Elgin/ Lake Huron SCADA Upgrades
SCADA Standards
Section 200 Preliminary Design

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Table of Contents

201 Preliminary Design General Requirements

1. General SCADA Design Details

1.1 Existing Documents and Record Drawings

1. The Owner will provide copies of available record drawings, reports, and other documents pertaining to the project. The Consultant shall note that changes may have been made over time without updating the documents or record drawings. Prior to commencement of the pre-design, the Consultant shall review the existing background information, as well as conduct a site review at the facility to confirm changes or omissions, if any, in the record drawings. The expected level of the site review includes a walk through the facility and visual observations. The Consultant shall record its findings and advise the Joint Board of any significant changes or omissions in the record drawings.

2. Any redesign work required due to the Consultant's failure to review documents or record drawings will be at the Consultant's own cost.

3. Review scope of current, parallel projects and identify potential impacts on the project. Ensure that any potential impacts/conflicts are identified and discussed with the project team.

1.2 Equipment Redundancy and Selection

1. The Consultant shall ensure that the level of redundancy for process and/or equipment at all facilities meets the Certificate of Approval criteria, operating objectives, and the functionality of the associated process equipment. The Owner has adopted, in principle, a policy to provide firm capacity for major processes and equipment. Under the policy for each process one or two process units could be offline for maintenance and repair, while still complying will the Certificate of Approval, as well as other provincial or federal regulations.

2. Discuss with Owner's staff their preferences for equipment selection. Identify suppliers and recommend equipment based on the following: best performance, reliability, flexibility, availability, life cycle costs, ease of maintenance, expandability, spatial requirements and supplier/owner references with respect to service in existing installations. List features, benefits, as well as advantages and disadvantages of the selected equipment, including information on equipment delivery and its impact on construction timelines. Except for proprietary equipment, consider at least three suppliers for each component, whenever possible.

3. In consultation with the Owner, prepare equipment list and data sheets for inclusion in the pre-design report. Ensure that the selected equipment/system can be fully automated and is suitable for unattended operation, where appropriate.

1.3 Approvals

1. During pre-design, the Consultant shall determine the project specific approvals and co-ordinate the process with the Owner and the approval agencies.

2. If applicable, conduct pre-consultation with the Ministry of the Environment prior to submitting an application for the Certificate of Approval.

3. Near the conclusion of the pre-design phase, identify if a pre-start health & safety review will be required at the conclusion of the design phase of the project.

2. Summary of SCADA Preliminary Design Deliverables

1. The following provides a list of deliverables upon completion of the pre-design. The Consultant shall note that the RFP may contain additional project specific deliverables or delete some accordingly.
   a. SCADA Preliminary Design Report
   b. Preliminary P&ID's
   c. Process Narratives

202 SCADA Design Philosophy

1. Degree of Automation

1. Unless specifically instructed in the Request for Proposal that automation in the facility is not required, all processes shall be fully automated, allowing for unattended operation of the system.

2. SCADA Performance Targets

2. The following SCADA Network Performance targets have been established. As part of the initial design activities for each project, the design should evaluate and document the current SCADA performance. In the Predesign report, the designer should identify any required SCADA infrastructure upgrades so that, at the end of the related construction activities, the SCADA Performance targets will continue to be met.

   a. In-plant alarms displayed on SCADA HMI in <2 seconds.
   b. In-plant responses to commands on SCADA HMI in <3 seconds.
   c. Remote facility alarms displayed on SCADA HMI in <5 seconds.
   d. Remote facility responses to commands displayed on SCADA HMI in <10 seconds.
   e. SCADA server minimum spare capacity >25% (RAM capacity, HD, and CPU performance).
   f. PLC CPU minimum spar capacity >50%.
   g. PLC field I/O minimum spare capacity >20%.
   h. Network switch ports minimum spare capacity >20%.
   i. Network traffic minimum spare capacity >50% during normal operating conditions.
   j. For all in-plant trunk fibre cables, a minimum 20% spare fibres, but all must be terminated in the patch panels.

3. For the continuous, efficient monitoring of the network traffic, the OPC Server monitoring software is installed.

3. SCADA Architecture

3.1 WTP SCADA System

1. The overall SCADA Architecture consists of dual, hot standby Front End Controllers (FECs) connected to remote I/O racks across the plants. For major mechanical equipment, including the high and low lift pumps, individual remote I/O racks are required.

2. The FECs are connected to dual hot standby SCADA Servers, with key historical data transferred to the historical SQL database.

3. All new field I/O and I/O racks must be integrated into this architecture.

3.2 Outstation SCADA System

1. Each outstation must be capable of operating safely, independently, when the WAN link fails. Therefore an PLC and limited local data collection is required.

3.3 Inter-WAN Links

2. Real time links to the secondary SCADA systems are used to transfer the critical, real time alarm between the Joint Board, Primary Water Supply SCADA System and the Secondary SCADA Systems. This is accomplished by using hardwired I/O between two PLC at the selected inter-WAN link site.

3. The key data that must be transferred from the secondary systems are tower/reservoir levels, major flow meters, key water quality parameters. The key data that must be transferred from the Joint Board to the secondary systems are major flow meters.

3.4 Historical Data Storage

1. All key operating parameter are transferred to the SCADA Historian, SQL database.

203 Equipment and SCADA Signal Coding

1. General Requirements

1.1 Overview

2. The objective of the Joint Board coding system is to ensure consistency in equipment labeling across all facilities. The following is a brief description of how the equipment and SCADA signal acronyms are composed and what each fragment of the acronym represents.

3. A summary of all codes found in the Joint Board system follows, broken down by fragments. Any clarification required with respect to the coding system will be provided by the Joint Board. No codes are to be used that are not identified in the following tables without prior approval from the Joint Board.

1.2 Major Equipment Codes

1. The equipment and instrument codes are as follows.

Tag Fragment	CCC	CCC	CC			
Fragment No.	1	2	3			

Explanation of Characters:

1. 3 Characters: Represents facility
2. 3 Characters: Represents major mechanical equipment
3. 2 Characters: Represents number of mechanical equipment

1.2.1 Fragment 1- Facility

Fragment 1 is a three character code representing the facility. Refer to the following table.

Elgin Area Water Supply Locations	
Acronym	**Facility**
EAW	Elgin Area Water Treatment Plant
EAL	Elgin Area Low Lift Pump Station
EFR	Fruit Ridge Surge Facility
EMP	Elgin-Middlesex Pump Station
CE4	Port Stanley Valve Chamber (inter-WAN site)
PB3	Port Burwell Valve Chamber MV1/MV2 (inter-WAN site)
EPA	Elgin Pipeline A
EPB	Elgin Pipeline B
EPI	Elgin Pipeline Interconnect

Lake Huron Water and Waste Water Locations	
Acronym	**Facility**
LHL	Lake Huron Low Lift
LHW	Lake Huron Water Plant
LH4	McGillvray Reservoir (Ausable)
LH3	B Line North Valve Chamber (including Exeter-Hensall Monitoring Station 1)
LH2	B Line South Valve Chamber
LH6	Monitoring Station MS1
LH7	Monitoring Station MS2
NM1	Mount Carmel Reservoir
LH5	Arva Reservoir
MC2	Denfield Booster Station

LU2	Lucan Booster Station/Link From Lucan Tower
	Exeter/Hensall Pipeline Sites
EH1	Exeter Hensall Reservoir and Booster Station
EH2	Exeter Hensall Monitoring Station 2 (Dashwood)
EH3	Exeter Hensall Monitoring Station 3 (Hensall)
EH4	Exeter Hensall Monitoring Station 4
SH1	Exeter Water Tower, South Huron
BW1	Hensall Water Tower, Blue Water
	Komoka Mt. Brydges Pipeline Sites
KB1	Komoka-Mt. Brydges Booster Pumping Station
KM1	Coldstream/Medway Monitoring Station #1
KM2	Falconbridge/Springwell Monitoring Station #2

APAM Water and Waste Water Locations	
Acronym	**Facility**
AY4	Aylmer Tower
AY3	Valve Chamber 16
AY2	Valve Chamber 13
PB4	Chamber E034 (Lakeview)
TM2	Copenhagen Booster Station
PB2	Port Burwell Tower
PB3	Port Burwell Chamber MV1/MV2
AY9	Aylmer Main Sewage Pump Station

St. Thomas Water and Waste Water Locations	
Acronym	**Facility**
WD3	Albert Roberts Booster Station
WS4	Ford Tower
WS1	Ford Meter Chamber
WD1	West Chamber
WS2	Southwold
WS3	Wellington PRV
SO9	Axford SPS
SO2	Confederation SPS
SC2	Crescent SPS
SO1	Dalewood SPS
SO3	Harper SPS
SC1	Lynhurst SPS
SO8	Parkside SPS
SO6	St. George SPS
SS7	Sunset SPS
SS4	Wolf SPS
SC3	Woodland SPS
SO5	Woodworth SPS

Central Elgin Area Water and Waste Water Locations	
Acronym	**Facility**
CE7	Belmont Water Tower
CE3	Belmont Waterworks
CE2	Port Stanley Water Tower
CE1	Port Stanley Chamber 1

CE4	Port Stanley Chamber 4
CE6	Sunset PRV
C71	Belmont Station 71 SPS
C72	Belmont Station 72 SPS
C73	Belmont Station 73 SPS
C51	Port Stanley Station 51 SPS
C53	Port Stanley Station 53 SPS
C54	Port Stanley Station 54 SPS
C55	Port Stanley Station 55 SPS
C56	Port Stanley Station 56 SPS
C52	Port Stanley Station Train Station SPS
CP2	Port Stanley Station 56 WPCP
CP1	Belmont WPCP

1.2.2 Fragment 2- Equipment Identifier Codes

1. Fragment 2 is a three character code representing the acronym for the mechanical equipment or area. Refer to the following table. For instruments associated with the building, such as flood alarms, Fragment 2 should be the building (BLD) code, plus the building number. Then Fragment 4 can be the instrument code for instruments associated with a common area or general piping area, not with a specific major mechanical device, Fragment 2 should be the area or piping header codes, such as “BWH”, backwash header.

CODE	**DESCRIPTION**
ACN	Air Conditioner
ACP	Air Compressor
ADS	Absorber
ADT	Alum Day Tank
AER	Aerator
AFP	Alum Feed Pump
AHU	Air Handling Unit
ALS	Alum Storage Tank
ALP	Alarm Panel Indication
ATF	Alum Transfer Pump
ATS	Automatic Transfer Switch
BLD	Building
BLO	Blower
BSK	Basket Strainer
BSP	Booster Pump
BWL	Backwash Line
BWH	Backwash Header
BWP	Backwash Pump
BWT	Backwash Holding Tank
CBP	Chlorine Booster Pump
CDT	Chlorine Day Tank
CFP	Caustic Soda Pump
CHL	Chlorinator
CHP	Chlorine Pump
CLF	Clarifier
CLR	Chlorine Room
CLW	Clearwell
CMP	Compressor
CNV	Control Valve
CPP	Cat 5 Patch Panel
CPU	Computer
CRN	Crane
CST	Chlorine Storage Tank

CODE	DESCRIPTION
CTP	Chlorine Transfer Pump
DCV	Decant Valve
DDT	Fuel Day Tank
DFP	Diesel Fuel Pump
DFT	Diesel Fuel Tank
DTF	Fuel Day Tank
DHR	Disk Header
DHU	Dehumidifier
DRN	Drain
DSV	Desludge Valve
DTR	Day Tank
DWL	Drywell
EAL_BLD01	Main Building
EAL_BLD02	Zebra Mussel Building
EAW_BLD01	Flocculation
EAW_BLD02	Chlorine
EAW_BLD03	Filter/HL/Clearwell/Main Building/
EAW_BLD04	Surge Tank
EAW_BLD05	Generator Building
EPE	Emergency Power Equipment
EWL	Effluent Water Line
EWP	Effluent Water Pump
EWS	Effluent Water Strainer
EXF	Exhaust Fan
FDT	Fluoride Day Tank
FIL	Water Filter
FLC	Flocculators
FLP	Fluoride Pump
FLT	Filters
FMC	Flash Mixing Chamber
FPP	Fiber Patch Panel
FRL	Network Firewall
FTK	Fluoride Tank
FTP	Fluoride Transfer Pump
GAF	Gas Furnace
GBT	Gravity Belt Thickener
GCL	Grit Classifier
GCP	Grit Chamber Pump
GEN	Generator
GFV	Gravity Flow Valve
GRF	Gravity Filter
GRI	Grinder
GRP	Grit Wash Pump
GSP	Grit Separator
GTE	Gate
GWP	Grit Wash Pump
HCT	Sodium Hypochlorite Tank
HLP	High Lift Pump
HWB	Hot Water Boiler
HWP	Hot Water Pump
HYD	Yard Hydrant
INJ	Injector
INT	Intake
IWL	Influent Water Line
LLP	Low Lift Pump

CODE	DESCRIPTION
MBR	Main Breaker
MCC	Motor Control Centre
MHL	Manhole
NGH	Natural Gas Headerline
NGH	Natural Gas Headerline
PAP	PAC Feed Pump
PAT	PAC Transfer Pump
PDT	Polymer Day Tank
PFR	Power Feeder
PKL	Parking Lot
PLP	Plant Service Water Pump
POP	Polymer Feed Pump
PST	Pneumatic Surge Tanks
PTK	PAC Storage Tank
PTP	Polymer Transfer Pump
PTR	Power Transformer
RCP	Recirculation Pump
RES	Reservoir
RFG	Refrigerator
RIO	Remote I/O
PLC	Remote Processing Unit
RSP	Raw Sludge Pump
RSV	Reservoir
RTK	Recirculation Tank
RTR	Network Router
SAM	Automatic Sampler
SAP	Sample Pump
SBV	Sludge Blowdown Valve
SCB	Scrubber
SCC	Screw Conveyor
SCP	SCADA Control Panel
SEC	Sediment Water Conduit
SED	Sedimentation Tank
SHP	Sodium Hypochlorite Pump
SLC	Sludge Collector
SLP	Sewage Pump
SMP	Sump Pump
SMT	Sump Tank
SPE	Standpipe
SPT	Septic Tank
SRV	Surge Relief Valve
SSV	Surge Suppressor Valve
STR	Storage Room
STT	Settling Tank
SUT	Surge Tank
SWI	Network Switch
SWG	Switch Gear
SWP	Surface Wash Pump
TFP	Fuel Transfer Pump
TSC	Traveling Screen
TSR	Transformer
UFT 1-9	Underground Fuel Tank
UHT	Unit Heater
UVS	U.V. System
UWP	Unwatering Pump

CODE	DESCRIPTION
VAP	Vacuum Pump
VCH	Valve Chamber
WLL	Well
WWL	Wetwell
WAP	Wireless Access Point

1.2.3 Fragment 3 – Equipment Number

1. Fragment 3 is a two character, equipment number ranging from 01 to 99. In special situations “00” is used to identify valves and instruments related to the common piping header, or area.

2. The following example is provided:

   EA1_HLP01 where:

   EA1 = Elgin Area Water Treatment Plant
   HLP = High Lift Pump
   01 = Pump Number 01

3. On the mechanical, process, and electrical drawings, fragment 1 can be referenced with a note, where appropriate. The other fragments are to be indicated beside each equipment symbol on the drawing. Underscores are to be provided on the drawings, as indicated in the examples above.

1.3 Minor Equipment and Instrument Codes

1. For motorized valves, instrumentation, and other minor equipment that is related to a major piece of process mechanical equipment, a suffix code is added to the main equipment code. This then relates and groups these minor devices together with their related major device. For instruments associated with the building, such as flood alarms, Fragment 2 should be the building (BLD) code, plus the building number. Then Fragment 4 can be the instrument code for instruments associated with a common area or general piping area, not with a specific major mechanical device, Fragment 2 should be the area or piping header codes, such as “BWH”, backwash header.

2. For situations such as multiple motorized valves on a discharge header, the valve codes should be related to the upstream group of pumps, based on the pump number 00, which represents the group of pumps. For example, if a group of motorized valves are downstream of high lift pumps 1-4 (HLP01 to HLP04), then the appropriate valve codes are HLP00_C01, PSP00_C02, etc.

Tag Fragment	CCC	CCC	CC	CCC		
Fragment No.	1	2	3	4		

Explanation of Characters:

1. 3 Characters: Represents facility
2. 3 Characters: Represents mechanical equipment
3. 2 Characters: Represents number of mechanical equipment
4. 3 Characters: Represents the minor device tag and number

1.3.1 Fragment 1-3

1. Fragments 1-3 are consistent with the equipment coding scheme noted above.

1.3.2 Fragment 4 Minor Device Code

1. Fragment 4 is a three character code that specifies the minor equipment. These codes, where applicable, are also shown on the plant P&ID’s to identify manual valves and similar items with no electrical connections.

2. The following example is provided:

EA1_HLP01 _PIT where:

EA1	= Elgin Area Water Treatment Plant
HLP	= High Lift Pump
01	= Pump Number 01
PIT	= Pressure Indicating Transmitter/or use PT1 if multiple transmitters nearby.

3. On the mechanical, process, and electrical drawings, fragments 1 and 2 can be referenced with a note, where appropriate. The other fragments are to be indicated beside each instrument /equipment symbol on the drawing. Underscores are to be provided, as indicated in the example above.

Fragment 4 Codes

Acronym	*Description*
Instruments	
AHH	Analyzer Switch High High (Hazardous Gas, Chlorine)
AI1-9	Analyzer Indicator 1-9
ALL	Analyzer Switch Low Low (Hazardous Gas, Chlorine)
APB	Acknowledge Push Button
ASH	Analyzer Switch High (Hazardous Gas, Chlorine)
ASL	Analyzer Switch Low (Hazardous Gas, Chlorine)
AT1-9	Analyzer Indicating Transmitters 1-9 (Hazardous Gas, Chlorine)
ATS	Automated Transfer Switch (Related to a particular Generator)
CB1-9	Power equipment protection devices 1-9 (Breakers)
CS1-9	Cluster Switch
DHH	Density Switch High High (Turbidity)
DI1-9	Density Indicator (Turbidity)
DLL	Density Switch Low Low (Turbidity)
DO1-9	Dissolved Oxygen Probes 1-9
DSH	Density Switch High (Turbidity)
DSL	Density Switch Low (Turbidity)
DT1-9	Density Indicating Transmitters 1-9 (Sludge and Turbidity)
FHH	Flow Switch High High
FI1-9	Flow Indicator
FLL	Flow Switch Low Low
FSH	Flow Switch High
FSL	Flow Switch Low
FT1-9	Flow Indicating Transmitters 1-9
FVN	Full Voltage Non reversing Starter
HS1-9	Hand Switches 1-9 related to Major Device
IS1-9	Electrical Isolation Disconnect Switches 1-9
JT1-9	Voltage or Power Monitoring
LHH	Level Switch High High
LI1-9	Level Indicator
LLL	Level Switch Low Low
LS1-9	Level Switches 1-9
LSH	Level Switch High
LSL	Level Switch Low
LT1-9	Level Indicating Transmitters
MD1-9	Mandown 1-9
MS1-9	Motion Sensors
MT1-9	Motor Temperature /Trip 1-9

MX1-9	Tank Mixers 1-9
PFC	Power Factor Correction Capacitors MS 1-9 Motion Sensor
PHH	Pressure Switch High High
PI1-9	Pressure Indicator
PLL	Pressure Switch Low Low
PM1-9	Power Monitoring Units 1-9
PSH	Pressure Switch High
PSL	Pressure Switch Low
PT1-9	Pressure Indicating Transmitters 1-9
RVS	Reduced Voltage Starter
SHH	Speed Switch High High
SI1-9	Speed Indicator
SLL	Speed Switch Low Low
SSH	Speed Switch High
SSL	Speed Switch Low
ST1-9	Speed Indicating Transmitters 1-9
SV1-9	Solenoid Valve 1-9
THH	Temperature Switch High High
TI1-9	Temperature Indicator
TLL	Temperature Switch Low Low
TM1-9	Timers 1-9
TSD	Electrical Surge Suppression Device
TSH	Temperature Switch High
TSL	Temperature Switch Low
TT1-9	Temperature Indicating Transmitters 1-9
VHH	Vibration Switch High High
VAC	Vaccum
VI1-9	Vibration Indicator
VLL	Vibration Switch Low Low
VSH	Vibration Switch High
VSL	Vibration Switch Low
VT1-9	Vibration Indicating Transmitters 1-9
WT1-9	Weigh Scales 1-9
Valves	
C01-CZZ	Motorized Control Valves 01-99 related to a major device, or group of devices
CV1-CV9	Check Valves
OC1-OC9	Discharge motorized Control Valve on major pumps, blowers, and similar devices
M01-M99	Monitored valves
PV1-PV9	Pressure reducing Valves
SC1-SC9	Suction motorized Control Valve on major pumps, blowers, and similar devices
V01-V99	Manual valves related to a major device, or group of devices
Water Filters	
AC1-9	Air Backwash Motorized Control Valves 1-9
DC1-9	Drain Motorized Control Valves 1-9
IC1-9	Inlet Motorized Control Valves/Gates 1-9
OC1-9	Outlet Motorized Control Valves/Gates 1-9
SC1-9	Surface Wash Control Valves 1-9
WC1-9	Water Backwash Motorized Control Valves 1-9
Motor Sensors	

MT1-9	Motor, Motor Brake, or Motor Bearing Temperature Transmitters or Switches 1-9
MV1-9	Motor Vibration Transmitters or Switches 1-9
MZ1-9	Motor Status Sensors (Starting or Stopping)
Building HVAC and Security	
AHN	Alarm Horn
BH1-9	Baseboard Heaters
CMI-9	Cameras
D01-99	Damper Motors
EF1-9	Building Exhaust Fans
L01-L99	Building Lighting
PH1-PH9	Building Photocells
SF1-9	Building Supply Fans
SM1-9	Smoke Detector 1-9
TH1-9	Building Thermostats
UH1-9	Building Unit Heaters
ZS1-9	Door Switches
Control Panel Equipment	
DCP	DC Power Supply
LCP	Local Control Panel
OIT	Operator Interface
UPS	Uninterruptible Power Supply
UV Systems	
B01-99	Ballasts 0-99 related to UV Banks
L01-l99	Lights 01-99 (related to UV Light Banks, plus similar)
W0199	Wipers 01-99 related to UV Banks
Other	
CP1-9	Single Device Control Panel/HS Station 1-9
STM	Strainer- Manual
STR	Strainer- Automatic
VFD	Variable Frequency Drive

Note: Motorized control valves is a generic term referring to electric actuators, pneumatic valves, hydraulic valves, and similar

1.4 Field Signal I/O Codes

1. For equipment that includes field signals to/from the PLC, the following identifies the coding scheme for labeling the field I/O.

Tag Fragment	CCC	CCC	CC	CCC	CCCCC	
Fragment No.	1	2	3	4	5	

Explanation of Characters:

1. 3 Characters: Represents facility
2. 3 Characters: Represents mechanical equipment
3. 2 Characters: Represents number of mechanical equipment
4 3 Characters: Represents 000, or the minor device code
5. 5 Characters: Represents the PLC input/output signal

1.4.1 Fragments 1-4

1. Fragments 1-4 are consistent with the equipment coding scheme noted above. Refer to Tables 1 to 5. If the signals are related to the major device, use “000” for fragment 4.

1.4.2 Fragment 5- PLC Field I/O

1. Fragment 5 is a five character code that specifies the equipment signals.

2. The following examples are provided:

   EA1_HLP01_000_START where:

EA1	= Elgin Area Water Treatment Plant
HLP	= High Lift Pump
01	= Pump Number 01
000	= Major Device Place holder
START	= Start Command (PLC Discrete Output)

   EA1_FIL01_IC1_OPENN where:

EA1	= Elgin Area Water Treatment Plant
FIL	= Water Filter
01	= Number 01
IC1	= Inlet Motorized Control Valve 1
OPEN	= Open Command (PLC Discrete Output)

3. On the control schematic drawings, fragment 1 can be referenced with a note, where appropriate. The other fragments are to be indicated beside each instrument /equipment symbol on the drawing. Underscores are to be provided on the drawings, as indicated in the examples above.

Fragment 5 Field I/O Codes

Acronym	*Signal*	*Description*
ALMDI	DI	General Alarm Input
ALMDO	DO	General alarm output (typically to turn on a light)
AOOUT	AO	Analog output to display value on local indicator
AUTOM	DI	Fixed Device in local Auto mode
BATLO	DI	Battery low alarm
CLOSD	DI	Valve/Gate is completely closed
CLOSE	DO	Valve/Gate close command
CLOSI	DO	Close output to display value on local indicator
DISBD	DI	Disabled
DISBL	DO	Device disable command
DUTY1	DO	Duty 1 command
DUTY2	DO	Duty 2 command
DUTY3	DO	Duty 3 command
ESTOP	DI	Emergency stop activated
FAULT	DI	Device fault general alarm
FAUTI	DO	Fault signal to display value in local indicator
FEDBK	AI	Position/speed setpoint feedback
FLLVL	AI	Fuel Level
FLSPL	DI	Fuel Spill
FWDRN	DI	Equipment running in forward mode
HMAOF	DO	Device alarm Disable (HMI command)
HMAON	DO	Device alarm Enable (HMI command)
HMAUM	DO	HMI Remote Auto Mode command
HMCLS	DO	Valve/gate close (HMI command)
HMMNM	DO	HMI Remote Manual Mode Command
HMOPN	DO	Valve/gate open (HMI command)

HMSEP	AO	Setpoint (HMI command)
HMSTP	DO	HMI Stop device command
HMSTR	DO	HMI Start device command
HTALM	DI	High Temperature alarm
LOCAL	DI	Device L/O/R switch is in LOCAL position
LKOUT	DI	Lockout DI
OPEND	DI	Valve/Gate is completely opened
OPENI	DO	Open signal to display value in local indicator
OPENN	DO	Valve/Gate open command
OVRLD	DI	Device overload alarm
POS01-POS99	DI	Position indicator, generally as.
RCKDI		Breaker Rocked In.
RCKDO		Breaker Rocked Out.
READL	DI	Device ready to be loaded
READY	DI	Device is ready for service
REMOI	DO	Remote signal to display value in local indicator
REMOT	DI	Device L/O/R, or L/R selector switch position indicator is in REMOTE position
REVRN	DI	Equipment running in reverse mode
RPAEN	DI	Device alarm enable status (generated by PLC logic)
RPALM	DI	Device alarm (generated by PLC logic)
RPCSG	DI	Valve/Gate closing status (PLC logic generated)
RPFBK	AI	Feedback (calculated by PLC logic)
RPFLW	AI	Flow (calculated by PLC logic)
RPOPG	DI	Valve/Gate opening status (PLC logic generated)
RPRTM	AI	Runtime (generated by PLC logic and modifiable from HMI)
RPSCN	AI	Start counter (generated by PLC logic and modifiable from HMI)
RPVLM	AI	Volume (calculated by PLC logic)
RUNNG	DI	Device is running
RUNNH	DI	Device is running at high speed
RUNNI	DO	Run signal to display value in local indicator
RUNNS	DI	Device is running at low speed
SETAI	AI	AI setpoint input from remote device
SETPT	AO	Position/speed setpoint
STAAI	AI	General instrument AI
STADI	DI	General device status input high
STADO	DO	General device digital output
STAHH	DI	Instrument/device status- high high value
STAHI	DI	Instrument/device status- high value
STALL	DI	Instrument/device status- low low value
STALO	DI	Instrument/device status- low value
STARL	DO	Start device on low speed command
START	DO	Start device command
STAST	DI	Motor starting status
STASP	DI	Motor stopping status
STOPP	DO	Stop device command
STREQ	DI	Start request
STPRQ	DI	Stop request
THALM	DI	Theft Alarm

TRQHI	DI	Device high torque alarm
VOLTH	DI	Voltage high
VOLTL	DI	Voltage low
Powermeter related		
AMPAV		average current
AMPPA		current phase A
AMPPB		current phase B
AMPPC		current phase C
COPWR		Commercial/Normal power
DKVAR		Demand of re-active power
EMPWR		Emergency power
KVA00		measured kVA
KWATT		measured kW
KWHR0		measured kWhr
KVARH		Total delivered re-active power
OKVAR		Total instantaneous re-active power
PF000		power factor
PRQLO		Low Power Quality
PTFLD		Protection Failed
PTTPD		Protection operated/tripped
PWRON		Power On
PWROF		Power Off
RCKDI		Breaker Racked in
RCKDO		Breaker Racked out
TPDKW		Demand of active power
TTKWH		Total delivered active power
TTPKW		Total instantaneous active power
TTTHD		Total harmony distortion percent
VOLAB		Voltage AB
VOLAC		Voltage AC
VOLAV		Average Voltage
VOLBC		Voltage BC
VOLAN		Phase A voltage
VOLBN		Phase B voltage
VOLCN		Phase C voltage
CPU Ethernet Channels		
RDSTA		read channel status
WRSTA		write channel status
Scaling Related Values		
ACWGT		accumulated weight
GSWGT		gross weight
NTWGT		net weight
TRWGT		tare weight
TTWGT		total weight

2. PLC Signals

2.1 MicroLogix Tagnames

1. For the MicroLogix PLC's the tagnames are limited to 20 characters, therefore the following standard is an extension of the field I/O coding.

Tag Fragment	CCC	CCC	CC	CCC	CCCCC	CCCC
Fragment No.	1	2	3	4	5	6

Explanation of Characters:

1. 3 Characters: Represents facility, and is not included due to tag length limitations
2. 3 Characters: Represents mechanical equipment
3. 2 Characters: Represents number of mechanical equipment
4 3 Characters: Represents 000, or the minor device code
5. 5 Characters: Represents the PLC input/output signal
6. 4 Characters: Represents the Attribute, which is an extension of the signal

2.1.1 Fragments 1-4

2. Fragments 1-4 are consistent with the equipment coding scheme noted above. Refer to Tables 1 to 5. If the signals are related to the major device, use "000" for fragment 4.

2.1.2 Fragment 5- PLC Field I/O

3. Fragment 5 is a five character code that specifies the equipment signals. Once the field signal is buffered and modified within the PLC logic, this fragment may change to reflect other characteristics.

2.1.3 Fragment 6- PLC Field I/O Attribute

4. Fragment 6 is a four character code that specifies the "attribute" related to the field signal. It is used to further define the signal within the program. Refer to the table following for specific codes.

2.1.4 Example

5. For reference, a typical signal within the PLC code is BSP01_PT1_STAAI_RAW, which is the raw input signal from pressure transmitter PT1 related to Booster Pump BSP01.

2.2 Compact Logix and Control Logix Tagnames

1. For the Compact Logix and Control Logix PLC's the tagnames are **not** limited to 20 characters, therefore the following standard is an extension of the field I/O coding.

Tag Fragment	CCC	CCC	CC	CCC	CCCCC	CCC	CCCC	
Fragment No.	1	2	3	4	5	7	6	

Explanation of Characters:
The first six, defined fragments are the same as those specified for the MicroLogix. One additional fragment- Fragment 7, has been added.

1. 3 Characters: Represents facility
2. 3 Characters: Represents mechanical equipment
3. 2 Characters: Represents number of mechanical equipment
4 3 Characters: Represents 000, or the minor device code
5. 5 Characters: Represents the PLC input/output signal
6. 4 Characters: Represents the Attribute, which is an extension of the signal
7. 3 Characters: Represents the related driver subroutine

Note that Fragment 7 is before Fragment 6

2.2.1 Fragments 1-4

2. Fragments 1-4 are consistent with the equipment coding scheme noted above. Refer to Tables 1 to 5. If the signals are related to the major device, use “000” for fragment 4.

2.2.2 Fragment 5- PLC Field I/O

3. Fragment 5 is a five character code that specifies the equipment signals. Once the field signal is buffered and modified within the PLC logic, this fragment may change to reflect other characteristics.

2.2.3 Fragment 6- PLC Field I/O Attribute

4. Fragment 6 is a four character code that specifies the “attribute” related to the field signal. It is used to further define the signal within the program. Refer to the table following for specific codes.

2.2.4 Fragment 7- Internal PLC Subroutine

5. Fragment 7 is a three character code that specifies the subroutine that is the source of the software signal within the PLC program. Refer to the table following for specific codes.

2.2.5 Example

6. For reference, a typical signal within the PLC code is LHW_BSP01_PT1_STAAI_BUF_RAW, which is the raw input signal from pressure transmitter PT1 related to Booster Pump BSP01, at the water plant LHW. The signal originates within the BUF (input buffering) subroutine.

2.3 SCADA HMI Tagnames

1. For the Rockwell SCADA HMI, the tagnames are the same as the Control Logix tagnames, with the PLC number added so that the maintenance staff are aware of the source of the signal.

Tag Fragment	C	CCC	CCC	CC	CCC	CCCCC	CCC	CCCC
Fragment No.	8	1	2	3	4	5	7	6

Explanation of Characters:
The first six, defined fragments are the same as those specified for the MicroLogix. Two additional fragments- Fragments 7 and 8, have been added.

1. 3 Characters: Represents facility
2. 3 Characters: Represents mechanical equipment
3. 2 Characters: Represents number of mechanical equipment
4 3 Characters: Represents 000, or the minor device code
5. 5 Characters: Represents the PLC input/output signal
6. 4 Characters: Represents the Attribute, which is an extension of the signal
7. 3 Characters: Represents the related driver subroutine
8. 1 Character: Represents the related source PLC

Note that Fragments 6, 7, and 8 are not in sequence.

2.3.1 Fragments 1-4

2. Fragments 1-4 are consistent with the equipment coding scheme noted above. Refer to Tables 1 to 5. If the signals are related to the major device, use “000” for fragment 4.

2.3.2 Fragment 5- PLC Field I/O

3. Fragment 5 is a five character code that specifies the equipment signals. Once the field signal is buffered and modified within the PLC logic, this fragment may change to reflect other characteristics.

2.3.3 Fragment 6- PLC Field I/O Attribute

4. Fragment 6 is a four character code that specifies the “attribute” related to the field signal. It is used to further define the signal within the program. Refer to the table following for specific codes.

2.3.4 Fragment 7- Internal PLC Subroutine

5. Fragment 7 is a three character code that specifies the subroutine that is the source of the software signal within the PLC program. Refer to the table following for specific codes.

2.3.5 Fragment 8- PLC Number

6. Fragment 8 is a one character code that specifies the PLC number at the specific site. For most of the sites, the location only includes 1 PLC therefore the number will be “1”. For a few sites, such as the water plants, more than one PLC is installed therefore subsequent numbers are also used.

2.3.6 Example

7. For reference, a typical signal within the HMI code is 1_LHW_BSP01_PT1_STAAI_BUF_RAW, which is the raw input signal from pressure transmitter PT1 related to Booster Pump BSP01, at the water plant LHW. The signal originates within the BUF (input buffering) subroutine within PLC 1.

2.4 Fragment 5, 6, 7, and 8 Codes

The following tables identify the fragment 5, 6, 7, and 8 codes.

Additional Fragment 5 Codes within the software

Acronym	*Signal*	*Description*
ALARM		Alarm
ALRST		Alarm reset
ARMED		Security system armed
ARRFL		Lookup table flow values array
ARRLV		Lookup table level values array
BTWST		Between starts
CBCAP		Combined capacity
CH1AC		PLC channel1 port active
D0AUT		Equipment duty alternation in auto mode
D0BST		Duty call to start backup equipment
D0MAN		Equipment duty alternation in manual mode
D1FFO		Duty 1 FIFO
D1SEL		Duty 1 selection
D1SPL		Duty 1 stop level
D1STL		Duty 1 start level
D1STR		Duty 1 start
D2FFO		Duty 2 FIFO
D2STL		Duty 2 start level
D2SPL		Duty 2 stop
D2STR		Duty 2 start
DASSN		Duty assignment
DLCOM		Communication failure monitor by data logger
DLUPD		Data logger update
DUTY0		Duty logic reference
ETRST		ETM reset
EVENT		Event identifier
FLCAL		Calculated flow
FLINI		Fault alarming initialization
GENAL		General alarm
HIRST		High condition reset
IDX01		Lookup table index 1
IDX02		Lookup table index 2
IDXMX		Lookup table maximum index
LAST0		Last (or previous) state of equipment
LKINI		Equipment lockouts initialization

LKRST		Lockout reset
LLKON		Level lockout on
LOCHB		Local heartbeat
LORST		Low reset
PMCAP		Pump capacity
MANLM		Manual mode
MASHB		Master heartbeat
MPERM		Mode permissive interlock
MULDI		Multidigital (or multistate) values
MXSPH		Maximum starts per hour
MXRST		Maximum resets per hour
OPERM		Operations permissive
OFCYC		Off cycle
ONCYC		On cycle
Q0ENB		Data logging record queue 0 enabled
Q0ENT		Data logging record queue 0 has record entry
Q0OVF		Data logging record queue 0 overflowed
Q0REC		Data logging record queue 0 number of records
Q0SZE		Data logging record queue 0 size
RMAST		Remote master
RNSTS		Run status
RST00		Reset
RSTPH		Resets per hour
RWMSG		Read/write message
SECGN		One second generator
SECIN		Security system in (or entry)
SECOT		Security system out (or exit)
SIGFL		Signal fault
SPH00		Starts per hour
SPHLK		Lockout related to starts per hour
STINI		PLC startup initialization
STPFL		Equipment fail to stop
STRFL		Equipment fail to start
SYSDA		PLC system calendar day
SYSDW		PLC system calendar day of the week
SYSHR		PLC system clock hour
SYSMN		PLC system clock minute
SYSMO		PLC system calendar month
SYSSE		PLC system clock second
SYSTM		PLC system time
SYSYR		PLC system calendar year
TMRST		Timer reset
UCSTR		Uncommanded start
UCSTP		Uncommanded stop
VLMLI		Total volume in litres
VLMM3		Total volume in cu. meters
VLRST		Totalizer reset

Fragment 6 Codes within the software

Acronym	*Signal*	*Description*
ALM		Alarm identifier
AUT		Auto status identifier
BUF	DI,AI	Buffered field input values
CMD		Command signals
CTR		Counters
DAY		Calendar day values
DBN		Signal debounce on timer
DBF		Signal debounce off timer
DLG		Data logger reference
DWK		Calendar day of the week values
EGU		Values scaled to EGU
EMN		Signal EGU zero scaling
EMX		Signal EGU span scaling
ERR		Error code identifier
ETM		Elapse running time (or elapse time meter) values
FFO		FIFO reference
FIL		FILO reference
HBT		Heartbeat
HMI		HMI entered values
HOR		Clock hour values
LUP		Lookup table reference
MIN		Clock minute values
MON		Calendar month values
PLS		Pulse signals
RAW	DI, AI	Raw field input values
REG		Temporary holding register identifier
REQ		Control request signals
RMN	AI	Minimum signal range values
RMX	AI	Maximum signal range values
RST		Reset
SEC		Clock seconds value
STS	DI	Signal status identifier
TMR		Timer identifier
TOT		Totalizer values

Fragment 7 Codes within the software

Acronym	*Signal*	*Description*
AIC		Input conditioning subroutine (analog signals)
ALH		Alarm handling subroutine
AST		Analog statistics computation subroutine
DIC		Input conditioning subroutine (digital signals)
DLG		PLC data logging subroutine
DRV		Device driver subroutine

DTY		Equipment duty subroutine
IBF		Input buffer subroutine
OBF		Output buffer subroutine
SEC		Facility security system subroutine
SEQ		Auto control sequence subroutine
STH		Startup and housekeeping subroutine
SYS		PLC system parameters subroutine

2.5 Typical Device Tagnames

The following provides the details on typical devices and I/O

Typical Minor Devices		
Fragment 5		
Motorized Open/Close Valve and Sluice Gates		
REMOT	DI	Device L/R switch is in REMOTE position
OPENN	DO	Valve/Gate open command
CLOSE	DO	Valve/Gate close command
OPEND	DI	Valve/Gate is completely opened
CLOSD	DI	Valve/Gate is completely closed
FAULT	DI	Device Fault
Monitored Open/Close Valve and Sluice Gates		
OPEND	DI	Valve/Gate is completely opened
CLOSD	DI	Valve/Gate is completely closed
Modulating Valve		
REMOT	DI	Device L/R switch is in REMOTE position
SETPT	AO	Position/speed setpoint
FEDBK	AI	Position/speed feedback
OPEND	DI	Valve/Gate is completely opened
CLOSD	DI	Valve/Gate is completely closed
FAULT	DI	Device Fault
Modulating Open/Close Valve and Sluice Gates		
REMOT	DI	Device L/R switch is in REMOTE position
OPENN	DO	Valve/Gate open command
CLOSE	DO	Valve/Gate close command
FEDBK	AI	Position/speed feedback
OPEND	DI	Valve/Gate is completely opened
STAAO	DO	Position speed indicator
CLOSD	DI	Valve/Gate is completely closed
FAULT	DI	Device Fault
Standard Transmitter (Pressure, Temperature, Flow, etc.)		
STAAI	AI	Position/speed feedback and general instrument AI
FAULT	DI	Device fault general alarm (if available)
Miscellaneous Inputs		
STADI	DI	General device status input high
STADO	DO	General Device status output to display value in local indicator

Typical Major Devices			
Fragment 4	**Fragment 5**		
FVNR Standard Starter			
000	REMOT	DI	Device L/O/R switch is in REMOTE position
000	START	DO	Start device command
000	STOPP	DO	Stop Device Command
000	RUNNG	DI	Device is running
000	FAULT	DI	Device fault general alarm
Traveling Bar Screens			
000	REMOT	DI	Device L/O/R switch is in REMOTE position
000	START	DO	Start device command
000	STOPP	DO	Stop Device Command
000	RUNNG	DI	Device is running
000	FAULT	DI	Device fault general alarm
Chemical Metering Pump			
VFD	REMOT	DI	Device L/O/R switch is in REMOTE position
VFD	START	DO	Start/Stop device command
VFD	RUNNG	DI	Device is running
VFD	FAULT	DI	Device fault general alarm
VFD	SETPT	AO	Speed or stroke setpoint
VFD	FEDBK	AI	Speed or stroke feedback
Typical Pump VFD			
000	REMOT	DI	Device L/O/R switch is in REMOTE position
VFD	START	DO	Start/Stop device command
VFD	RUNNG	DI	Device is running
VFD	FAULT	DI	Device fault general alarm
VFD	SETPT	AO	Speed or stroke setpoint
VFD	FEDBK	AI	Speed or stroke feedback
000	FAULT	DI	Device fault general alarm
000	TRQHI	DI	Device high torque alarm
Screw conveyors and similar devices			
000	REMOT	DI	Device L/O/R switch is in REMOTE position
000	START	DO	Start device command
000	RUNNG	DI	Device is running
000	FAULT	DI	Device fault general alarm
000	TRQHI	DI	Device high torque alarm
000	ESTOP	DI	Emergency stop/ pull cord activated

2.6 Control Wiring Labeling

1. The equipment labeling system is also used to complete the control wire labeling. Some of the fragments are not used, to reduce the length of the wire labels.

Tag Fragment	CCC	CCC	CC	CCC	CCC	
Fragment No.	1	2	3	4	5	

Explanation of Characters:

1. 3 Characters: not used
2. 3 Characters: Represents mechanical equipment or instrumentation
3. 2 Characters: Represents number of the major mechanical equipment
4. 3 Characters: Optional, represents the number of the minor piece of equipment, if applicable
5. 3 Characters: Represents the wire number

2. Fragments 2-4 are consistent with the equipment coding scheme noted above. Fragment 5 is a 3 digit wire number, referenced on the control schematics.

2.7 Control Panel Labeling

1. All control panels must be labeled on the engineering drawings, and other design documents. In order to accomplish this in an efficient manner, the following approach will be used.
   a. Large, major control panels will be identified using the CCP (centralized control panel) as fragment 2. This is generally used when the panel has equipment and/or hand switches related to many devices. For example, CCP is used in the water filter area to designate the panels, which contain hand switches and indicators for all valves related to one water filter cell.

   b. For the smaller, local hand switch station, or emergency pushbutton station, related typically to only one major or minor device, the approach is to deviate slightly from the main equipment coding system. Utilize PANEL for fragment 5, as an acronym for control panel. For example, a local motorized valve hand switch station can be indicated as HLP01_DC1_PANEL on the drawings, and in the specifications where required. This is simply a method for uniquely identifying the panels for the tender documents, and maintenance staff, and is not related to SCADA I/O.

204 Process & Instrumentation Drawings (P&ID's)

1. General

This standard clearly presents Joint Board's intent in developing P&ID's. This standard is based on the Instrumentation Society of America (ISA) standard ISA-S5.1-1984, "Instrumentation Symbols and Identification." The 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. Comments are welcome for its enhancement.

1.1 Purpose of Standard

This standard is intended to provide a consistent way of showing information. Consistent presentation will speed reading and improve understanding of the diagrams. Consistent preparation of the diagrams will enable the use of data base access to and from information on the diagrams.

This standard will be included by reference into each design project and design or construction contract that prepares or modifies P&ID's.

Diagrams already prepared which are inconsistent with this standard will be converted to this standard whenever they are revised for other reasons. Existing diagrams, which are not compliant with this standard may also be converted to this standard if people using the diagrams can show benefit for the cost.

The P&ID legend sheet and P&ID symbol sheets should be included in each instrumentation and control (I&C) drawing set developed for the Joint Boards.

1.2 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 Organization (ISO). The Joint Board has decided to produce P&ID's that are consistent with ISA in order to have documentation readily understood by as wide an audience as practicable. The use of specialist symbols on P&ID's would result in additional cost for training, documentation and workforce inflexibility. The use of symbols and nomenclature from standards other than ISA will be incorporated into this standard where no conflict exists.

The CGA symbols were reviewed as part of preparing this standard. The CGA does not require the Joint Boards to prepare documentation using the symbols that the CGA itself uses in its standards and other publications. However, having documentation in a format familiar to boiler inspectors could expedite inspections and licensing of boilers. Therefore, the possibility of using CGA symbols instead of ISA symbols for boilers was explored.

A number of conflicts occurred, particularly where the CGA was showing instrumentation and control information. The major problems came from misunderstanding of CGA instrumentation symbols by people applying ISA meanings to them. An alternative of showing both symbols sets, ISA and CGA, on the same drawing was examined. It would greatly increase drawing complexity and could also be misinterpreted as indicating two instruments when only one exists. Another alternative was explored of having two drawings, one where ISA symbols would be used if conflict occurs with CGA and another drawing showing only the CGA symbols. This method has several advantages. Two drawings are typically provided now. The ISA style drawing is part of the engineering design phase and the CGA drawing is part of the documentation provided by the boiler or compressor manufacturer.

The result of this analysis is to prepare P&ID's consistent with ISA and incorporate symbols from other standards organizations as needed.

1.3 Purpose of P&ID

1. P&ID's convey process, instrument and control equipment information. A P&ID should enable anyone reading it (and having a reasonable amount of plant knowledge) to understand the means of measurement and control of the process.

2. A P&ID is a specific schematic representation of the mechanical, electrical, instrumentation and control aspects of a given process. The P&ID is developed from the process design engineer's drawings and is expanded by the control engineer to include other instrumentation as needed.

3. The P&ID must be an accurate representation of the physical process or system and should show equipment in the proper functional relation. A P&ID should include the following:

a. Process piping, tanks, structures, and equipment.
b. Primary elements, transducers, and analyzers.
c. Actuators and final control elements.
d. Panels and controls.
e. Input/output signals to digital controllers.
f. Schematic representations of control signal interconnections.

4. The P&ID is the only document which shows both process and control information. As such, it can be a valuable tool during design construction, and start-up. P&ID's are used during design as a basis for:
   a. SCADA control strategy design.
   b. SCADA input/output point list development.
   c. Field instrument schedule development.
   d. Control panel design.
   e. Electrical interface definition.
   f. Mechanical and electrical equipment tagging.
   g. Overall design coordination.

5. During construction and start-up P&ID's can be used for:
   a. Shop drawing review of computer controls, panel and loop submittals.
   b. Electrical interface coordination.
   c. Graphic display development/approval.
   d. Process control operational checkout.
   e. Developing as-built and operation and maintenance manuals.
   f. Training.

1.4 Drawing Phases

1. The P&ID's are developed in stages in order to add information at the appropriate time. The usefulness of added details must be weighed against the expense of preparation and review effort. The P&ID development stages are shown in the following table.

Major Item	**Preliminary Design**	**Detailed Design**	**Implementation**
Piping, tanks, equipment and valves for process and auxiliary processes	Required	Required	Required
Sensors, transmitters, switches	Required	Required	Required
Actuator type with pneumatic and hydraulic instrumentation	Required	Required	Required
PLC I/O Points Indicated	Not required	Required	Required
Panel - Face mounted instrumentation new/modified custom panels existing custom panels equipment package panels specialty package panels	 Not required Not required Not required Not required	 Required Required Not required Required	 Required Required Required Required
Panel - Internal instrumentation new/modified custom panels existing custom panels equipment package panels specialty package panels	 Not required Not required Not required Not required	 Required Required Not required Required	 Required Required Required Required
Representation	Typical is okay	No use of typicals	No use of typicals
Control loops - hardwired	Not required	Required	Required
Setpoints, limits	Not required	Not required*	Required

* Required on instrument data sheets.

1.5 Scope of Drawings

1. A set of P&ID's for a process or sub-process includes 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&ID's for a pumping sub-process would include the main system, e.g. backwash 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.
    a. The information includes all components of the process or sub-process. That is, the drawing set must show :
    b. automated and non-automated systems,
    c. current project additions, deletions and modifications,
    d. existing conditions and future provisions if known.

2. The information shown on the P&ID's includes major control logic of the process or sub-process control strategies. That is, the drawing set must show :
    a. all hardwired interlocks, totalizers and signal converters,
    b. all standard controllers.

3. The P&ID's must show all inputs and outputs of the Process Control System and the instruments and equipment which provide the inputs and receive the outputs.

4. The P&ID's do not need to show virtual points except as needed to clarify control logic.

5. The P&ID's 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.

1.6 Terminology

1. The following definitions are from ISA-S5.1-1984, "Instrumentation Symbols and Identification."
    a. Instrument - A device used directly or indirectly to measure or control a variable or both. The term includes control valves, relief valves, and electrical devices such as annunciators and push-buttons.
    b. Instrumentation - A collection of instruments or their application for the purpose of observation, measurement, control, or any combination of these.
    c. Primary Element - That part of a loop or of an instrument that first senses the values of a process variable. The primary element is also known as a sensor.
    d. Final Control Element - That device that directly controls the value of the manipulated variable of a control loop.
    e. Switch - A device (instrument) that connects, disconnects, selects, or transfers one or more circuits and is not designated as a controller, a relay, or a control valve.
    f. Controller - A device having an output that varies in response to an input of a measured process variable to regulate a controlled variable in a specified manner. Typical instrument identifications are XC, XIC, and XFIC for controller, indicating controller and ration indicating controller respectively. X is the process or initiating variable. Controller types are auto/manual, computer/auto/manual or supervisory set point.
    g. Control Station - A manual loading station that also provides switching between manual and automatic control modes of a control loop. It may be called an auto-manual station or an auto-selector station. The word computer may be substituted for auto when the control station is used with a computer. Typical instrument identification is HK or HIK. In rare cases, XK or CIK may be used where X is the process variable.
    h. Manual Loading Station - A device having a manually adjustable output that is used to actuate one or more remote devices. It may be called a manual controller, manual station or remote manual loader. The station does not provide switching between manual and automatic control modes. Typical instrument identifications are HFK and HIXK for hand ratio control station and hand indicating unclassified control station. Manual loading stations are rarely, if ever, used in computer control systems.
    i. Balloon - The circular symbol used to denote an instrument or instrument tagging. Synonym for bubble.
    j. P&ID - Process and Instrumentation Diagram. Do not substitute the words "piping," "instrument" or "drawing".

1.7 Process Layout

1. There are two general types of process layouts: those which show cast-in-place (concrete) or fabricated-in-place (steel) tanks and those which show mechanical equipment or prefabricated process systems. An example of the former is a sludge treatment process, which includes (tanks), sludge pumps, and the

associated interconnecting piping and channels. Examples of the latter might include: centrifuges, +polymer batching system, instrument air supply systems, and chlorinators and ejectors. Each layout has certain graphic presentation characteristics, which are discussed below.

1.8 Tank System Layout

1. Always use plan views on this type of layout.

2. Although P&ID’s aren’t required to have a north-south orientation, in general, true north or plant north should be toward the top of the drawing. In some cases, you may wish to rotate the process 90 degrees on the drawing so that it fits better. Rotate the process counter clockwise so that north is to the left.

3. Flow streams may enter and exit the drawing on all four sides. It is not necessary or desirable to maintain a left to right or top to bottom flow direction. Flow streams enter and exit in relation to the process orientation and actual layout of the process.

4. Distinguish between channels and pipes and between prefabricated and cast-in-place tanks. Use double lines spaced about 1/8” to indicate channel or cast-in-place tank walls.

5. Occasionally, you may have difficulty deciding whether to show a conduit as a pipe (single line) or a channel (two pairs of lines to represent walls). Use the following guidelines:

6. Any conduit containing sluice gates, slide gates or flap gates either must be shown as a channel or must contain a gate structure to hold the gate.

7. A conduit which is cast-in-place with a tank or set of tanks should normally be shown as a channel. Do not sacrifice clarity to show the process schematically.

8. DO NOT typify process tanks or piping except through the use of process overview drawings.

1.9 Mechanical Equipment Layout

1. Plan or profile views may be used in this type of layout. In general, all piping to and from mechanical equipment or piping within a prefabricated process system should be shown in plan view. Exceptions might include a water filter where a profile view would better show the feed pipes at various levels.

2. Flow direction should be from left to right and from top to bottom as much as possible. If a north-south orientation is desired or is shown on other drawings, use that orientation.

1.10 Controls Layout

1.10.1 Control Levels

1. Use a layered approach to distinguish the various levels of control. 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. Locate computer input/output symbols and tags at the highest level.

2. The normal approach should use the area or unit process identification as recommended by ISA. An I/O point sort by this identification can be used to establish the number of points in each area and the number of PLCs, RTU’s, DPCs, or RSCs based on assumed or specified sizing constraints.

1.10.2 Package Panels

1. Package panels are of two general types: equipment supplier furnished and specialty supplier furnished. Examples of equipment supplier furnished materials are: blower or centrifuge control panels, polymer or similar chemical mixing system control panels if furnished by the mixing system supplier, and pneumatic transport system controls. Examples of specialty panels are: motor controllers, variable speed drives, sump pump control systems, and HVAC controls.

2. For package panels, the supplier is responsible for the proper operation of the panel. The supplier must perform the detailed engineering design to meet the functional requirements specified. The functional requirements include the desired operation, face of panel mounted equipment, panel layout, and interfaces with other control panels or computers. In many cases, the panel specifications are included within the equipment specifications and are written by others.

3. For example, a motor controller (MC) can be equipped with run lights, motor overload relays and lights, start/stop or on/off push-buttons and switches, local/remote switches and practically any other feature you desire including programmable controllers. Indicate these options on the P&ID's using a combination of balloons for face mounted equipment and signal line labels for signals which are derived interior to the package panel and used elsewhere in the control loop.

4. Show the package panels as boxes with face of panel mounted instruments only. Do not show interconnections, interlocks, interior signal function balloons, or signal function codes within the box.

5. All panels should be labeled in the upper left corner. If the package panel is shown on more than one drawings, the word PARTIAL shall be included with the label.

1.10.3 Custom Panels

1. Custom panels are those panels which are designed by the engineer for fabrication by a panel shop or the control system supplier. The supplier of the equipment controlled by these panels usually has no contractual responsibility for the proper operation of the equipment.

2. Show these panels with both face and interior mounted instruments. 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.

3. Label panels in the same way as package panels.

1.10.4 Control Signals

1. Run SCADA output signal lines to local/remote 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 Figure 2.

2. Label signal lines any time you think the function of the signal may be unclear. The label should be enclosed in quotation marks.

1.10.5 Interlocks

1. 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 shown on electrical drawings. Drawing notes should describe the function of all interlocks and should refer to the electrical drawings and/or specifications for additional details.

2. Device protective interlock symbols should be shown if this is the policy started in the design guide for the particular project. Protective interlocks are usually provided with the control device. For example, a pump may have protective interlocks which cause shutdown if sensors detect conditions such as excess vibration or high bearing temperature. This type of interlock is generally specified as a part of the device specification. It may or may not be shown on the electrical drawings. Always show these interlocks if the condition is to be displayed, alarmed or monitored.

1.10.6 Typifying

1. You can typify controls during preliminary design whenever you have typified equipment items. In addition, you can use typicals to reduce duplicated material. However, the 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.

2. Do not sacrifice clarity — when in doubt, do not typify even if additional drawings will be needed.

3. When typifying controls, the following rules apply:
   a. Show all signals to and from balloons, control devices or primary elements.
   b. Include equipment tags whenever there are no other balloons which indicate the loop number.
   c. Show the loop numbers, panel designations, and equipment tags of all devices represented by the typical box.
   d. Signal line arrowheads should point to the typical.

1.11 Overviews and Details

1. Drawings are attached as examples for reference.

1.11.1 Plant or System Overview

1. Prepare a plant or system overview drawing on all projects involving several unit processes, plants, or process areas. It will serve as a road map for the P&ID's. The overview should be prepared after the P&ID's are complete or near complete and should precede the P&ID's in the drawing set.

2. The overview should show:
   a. Each unit process, plant or process area by name and number.
   b. Flow streams between processes.
   c. P&ID or unit process overview drawing numbers.

1.11.2 Unit Process (Area) Overviews

1. Large or complex processes may require a process overview drawing. The overview may include a limited number of instruments and balloons. The overview should be oriented with north toward the upper part of the drawing if at all possible. Show process stream connections to other areas or unit processes. Subdivide the overview to correspond to the detailed P&ID's. Process stream connections among P&ID's within the unit process need not be shown.

1.11.3 Device Overviews

1. Large or complex devices may be shown as an overview symbol on a P&ID and then detailed on a separate drawing. The overview should identify the device, name the detail reference and show which panels contain instrumentation presented on the detail. If a panel is dedicated to the device it should only be shown on the device detail.
2. Some frequently occurring devices may also be shown as an overview symbol on a P&ID and detailed on another drawing as standard devices. The number of overview and detail layers should be minimized to reduce flipping between drawings. One drawing would be more convenient in the field, because of less paper handling and less chance of not bringing all the detail needed. Its usage should be restricted to where it is needed for clarity and consistency.

3. The choice and number of standard device designations needs to be managed on each project.

1.11.4 Redundant Information

1. Information should only be shown once. Do not repeat symbols for the same I/O point, instrument or piece of equipment.

1.12 Symbol and Legend Sheets

1. Refer to example drawing attached.

1.12.1 Primary Element Symbols

1. Identify the type of primary element early in the project. Mechanical layouts, instrument takeoffs, instrument application engineering, and quality control require definition of the type of primary element.

2. Minimize the use of unclassified primary element symbols. The most common use of the unclassified flow symbol is for a flow switch. Use the unclassified level symbol when a pressure sensing instrument is used to indicate level, or for vendor packaged level instruments where the type is vendor dependent.

1.12.2 Miscellaneous Symbols

1. Any special, non-standard symbols can be added to this group.

2. The sight glass must be used in the vertical position as shown.

1.12.3 Actuator Symbols

1. Pneumatic and hydraulic actuators are equipped with solenoid actuated pilot valves. Show these valves. Show a pipe stub(s) for the air supply or hydraulic fluid supply and return.

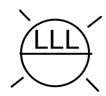
2. Hydraulic operators may have an associated oil or water pump or may be connected to a hydraulic fluid system. Show the hydraulic fluid system, instrumentation and controls. Indicate the normal operating pressure range.

3. Always show the fail position designation at the lower right of the actuator symbol for the fail-safe action in case of loss of air, hydraulic or electric power supply or control signal. Use abbreviations: FO (fail open), FC (fail close) or FL (fail lock).

1.12.4 Instrument and Function Symbols

1. Use separate, touching balloons for instruments that have more than one function such as controllers, control stations, valve actuators, multiple electrode level switches, sludge blanket detectors, and lighted switches.

2. Designate a panel mounted alarm light as:

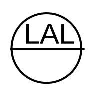


Level Light Low

3. For any light, the second letter must be an L. Placement of the L in the second position is needed to distinguish between readouts and modifiers. For example:

LAL	=	level alarm low
LL	=	level low (level light makes no sense)
LLL	=	level light low
LLLL	=	level light low low

4. Designate a panel mounted alarm annunciator point as:



Level Alarm Low

5. Note that annunciators are distinct from alarm lights. An alarm light simply lights under alarm conditions. An annunciator requires an acknowledgment to silence horns, stop the light from flashing or other actions. An annunciator may be a single light or may be part of an annunciator panel.

1.12.5 Flow Stream Identification

1. Identify all flow streams. Use the flow stream identifications shown on the P&ID Legend Sheet. If the project requires other flow stream identifications, you can alter the table shown. However, try to minimize the number of changes.

2. Except for plant influent and primary influent, label all flow streams based on the upstream process. For example, use primary effluent not secondary influent.

1.12.6 Equipment Tagging

1. Use the rectangular equipment tag box if no balloon is used. If you use equipment tags which do not contain the loop number, you should use balloons to show the loop number.

2. Equipment tags are mandatory when typifying to show which device is associated with which loop.

1.12.7 Flow Stream and Instrument Line Symbols

1. Use three different line weights to distinguish flow streams. The main flow stream is the liquid train, the secondary flow streams include backwash water and process air, and other flow streams include chemicals, instrument air, drains, water, and steam.

2. Use dashed lines to indicate alternate flow streams. These streams included bypasses and streams, which are not used for normal operations or for automatic backup.

3. Show all cast-in-place open channels and tanks in plan view and use double lines to indicate walls. Double lines help to distinguish between closed conduits (pipes) and tanks and open channels. Line weights and dashed lines are used as in the two previous items.

4. Use arrowheads to indicate direction of flow. Always use arrowheads where pipes connect and where pipes enter tanks.

5. Do not use arrowheads upstream of primary elements, gates, pumps, valves, and other equipment. Use enough for clarity and ease of tracing the flow stream.

6. When annotating flow streams or signal lines, enclose the annotation in quotes.

7. Label process equipment with a functional name, e.g. “raw sludge pump” or “treated water pump”. Underline the names of pumps, tanks and other process equipment.

8. All process flow streams and signal lines which are continued on another drawing shall be linked using the labeled arrowheads. The arrowheads must be labeled with unique labels. The label is composed of the drawing number where the line is continued and an arrowhead number unique to that drawing. In complex cases, the arrowhead number should be made unique to all drawings in a sub-process. It is not necessary to add any other notes to indicate origin or destination.

9. Minimize the use of the continuation symbol, especially for flow streams.

10. Use the slashed arrowhead to indicate an origin or destination which is not a part of the project and which is not continued on any other P&ID. Notes must be added to indicate origin or destination. Non-process lines such as potable and non-potable water used for flushing or pump seals, instrument-air lines and similar ancillary piping may be shown without slashed arrowheads.

1.12.8 Explanatory Notations

1. Hand switch and instrument designations should be placed at about the 1 o’clock position if at all possible. If confusion will result, place the designation at the 5 o’clock position.’

2. Spring return to center hand switches are similar to push-buttons. If a spring return switch is used, place a note on the P&ID. If the project requires many spring return switches, supplement the explanatory notations. Use HMS to designate momentary switches.

3. Latching type push-buttons are not covered. If they are used, annotate them similar to spring return switches. Use HS to designate maintained switches.

4. Hand switches and push-buttons may be equipped with lights. In most cases, the lights are connected to field contacts such as valve position switches or motor running auxiliary relays. In some cases, the light may be used to indicate the switch position.

5. In some applications, you may wish to show both on and off status using two lights driven from one auxiliary relay.

6. Show analysis instruments which are mounted in tees or which use pipe saddles or corporation stops as tapped.

205 Process Narratives

1. General Requirements

1. The Process Narrative is a written description of key items and procedures of a specific process within a treatment plant or pumping facility. The Narrative outlines the sequence of operations in Normal, Maintenance, and Emergency conditions, each in manual and automatic modes of control.

2. Text and descriptions are best given in concise sentences or paragraphs, or else in short, point-by-point items.

3. Process Narratives can serve several different functions or purposes during the life of a project:
   a. Background for planning and design of improvements
   b. Process control description for software development
   c. Basis for, or inclusion in, an Operations Manual
   d. Basis for Operations Practices Review
   e. Assist in development of Emergency Management System (ISO 14000)

4. Narratives start at the Project Planning stage, and evolve through the detailed design, implementation, commissioning, and operation stages of a project. A pre-design narrative should include the equipment to be controlled and the methods (see philosophy) to be used. As the design progresses, the final process narrative details are within a "Software Programming Requirements" document which should define exactly items such as equipment, I/O points, tag identification, equipment coding, methods of control and monitoring, normal operations, emergency operations, etc.

1.1 Content

1. Each distinct facility (water plant, pumping station, reservoir) within the Joint Board will have its own narrative. All narratives will be of a consistent layout & format. Typically, there will be an overall facility process description, followed by a number of individual process and control description(s), dependant upon the complexity of the facility.

2. Each Process description is to define how each process is operated, and how the site-specific components of the SCADA system operate and control the process under discussion. All process descriptions will be of a common format and content, as outlined further in this Standard.

1.2 Process Descriptions

1. A process description defines the physical operation of each process, either as an individual entity within a treatment plant, or as a standalone description of an outstation.

2. Examples of Process Descriptions, which may be required within a Site Specific Process Narrative, include:
   a. Water Plant
   b. Raw Water Pumping Station
   c. Preliminary Treatment
   d. Filtration
   e. Chemical System
   f. High Lift Pumping
   g. Standby Power
   h. Water Station/Reservoir Pumping (& Storage) Facilities
   i. Chemical Treatment
   j. Wastewater Lift Station Pumping Facilities

3. Each Process Description is to consist of two sections:
   a. Operation Description
   b. Control Description

1.2.1 Operation Description

1. The operation description defines how the process system works, and how tasks interrelate to achieve the end result/product from the process being described.

2. Several of the items to follow will require information or procedures in response Normal, Maintenance and Emergency conditions.

Process Description	The definition will include the process name, relationship to other processes, general components & physical parameters. Process capacities should also be included for Minimum, Average and Maximum Day conditions.
Process Objectives	The objectives and general goals for this process are outlined here. Objectives and goals are related to the efficiency, effectiveness, and end quality of the process itself. Due to the interrelation between plant processes plus variance in operating conditions, it is recognized that there may need to be distinct objectives defined for any of normal, maintenance and emergency conditions. However, it may suffice to establish general objectives only for the normal operating conditions.
Process Control Strategy (ies)	The strategy is a description of the process decisions to be taken to meet the treatment objectives outlined above. The strategy should include frequency of measurement of input variables, on which process adjustments are made. As an extension of the Process Objectives, it will be necessary to establish specific Process Strategies for each of Normal, Maintenance and Emergency conditions.
Influent Sources	A short outline of all the sources of influent into a process, including those flows re-circulated within a treatment facility. Where multiple sources exist, provide the normal contribution of each source (as a percentage) to the overall process.
Effluent Destination(s)	Information is presented as to where effluent and waste from the treatment process are normally directed. As an example, primary clarifier by-products include sludge and scum. Where multiple destinations exist, provide the normal percentage distributed to each point.
Process Control Equipment/Devices	In this section, each instrument or piece of equipment (pumps, valves, transmitters) that can directly or indirectly control overall process influent or effluent must be identified. Identification should include name, equipment number (if possible), as well as performance ratings. The use of each device/piece of equipment is to be outlined, including operation, individual control and performance objectives, and control methods. Please see an example of an equipment / device identification summary at the end of this Standard.
Ancillary Processes	Description of all processes associated with the main process, but not specifically involved with the influent, effluent, or actual treatment of the main process. An example would be Activated Sludge Pumping Systems. These processes will have their own description in the same format.
Process Measurements/	

Calculations	The process description shall include, in tabular form, a summary of all end values and calculations which result from the monitoring and control of this process, and where the information is to be used. This information will be used for process operation & evaluation, as well as report generation.

1.2.2 Control Description

1. The control system description outlines the general hardware and software requirements for operation specific to the process being outlined. The overall SCADA system description has been outlined earlier in this Standard.

Description	This section outlines the operation of the process using the control system and control logic. General components are described including controllers, location of I/O and panels, etc.
Control Modes	Description of the four possible control modes within the control system (Local Control, SCADA Manual Control, Automatic, Expert System).
Control Logic	This section contains the descriptions for Normal Operation Emergency Response Operation Hardware Interlocks Software Interlocks Associated Alarms for all equipment and devices within the Process.