function, normal position or status, base specification, and location for each item.

(j) Panel Drawings

- Provide scaled, referenced, front of panel layouts, and general arrangement drawings.
- Provide scaled, referenced, internal panel layouts (may be combined with the above) showing mounting of face-mounted instruments and arrangement of wire raceways, termination strips, relays and timers, field control, power supply, and surge protector.
- Include control power schematic showing power wiring, grounding, fusing and circuit breakers for each panel connected device.

7.03 CAD Drawing Standards

All drawings will conform to the City of London CAD Drawing Standards. In addition to these standards, layers and line standards shall conform to the following table.

Level #	Level Name	Sub Classification	Colour	Style	Weight	Font	Notes
2	E/P		0,4	0	1	N/A	
3	Curb/Gut & Sidewalk		0	0	1	N/A	
4	P/L		5	0	3	N/A	
5	Fence		0	Curtain	0	N/A	
6	Bldg		3	0	2	N/A	
7	PCS						
		Grit Chamber	37	0	1	N/A	
		Primary Clarifiers	6	0	1	N/A	
		Secondary Clarifiers	62	0	1	N/A	
		Chlorine Tank	7	0	1	N/A	
		Aeration Tank	100	0	1	N/A	
		Final Tank	50	0	1	N/A	
		Ultra Violet Channel	26	0	1	N/A	
		Equalization Tank	4	0	1	N/A	
		Scum Chamber	57	0	1	N/A	
		Miscellaneous PC (Parshall)	11,12	0	1	N/A	
8	Ground		2	0	0	N/A	
9	Storm		2	3	1	N/A	
10	Water		1	4	1	N/A	
11	Utilities						
		Gas	4	6	0	N/A	
		Hydro	16	7	0	N/A	
		Air	13	0	0	N/A	
12	Sanitary		3	0	1	N/A	
13	Dimensions		0	0	0	N/A	
14	Labels		0	0	1	1	
15	Rebar		72	0	1	1	
16	Storm Appertenance		2	0	1	N/A	
17	Sanitary Appertenance		3	0	1	N/A	
18	Water Appertenance		1	0	1	N/A	
19	Utility Appertenance		1	0	0	N/A	
20	Soils		9	0	0	1	
21	Miscellaneous Steel		87	0	VARY	N/A	Screens, Checker Plate, Handrails etc.
22	Mechanical		38,50	0	1	N/A	Sluice, Valves, Weirs, etc.
23	Miscellaneous		162,163	0	1	N/A	Insulation, Wood, Waterstops, Concrete, etc.
24	Rebar Labels		0	0	0	1	
25	Electrical		246	0	1	1	
26	Piping		12	0	1	N/A	
27	Ferric Chloride		159	0	1	N/A	
28	Instrumentation		0	0	1	1	Equipment Tags
29	Demolished Structures		142	3	0	N/A	
30	Contours		200	0	0	1	including elevations
62	Title Block		0	0	1	43, 1	
63	Grid		160	0	0	N/A	

PART 8 PROCESS CONTROL NARRATIVE

8.01 General

The Process Control Narrative (PCN) will describe how the control philosophy has been implemented on a given project. It will identify the equipment to be controlled on a process-by-process basis. For each process, all available modes of control will be clearly defined.

The document will define how control software is to function, provides a clear description of how operators interface with the system, and defines process indicators to be monitored to ensure that the process is operating efficiently. This includes complete listing of all device names, IO points, control loops, tagnames, etc.

Short bullet point phrases, tables, and diagrams are to be used in order to keep the document as concise as possible. The following sample process description demonstrates how bullets are to be used to present descriptions in a clear concise fashion.

“At Oxford, alum is used to supplement biological phosphorus removal and enhance clarifier performance. The process is as follows.

1. Transferred daily to day tank (local control)
2. Dosed from day tank (auto, manual & local control)
3. Injected normally near comminuter
 4. Alternate injection point provided at aeration inlet
5. Phosphate & Turbidity used to determine required dosage”

The PCN is generated by the System Integrator as the first stage of system integration before commencing on any programming or configuration.

Each narrative follows a standard format. Items in the standard format that are not relevant or not used for a control narrative are not shown.

8.02 Document Structure

The following outlines the basic structure to be followed.

1.0 General

.1 Introduction

.2 Performance Monitors

2.0 Typical Process Section (repeated for each process)

.1 Equipment Summary

.2 System Control Strategy

To include the following in order

- ✓ Summary Statement
- ✓ Control Parameters / Set-points
- ✓ Control Logic Description
- ✓ Equipment Failure Response
- ✓ Input Validation

.3 Equipment Control Strategy (repeated for each device)

Introduction addressing the following

- ✓ Available Control Modes
- ✓ Hardwired Interlocks

.1 Local (i.e. MCC or VSD)

.2 Remote (i.e. PLC)

Introduction addressing the following

- ✓ Local / Remote Transitioning
- ✓ Software Interlocks

.1 Manual (i.e. Operator initiates all changes)

.2 Automatic (i.e. PLC makes dynamic changes)

To include the following in order

- ✓ Control Description
- ✓ Failsafe (i.e. PLC Failure)

.3 Programmed Interlocks

.4 Device Set-points

3.0 SCADA Configuration

.1 Input Validation

.2 Alarms

.3 Trended Values

Each narrative follows a standard format. Items in the standard format that are not relevant or not used for a control narrative are not shown. The following outlines the basic structure to be followed.

(a) General Section

The following describes the information to be included in the applicable sections.

Introduction

- An overview of the process control system highlighting deviations from the City of London Standards.
- Table of processes listing the level of control (Local, Monitor, SCADA Manual and SCADA Auto).

Performance Indicators

- This section describes performance indicators provided by the control system that may be used to track operational efficiency along with objectives for each parameter. These objectives tend to relate to efficiency, effectiveness and/or quality. For example, the objective of chemical dosing system may be to minimize chemical consumption while still achieving satisfactory effluent objectives.

(b) Process Sections

The following describes the information to be included in the various sections.

Description

- The description defines the physical process including its relationship to other processes.
- In addition, the equipment related to the process is described (the tanks, pumps and other units of the process) and a block diagram included which shows the logical connection and interaction of the control system components.
- This section will focus on factors that differentiate the process at the particular facility from other facilities.

Process Control Strategies

- The control strategy describes how the process is controlled. Field selector switches allow equipment to be selected for either Local or Remote service. Local is defined as manual control which bypassing the process controller (RPU), while remote is defined as controlled by the RPU. These general modes of operation are expanded as follows.

The following describes the information to be included in the various sections.

- The control strategy describes how the process is controlled. Field selector switches allow equipment to be selected for either Local or Remote service. Local is defined as manual control which bypassing the process controller (RPU), while remote is defined as controlled by the RPU. These general modes of operation are expanded as follows.
 - Local
 - ❖ Hand – In this mode, the device is controlled from a local control panel or from the MCC, in both cases without control requiring the PLC. In this mode, all interlocks, except for safety interlocks such as overloads & emergency stops, are bypassed. As this mode is only to be used in an emergency or during maintenance, possible limitations on an operators ability to run the device are to be minimized – even to the possible detriment to the equipment itself.

- ❖ Hardwired Interlocks – list of all hardwired interlocks provided for protection of staff. Where possible the list also identifies internal interlocks provided within devices such as integral overload protection on motors. These interlocks are kept to an absolute minimum.
- Remote
 - ❖ Programmed Interlocks – list of all programmed interlocks provided for protection of equipment, process automation, etc. Most interlocks (including interlocks such as low pump well lockout) are programmed and not hardwired.
 - ❖ Manual – In this mode the PLC will not make any changes to the process (or related equipment) this is not specifically requested by the operator. From the OS the operator will be able to manually control the process (e.g. start & stop equipment, set fixed chemical feed rates, etc.). If not all equipment that is required for the system to operate is in Remote; the remaining equipment will default to Manual.
 - ❖ Automatic – This is the normal mode of operation for a device. In this mode, the PLC controls all aspects of the process adjusting the process based upon predefined algorithms. This section will describe the adjustments that the operator normally makes to the automatic controls to accomplish the process objectives including setpoints, limits, timer settings and option selections. In addition, the section will include a detailed control logic diagram, list of all control parameters, and list of all interlocks.
 - ❖ Failsafe – This section describes how the process is to function in the event of equipment failure, including the failure of the PLC. Depending upon the process this may require the device to hold last state, shut down, or local relays to take over control of the device.

(c) SCADA Configuration

- This section provides specific details regarding the configuration of the OS not addressed specifically in the process description. Note that both real (generated directly by field IO) and virtual (generated by a prescribed set of parameters) conditions are treated in the same manner.
- In order to reduce the number of entries in each table, typical entries can be used where all represented are identical with regards to configuration. However the description is to indicate each individual device (for example, five identical sludge pumps can be described as “Sludge Pumps 1 to 5”)
- Input Validation – Detailed description of any checks for logical inconsistency of inputs. This section will include only those checks that are not inherent to the software programming standards. For example, a flow

switch on a pump discharge used to validate pump run status would be listed, but confirmation that the pump run coil and the pump run status input both indicated running would not.

- Alarms – a table listing all alarms and related alarm configuration. The following table provides the general concept to be followed to ensure all relevant information is provided (see Programming Standards for additional information).

Real / Virtual	Description	Classification		Settings										Historical	Operator Control			
				LoLo		Lo		Hi		HiHi		Deadband		Log	Adjust Level		Disable	
		Group	Priority	Level	Page	Level	Page	Level	Page	Level	Page	Value	Time		Duration	Lo		Hi

- Trended Values – a table listing all parameters that are to be trended along with logging configuration parameters. The following table provides the general concept to be followed to ensure all relevant information is provided (see Programming Standards for additional information).

Real / Virtual	Description	Valid Range			Deadband		Historical Summary Generation							
		Min	Max	Units	Value	Time	Hourly				Daily			
							Min	Max	Avg	Tot	Min	Max	Avg	Tot

Deadband - Value is absolute (e.g. +/- 0.05m) and typically derived from instrumentation accuracy, time is required sample resolution

Disable - Auto disable works by value falling outside of valid range, manual is operator selectable