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CITY OF SUNNYVALE

WATER POLLUTION CONTROL PLANT

DESIGN STANDARDS

INSTRUMENTATION AND CONTROL

FINAL
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in association with

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CITY OF SUNNYVALE

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INSTRUMENTATION AND CONTROL

1.0 PURPOSE AND CONTENTS

This document presents an analysis and selection of design standards for the City of Sunnyvale's (City) wastewater facility process control systems. The automation control system (ACS) planning recommendations proposed for the facility are based on providing the needed improvements through multiple projects to meet the facility's long-term goals and objectives.

The goal of any control system is to provide a set of highly functional tools that allow both operations and maintenance (O&M) staff reliable control of the facility, capture historical performance of the facility and to provide an instrumentation communication network to aid in configuration, maintenance, and troubleshooting. The City has also expressed the desire to have the flexibility to evaluate the impacts of operating the facilities with reduced staffing levels.

1.1 Instrumentation and Controls (I&C) Design Guide

These design standards were prepared based on utilizing a Rockwell ControlLogix and CompactLogix Programmable Logic Controller (PLCs) with Rockwell FactoryTalk View or Wonderware System Platform being used as the human machine interface (HMI) software. The intent of this document is to capture the building blocks of the control system and requirements for the deliverable process and staff interaction through the various process improvements at the City's Water Pollution Control Plant (WPCP).

The information provided is based on current and proven technology that is readily available at this time (June 2014). These standards should be routinely updated as technology evolves.

1.2 Control System Team - Involvement in Design

The City has identified a team of individuals that are stakeholders in the system – these individuals are known as the Control System Team (CST). From a consultant's perspective, this means there will be significant review, input, commentary, and collaborative decision making over nearly every detail of each project's instrumentation design.

The CST will be responsible for providing a detailed review and receiving feedback on the approach, instrumentation, equipment panel layouts and all aspects of the programming. This review and collaborative decision-making process needs to be scheduled into the milestones of every project.

1.3 Coordination Meetings

The coordination meetings serve to provide input and receive feedback between the consultant design team and the CST. It also provides a means for the City staff not directly involved to stay informed about the project components and how the design is progressing.

Table 1 indicates the recommended coordination meetings.

Table 1 Coordination Meetings
Instrumentation and Control Design Standards
City of Sunnyvale

Meeting	Control System Team	Consultant	Review Topics / Deliverables
Development of 30% Design	Ongoing – Typical	Required	Block diagram and network backbone infrastructure. Control signals indicated on the P&IDs and overall control philosophy, Equipment naming and loop numbering.
Completion of 30% Design	Required	Required	P&IDs, block diagram and physical location of control enclosures. Conformance to the topics from the development of the 30% design.
Development of 60% Design	Ongoing – Typical	Required	Control cabinet layout discussions, field network distribution and process redundancy layouts. Capture training requirements, verify startup sequence and testing steps
Completion of 60% Design	Required	Required	P&IDs, Block diagram and physical location of control enclosures. Implementation of non-process control networks such as Security, CCTV, VoIP etc. Conformance to the topics from the development of the 60% design.
Development of Final Design	Ongoing – Typical	Required	Network junction box layouts and locations finalized field networks, identify all fiber usage, verification packaged controls conforms with the control system.
Completion of Final Design	Required	Required	Finalization of all design elements and conformance to the topics discussed in all previous reviews and meetings.
Construction	Required	Required	Submittal review, field inspections, Factory Acceptance Test, screen review and PLC code review, and Field Acceptance Tests

2.0 STANDARD DEFINITIONS AND ABBREVIATIONS

ACS Automated Control System

AMS Asset Management Systems

AOI Add-on Instruction

AOP	Add-on Profile
BIM	Building Information System
BSN	Business Network
CMMS	Computerized Maintenance Management System
DCS	Distributed Control System
DLR	Device Level Ring
DMZ	Demilitarized Zone
ECHP	Energy/Combined Heat & Power
EWS	Engineer Workstation: Computer level hardware with adapters that permit access to the Programmable Logic Controller network.
eO&M	Electronic Operations and Maintenance Manual
FVNR	Full Voltage Non-Reversing Starter
GE	General Electric Company
HART	Highway Addressable Remote Transducer
HMI	Human Machine Interface: Software interface between workstations and control system.
I&C	Instrumentation and Control
I/O	Input/Output
LAN	Local Area Network
LIMS	Laboratory Information System
LOA	Level of Automation
LOR	Local Off Remote
MCC	Motor Control Center
MTBF	Mean Time Between Failure
OIT	Operator Interface Terminal: Programmable Logic Controller based operator interface.
OLE	Object Linking and Embedding: Enables creation and linking of objects

OPC	Object Linking and Embedding for Process Control
OWS	Operator Workstation: Computer level hardware presenting the Human Machine Interface.
P&ID	Piping & Instrumentation Drawing
PCM	Process Control Module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
PCN	Process Control Network
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
PTT	Push to Test
RIO	Remote Input/Output
RTU	Remote Telemetry Unit
RVSS	Reduced Voltage Solid State Starter
SCADA	Supervisory Control and Data Acquisition: Telemetry to facilities outside of the plants main property line.
UPS	Uninterruptable Power Supply
VFD	Variable Frequency Drive
VMWare	Virtualization for Desktops, Servers, and Applications
VPN	Virtual Private Network
WAN	Wide Area Network
WPCP	Water Pollution Control Plant

3.0 CODES AND STANDARDS

Control panels shall be constructed in a UL 508 shop and constructed with UL 508R components.

ISA guidelines shall be followed where applicable unless defined otherwise in the documents.

4.0 DELIVERABLE DOCUMENTS

A summary of typical deliverable documents for design projects is presented in Table 2. The expected timing of document development is also presented. Design documents may include technical memos, reports, drawings, specifications, procurement packages, lists and schedules, etc. Additional description of typical documents are described in the following sections.

Table 2 Deliverable Documents
Instrumentation and Control Design Standards
City of Sunnyvale

		Project Development Phase			
	Document Work Production	**Conceptual Design**	**Prelim (30%) Design**	**Mid (50-60%) Design**	**Final (90-100%) Design**
1	Control System Concept Memo	Draft	Final		
2	Process Flow Diagram	Draft	Final		
3	P&ID		Draft	Addition Info	Final
4	Control System Architecture Diagrams		Draft	Final	
5	I/O List			Draft	Final
6	Control Strategies		Draft	Develop	Final
7	Fiber Patching			Draft	Final
8	Field Network Diagrams			Draft	Final
9	Control Cabinet Layouts			Draft	Final
10	Network Junction Box and Control Station drawings			Draft	Final

4.1 Process Flow Diagram

The process flow diagram (PFD) is typically prepared by other disciplines as the first step in the preparation of P&IDs. As a result, instrumentation and control (I&C) input should be obtained during the preparation of the PFDs to identify major points of control such as pumps, gates, valves, etc. and to support initial discussions by the project team about how the process should be controlled.

4.2 Piping and Instrumentation Diagrams

Piping and instrumentation diagrams (P&IDs) are initially developed for use during construction, but are primarily used as part of the long-term maintenance and operations of a facility. As such, P&IDs must present equipment, piping, instruments, valves, power, and control panel connections in a manner that is easy to read and understand by the City staff. For that reason, a consistent format for the PI&Ds should be utilized. Example legend drawings and example P&IDs are presented in Appendix A1. Style, format, and basic information indicated in the sample drawings should be provided. Symbol libraries (provided in AutoCAD 2014 format) and P&ID templates will be made available to each design consultant so that they are consistent for all future projects.

4.3 Control System Architecture (Network) Diagrams

Most, if not all, of the project upgrades at the WPCP would result in some level of modification to the existing plant process control system. Overall ACS architecture (network) drawings should be continually updated to reflect the most current project changes and to keep the overall ACS documentation up to date. While a simplified block diagram may suffice to describe proposed changes in a TM, the plant Process Control Network overview diagrams should be updated for complete project documentation. It is often best to address these updates early in the design process to fully understand how modifications will be integrated into the overall ACS, and to get identifying nomenclature and nodes assigned (see Section 4.9 Project Record Drawings).

4.4 Wiring and Loop Drawing Standards

Loop drawings should be generated for every control loop in the facility. These drawings are used to represent wiring from the PLC control panel to field instrumentation and equipment should contain the information shown on example drawing IC08 in Appendix A2. The example drawing starts at the field instrument or equipment and shows all status and control wires connecting to the PLC control panel with information on the junction or other intermediary terminations boxes. PLC rack slot and point are also indicated on the drawing. This format is easy to decipher and can be quickly understood. Similar to the P&IDs, a standardized format will facilitate the City's staff access to the information contained within these drawings and will assist in their troubleshooting efforts. These documents should be developed through construction activities of the integrator and need to reflect the final "as-constructed" state of each loop. Once the project is completed, these drawings must be included within the final project record drawings.

4.5 Input/Output List

Input/Output (I/O) lists for distributed control systems (DCS) and PLC-based systems are required whenever I/O is added or modified. These lists serve as a basis for procurement and PLC programming maintained as long-term documentation of the systems. Due to various programming features, the arrangement of I/O on modules may need to be optimized. I/O should be split across multiple I/O cards so that failure of a single card would not create a shutdown of multiple process units or multiple process trains. The distribution of the I/O should be prepared in a tabular format.

Information included in the I/O table should include the following:

- PLC identification
- I/O tag
- Description
- Process area
- Service
- Rack location
- Slot location
- Point location

4.6 Control Strategies

Control strategies should be developed for every process and describe the intended functions of the strategy with sufficient detail so that a competent programmer can successfully implement the desired functionality. Control strategies should be presented in the format provided in Appendix A3. As project construction progresses, field modifications or deviations should be documented. After programming has been completed, the "PLC/HMI Logic" section of the control strategies for each loop should be added or updated to reflect the AOIs or AOPs used. Updated control strategies that reflect "as-constructed" conditions should be included in the eO&M documents.

Control strategies should also address the following:

- Automatic start-up and shut down sequencing
- Load shedding
- Power failure scenarios

The above sections may be addressed separately from the individual equipment control strategies if the requirements and logic can be communicated more effectively.

4.7 Fiber Patching Diagrams

The ACS networks are implemented using redundant optical fiber systems across the plant site. Fiber would also be used for remote I/O (RIO), Fieldbus, and other networks. The material and methods preferences must be followed unless specific exceptions are made. All modifications to the fiber networks including adding or re-assigning fiber, termination panels and patching must be documented. Fiber should be installed so that the first color of the buffer tube and strand colors of the buffer tubes match throughout the entire backbone. Drawing IC09 in Appendix A4 gives an example of how the backbone information can be documented.

4.8 Fieldbus Network Diagrams

The goal is to utilize intelligent field devices wherever reasonable. HART, Profibus DP and PA, Ethernet/IP, and others should be used and are anticipated to be the preferred design approach for most projects. Fieldbus systems should be designed and installed in full compliance with the related standards to provide the required reliability and utility of the connected systems. Fieldbus networks should be fully documented including physical layout.

4.9 Project Record Drawings

Project record drawings are typically prepared as part of the Engineering-Services-During-Construction phase of the project and are described here simply as background information. Record drawings are prepared by modifying the contract drawings to show the final, "as-constructed" status of the facility. A finalized version of the **complete** ACS architecture drawing, field networks, P&IDs, loop drawings, and communications cabinets should be prepared and submitted in AutoCAD 2014 format so that a master set of documentation can be available for City staff and future project use. This requirement must be included in future design specifications to ensure the City receives the required updated drawing set, and that it is in a format that can be edited and transferred to future consultants. City staff should then utilize these project record drawings to update their facility drawing set. This way, when a new project is begun the designers need only refer to the complete set of facility drawings, and will not need to collect and coordinate project record drawings from the latest projects in each part of the facility.

5.0 PHILOSOPHY OF CONTROL

All equipment will have local control stations located in the field adjacent to the equipment. In the case of equipment located in hazardous areas, remote mounting of the controls outside the hazardous area may be permitted. In such cases, a maintained mushroom E-Stop should be mounted adjacent to the equipment.

Two types of basic control could be provided:

- Two-Wire Control:

  Two- wire control implies that the control are non-latching. An example is when a PLC sends a signal for a pump to run, the signal must be sent continually to keep the pump running. Once the signal is absent, the pump will stop. In essence, the PLC sends a signal to run and no signal means stop. This mode requires a single PLC output to control the pump.

While this simplifies the control, it does incorporate an element of risk. If the plant experiences a small duration power outage, the control system stays powered due to the UPS. Any equipment previously running (especially in HAND) will all start when plant power is restored. Under certain conditions this can be harmful to equipment, process and potentially dangerous to staff. A second issue is this type of control can impact power costs, due to the fact that multiple pieces of equipment could start at once under their highest current draw. This could result in higher utility demand charges.

- Three-Wire Control:

  Three-wire control implies that the controls are latching. An example is when a PLC sends a signal for a pump to run, which the software latches the signal to keep the pump running, and then PLC signal is turned off. When the PLC wants to stop the pump, a second output sends a signal to stop the pump.

  This style of controls is more complex and requires additional pilot devices in the field and more I/O to function. Any power outage resets the running equipment to off and the PLC must re-start the equipment. In the case of equipment running in the “Hand Mode,” this equipment will also shut down and require a manual start using local controls.

5.1 Field Controls

The City desires to have field controls located adjacent to the equipment for manual operations and to assist in maintenance activities. A tabular reference of the locations field control devices are utilized in Table 3.

The control station would allow an operator to take the equipment out of Automatic mode and place into hand mode and initiate starting/stopping or opening/closing of the equipment.

In the case of equipment such as VFDs, the speed control should also be available in the field.

Table 3 Field Control Devices Instrumentation and Control Design Standards City of Sunnyvale								
Field Control – Pilot Devices								
Equipment	**Local-Off-Remote**	**Start**	**Stop**	**Speed**	**Local-Stop-Remote**	**Open-Close**	**Pilot Lights**	**Hand-Off-Auto**
Actuator - Valves					✓	✓	✓	
Actuator - Gates					✓	✓	✓	
Pump - VFDs	✓	✓	✓	✓			✓	
Pump - RVSS	✓	✓	✓				✓	
Pump - FVNR	✓	✓	✓				✓	
Vendor Control Panels								✓

5.1.1 Local-Off-Remote with Start-Stop

Local control panels with this functionality will have the pilot devices arranged as follows:

- Top of panel: Local-Off-Remote selector switch.
- Second row: Start and Stop pushbuttons.
- Third row: Running and Stopped lights.
- Fourth row: Emergency Stop mushroom button and Reset pushbutton.

The functionality of equipment with the L-O-R selector switch in each position is given below:

- Local: Enable manual control where control decisions are made by an operator through the Start-Stop pilot devices.
  - Start: Manual pilot device initiates an equipment start.
  - Stop: Manual pilot device initiates an equipment stop.
- Off: The associated equipment cannot be run with either local pilot devices or remote PLC commands.

- Remote: The normal, automatic control, which allows full PLC control in response to process conditions and programmed sequences.
  - Start: Remote control is disabled and the PLC calls for all associated equipment to start.
  - Stop: Remote control is disabled and the PLC calls for all associated equipment to stop.

5.1.2 Hand-Off-Auto

HOA control is associated with equipment that has vendor control panels. Monitor the device's HOA switch (the hard-wired switch typically located in the field adjacent to the equipment) to determine when the PLC has control of the associated equipment. Display remote status on the HMI screens and monitor the device's running status to display running or stopped on the HMI screens.

Use the device's status to calculate total run time and daily run time, and to count total starts and daily starts. Provide a time stamp for each start. Provide software to prevent exceeding the manufacturer's recommended maximum starts per hour.

The HOA should perform the following functions:

- Hand: Start the device.
- Off: The device is prohibited from running.
- Auto: The device is controlled remotely.

5.1.3 Local-Stop-Remote with Open-Close

All valve and gate control controllers will be provided with LSR and OC selections allowing for the following functions:

- Local: Enable manual control where control decisions are made by an operator through the Open/Close, or other selections as indicated.
  - Full Open/Close operation: For gates or valves that are used for isolation the operator will press and released either the Open or Close button and the actuator will move the valve or gate to the selected full open or full close position.
  - Modulating operation: Gates or valves that require modulation or specific position must use jogging controls to move the gate or valve to the desired position. In this case, the operator will need to hold the open or close button down until the valve or gate reaches the desired position.
- Stop: Automated control is disabled and PLC calls for all associated equipment to stop and valves to close or go to their identified safe state.

- Remote: The normal, automatic control mode, which allows full PLC control in response to process conditions and programmed sequences.

5.1.4 Permissives

Implement software permissives where indicated to place equipment in a safe condition in response to impending hazardous process conditions. Apply software permissives when equipment is operating in Auto or Hand:

- Where indicated, provide a selection to bypass software permissives for maintenance functions. This option shall only be selectable in manual.
- Use hard-wired permissives for equipment protection.

5.1.5 VFD Speed Control

Modulate speed on VFD-driven motors using jog and hold, or PID control algorithms to maintain process conditions as described in the specific loop descriptions.

Operate speed control within a pre-defined range where the minimum speed will be determined by equipment manufacturer and the maximum speed is 100 percent.

5.1.6 Actuator Control (Gates and Valves)

- Isolation Actuators:

  Actuators by default come with Local-Stop-Close controls with Open-Close controls for isolation (full open, full close). These should be wired so City staff can put the actuator in Local and simply hit the Open or Close pushbutton and walk away.

- Modulating Actuators:

  Actuators with modulating controls by default come with Local-Stop-Close controls with Open-Stop-Close controls. The Open-Close pushbutton or selector switch is typically a spring return to stop. This would allow staff to hold the desired control in place until the actuator modulates to the desired position and the staff releases the control to maintain the position.

5.2 Intelligent Field Networks

The preferred network and Fieldbus topologies should be identified during pre-design. However, if new technology becomes available during the design process, contingencies should be added to upgrade existing equipment to match the new technology. The networks require full industrial testing prior to startup. During the construction of the Fieldbus networks, the testing should be contracted to provide testing before and after commissioning the Fieldbus network. The following principles should be applied for the design of Fieldbus networks.

- The preferred approach would be to use process redundancy and spread like elements across multiple networks. For example, an MCC could have up to 120 nodes on a single MCC EtherNet/IP network. Where two MCCs are used to serve a process area, each should have its own EtherNet/IP network or multiple networks. If a single large MCC is provided, at least two EtherNet/IP networks should be provided even if both are lightly loaded. Redundant equipment such as lead/standby pumps should be distributed evenly on the two networks so that a network failure would not result in failure of all critical equipment for a system.

- For field devices, the preferred design approach would be to diversify related equipment across two or more networks such that no more than half of the equipment for a given system or sub-system is connected to a single Fieldbus network.

- At least 20 percent spare node capacity and 20 percent spare power capacity (where applicable) should be provided in each network or segment.

Although many field networks are available and the ControlLogix platform can communicate to an abundant amount of networks, the networks should be consolidated to as few as protocols as possible. This allows staff to have focused training and familiarity with the tools required to configure, troubleshoot, program and maintain communications to the equipment and instruments.

5.2.1 Profibus DP and PA

Profibus is available in two types: DP (Decentralized peripheral) and PA (Process Automation). DP devices require being powered independently of the DP cable. The information read by the instrument resides on the DP cable. Profibus PA are similar to loop powered devices, the PA cable provides both the power and signal transmission. PA devices can be made intrinsically safe.

Profibus includes several levels of functionality which are identified as V0, V1, and V2:

- DP-V0: Cyclic Data Exchange, process data and control and diagnostics (all devices).

- DP-V1: Acyclic Data Exchange, supports engineering access, monitoring and alarm handling. Typical for PC based diagnostics such as field device tool (FDT). This is typical and preferred for most current field devices.

- DP-V2: Peer-to-peer, Clock Synchronization and Time Stamp such as coordinated drives and redundancy applications.

The versions build on top of the other and are interoperable and backward compatible. For example, a V1 FDT diagnostic tool can operate over V0 and V1 slave devices.

5.2.1.1 Profibus Design Considerations

All Profibus designs shall fully conform to the PI North America (formerly PTO-Profibus Trade Organization) published standards and the design and installation instructions of the various component manufacturers. Attention to details is critical to successful startup and continuing operation of Fieldbus systems.

- All equipment on Profibus shall carry the FDT certification. Profibus instrumentation is acceptable for the following applications:
  - Field analyzers.
  - Field Instruments such as level transmitters and flow meters.
  - Actuators for valve and gate controls.

All Profibus designs should consider the published limitations including maximum number of nodes per bus, maximum power requirements, maximum size of data transfers, etc. Note that specific hardware manufacturers may impose more restrictive limits than the International Standards, so these limits must also be considered. The design of each bus and segment with regard to published limitations shall be documented and reviewed by the staff.

- Maximum number of nodes per network (DP plus PA) = 126.
- Maximum number of nodes per PA segment = 32.
- Maximum number of data bytes per DP node = 244.
- Maximum current on a PA segment is limited by the DP/PA gateway/segment coupler.

Profibus masters (scanners) communicate using DP protocol. Segment couplers or gateways should be used to establish and communicate to PA segments. Gateways should be FDT/DTM compliant and manufactured by Procentec

- An Ethernet gateway should be provided on each DP network to support remote configuration and diagnostics. Preferred Fieldgate devices are:
  - Procentec.
- Profibus cable connections should be made using field wireable Eurofast style connectors, Turck Interlink, or equal.
- Profibus DP requires active (powered) bus termination. Termination devices and power supplies may be located in field enclosures or the bus may be looped back to the control cabinet with termination provided in the cabinet. Preferred terminators are Procentec, Turck, Pepperl+Fuchs, or Siemens.

- Profibus PA can power two-wire devices in addition to communications. Power capacity of the gateway and the cable media must be considered in design.
- Profibus PA requires passive bus termination. Preferred terminators are Procentec.
- Surge protection devices specific to each protocol and media type should be provided on all Profibus segments that are located outdoors.
- Profibus DP shall utilize 2/C shielded cable with a purple jacket and certified for use as Profibus DP cable. Typical cabling is 300-Volt (V) rated. 600-V rated cable is available and may be preferred to simplify wiring in some areas.
- Profibus PA should utilize 2/C shielded cable with an orange jacket and certified for use as Profibus PA cable. 300-V rated cable is available.

5.2.2 EtherNet/IP

EtherNet/IP is the preferred communications protocol and should be implemented wherever possible:

- EtherNet/IP is supported by Allen-Bradley and other vendors and is acceptable in the following applications:
  - Motor starters grouped in MCC structures. These structures can be factory prewired with network interconnections resulting in much simpler field interconnections.
  - VFDs installed in MCC structures can share the same DeviceNet as individual starters.
  - VFDs installed in separate enclosures so that all VFDs utilize the same network hardware and programming interface.
  - Field analyzers.
  - Field instruments such as level transmitters and flow meters.
  - Peer to peer communications between PLCs.
  - Communications between PLCs and the HMI I/O servers.
  - Communications between PLCs and remote I/O drops.

5.2.2.1 EtherNet/IP Design Considerations

- Careful design layout should be provided to keep field network traffic divided from peer-to-peer traffic.
- Device-level-ring switching technology should be utilized for field networks and remote I/O.
- Power monitors should feed directly to a managed Ethernet switch.

- Communication racks should incorporate a Level 3 managed switch and should control a sub-network to the connections into the switch. Depending on the number of PLCs in an area, routing to a single communication cabinet multiple sub networks could be used.

5.3 Network and Communications

All servers will be located in clean, conditioned, and dedicated rooms rack mounted in seismically mounted open frame racks. If rack-mounted UPS are needed, they should be mounted in the bottom portion of the rack, allowing for easy maintenance. Backbone patch panels should be mounted at the top of the rack, any monitor or keyboard should be mounted mid rack allowing for ease of access from the standing position.

To connect process facility workstations and PLC cabinets to the business and PLC networks, co-location communications cabinets in process areas should be used as configured in Appendix B (Drawing IC11 - closed cabinet). For designs in conditioned closets or electrical room, an open cabinet style can be used (see Appendix B Drawing IC12). This type of separation and dual access allows for servicing of equipment for the business networks (the top half) and servicing of equipment for PLC networks (the bottom half).

Network junction boxes should connect to PCMs via Ethernet or fiber optic cables and should concentrate the digital signals from instruments. The Network Junction Box (NJB) interior and exterior layouts shown in Appendix B (Drawings IC13, IC14, and IC15) were developed to allow space for a variety of digital bus technologies.. Various types of control panels could be designed in several standardized layouts. For example, NJB Type 1 allows for a concentration of a variety of digital signals and therefore is the largest in size. The size of NJB Type 3 allows for a concentration of a small number of digital signals, while Type 2 NJBs have enough space for more digital signal types than Type 3, but less than Type 1. All NJBs should adhere to these standards.

5.3.1 Equipment Requiring Network Communications

The use of intelligent field components provides for the reduction of wire and terminations as well as for enhanced programming capabilities. Information sent back from these devices can save, programming time, trouble shooting time, and construction dollars. The following equipment (Table 4) should be designed to utilize network communications where deemed appropriate.

Table 4	Equipment Communications Instrumentation and Control Design Standards City of Sunnyvale				
	Communication Networks				
	Device / Equipment	EtherNet/IP	DLR EtherNet/IP	Ethernet TCP/IP	Profibus
1	Motor Control Centers		✓		
2	Power Monitors	✓	✓		
3	Stand alone VFDs	✓	✓		
4	Actuators				✓
5	Pneumatic Valve Controllers	✓	✓		✓
6	Analyzers	✓	✓		✓
7	Un-interruptible Power Supplies			✓	
8	Instruments	✓	✓		✓

The uninterruptible power supplies use Ethernet TCP/IP communications for monitoring and trouble-shooting. Because the manufacturer's software is used, these values are not pulled into the PLC logic nor are they stored in the Historian.

5.4 Vendor Control Panels Communications

Vendor control panels (VCP) with PLCs should be equipped with Rockwell ControlLogix or CompactLogix controllers. Communications to the plant control system should use EtherNet/IP or EtherNet/IP DLR modules or DLR equipped processors. Not all packaged control systems would require network communications. In those cases, a few points would be relayed to one of the facilities main PLC cabinets, RIO enclosures or network junction boxes.

6.0 SAFETY BY DESIGN

Due to Arc Flash concerns, the PLC control cabinets and communications cabinet should be physically separated from electrical rooms. This enables the staff to service the control equipment without having to suit up with personal protection equipment to service or inspect those pieces of equipment.

7.0 TAG NAMING STANDARDS

Instruments, analyzers, and facility equipment should be tagged in such a manner as to provide the WPCP staff with an understanding of their function. A good tagging system will provide knowledge about the equipment's purpose and place within the process model by simply reading the alphanumeric sequence. Appendix C should be use as the standard tagging scheme. The lists of functions and descriptors have been tailored to fit the current and future needs of the facility. A dash ("-") has been added in between groups of characters to more clearly delineate between them and to make each set easier to remember. Flexibility was provided by leaving gaps between numbers to facilitate room for expansion. Instruments in a single control loop should have a common portion of their tag to show their relationship as a group, while still maintaining each instrument and equipment item possessing a unique identification. Similar processes in different areas of the same facility should follow the same tagging patterns.

The requirements that follow dictate tagging standards for process control modules (PCMs), vendor control panels (VCPs), remote input/output cabinets (RIOs), remote telemetry units (RTUs), PCM components (PLCs, OITs, Ethernet switches, fiber patch panels), HMIs, communication equipment (fiber patch panels, Ethernet switches, etc.), network junction boxes (NJBs), MCCs, and variable frequency drives (VFDs). In general, tag numbers should be assigned from North to South and from West to East. This requirement can be superseded where alternative labeling methodology is logical but deviations should be pointed out to City staff.

7.1 PCMs, VCPs, RIOs, RTUs and PCM Components

PCMs: PCM-SXX where S represents the facility (Sunnyvale) and XX is a sequential number:

- 01 through 09 for administration and maintenance support facilities.
- 10 through 49 for liquid stream and solids handling facilities.
- 50 through 59 for support systems.

VCPs: VCP-SXXY where XX is a sequential number that matches the PCM to which the VCP is attached. Y is an optional letter designation that starts at A and continues down the alphabet for every VCP associated with that PCM.

RIOs: RIO-SXXY where XX is a sequential number that conforms to the numbering discussed for PCMs. Y is an optional letter designation that starts at A and continues down the alphabet for every RIO in a process area.

RTUs: RTU-SXX where XX is a sequential number that conforms to the numbering discussed for PCMs.

PLCs: PLC-SXXY where XX is a sequential number that matches the PCM number. Y is an optional letter designation that starts at A and continues down the alphabet for every PLC in the PCM.

OITs: OIT-SXX where XX is a sequential number that matches the PCM number.

Ethernet Switches: ES-SXXY where XX is a sequential number that matches the PCM number. Y is an optional letter designation that starts at A and continues down the alphabet for every Ethernet switch in the PCM.

Fiber Patch Panels: FPP-SXXY where XX is a sequential number that matches the PCM number. Y is an optional letter designation that starts at A and continues down the alphabet for every fiber patch panel in the PCM.

7.2 HMIs

HMI-SXXY where XX is a sequential number that conforms to the numbering discussed for PCMs. The sequential number should match the PCM number of the process area where the HMI is located. Y is an optional letter designation that starts at A and continues down the alphabet for every HMI in a process area.

7.3 Communications Equipment

Communications Cabinets: CC-XX-YY where XX is a two-letter combination that abbreviates the process area where the communication cabinet is located. YY is a sequential number that starts at 01 and continues for every communications cabinet in the process area.

Business Network Fiber Patch Panels: FPP-BSNXXY where XX is a sequential number that matches the communications cabinet number. Y is an optional letter designation that starts at A and continues down the alphabet for every business fiber patch panel in the communications cabinet.

PCS Network Fiber Patch Panels: FPP-PCSXXY where XX is a sequential number that matches the communications cabinet number. Y is an optional letter designation that starts at A and continues down the alphabet for every PCS fiber patch panel in the communications cabinet.

Business Network Ethernet Switch: ES-BSNXXY where XX is a sequential number that matches the communications cabinet number. Y is an optional letter designation that starts at A and continues down the alphabet for every business Ethernet switch in the communications cabinet.

PCS Network Ethernet Switch: ES-PCSXXY where XX is a sequential number that matches the communications cabinet number. Y is an optional letter designation that starts at A and continues down the alphabet for every PCS Ethernet switch in the communications cabinet.

Business Network Ethernet Patch Panel: EPP-BSNXXY where XX is a sequential number that matches the communications cabinet number. Y is an optional letter designation that starts at A and continues down the alphabet for every business Ethernet patch panel in the communications cabinet.

PCS Network Ethernet Patch Panel: EPP-PCSXXY where XX is a sequential number that matches the communications cabinet number. Y is an optional letter designation that starts at A and continues down the alphabet for every PCS Ethernet patch panel in the communications cabinet.

7.4 NJBs

NJB-XX-YY where XX represents the process area, and YY is a sequential number that begins with 01 and continues for every NJB in the given process area.

7.5 MCCs

MCC-XX where XX is a sequential number that begins with 01. This number should be incremented for every MCC that is installed.

7.6 VFDs

VFD-XX-YYY where XX represents the process area, and YYY is a sequential number that begins with 01 and continues for every VFD in the given process area. In general, VFDs should be tagged by the process equipment they are serving.

8.0 INSTRUMENTATION

The following sections specify the requirements of instruments and analyzers that may be used. Recommendations are made from information available at the time of issuing of this document (June 2014). For each project, these recommendations should be reviewed with City staff and updated as necessary.

8.1 Level

8.1.1 <u>Ultrasonic</u>

1. Application: May not be used in digester and applications with foam and vapor gases. Not to be used in applications with vapor or two-phase liquid (for example, foam or grease mat). In outdoor applications, weekly housekeeping (removal of spiders' webs) is required.
2. Accuracy: ±0.25 percent.
3. Precision: ±0.1 percent of span.
4. Communications: Profibus DP.
5. Commissioning requirements: Should be installed at 6 inches above the surface and far enough from the wall to avoid false echo.
6. Preferred Manufacturers: Rosemount, Siemens, Endress+Hauser, Drexelbrook, Magnetrol.

8.1.2 Microwave (Radar)

1. Accuracy: ±0.5 percent.
2. Precision: ±0.025 percent of measured distance.
3. Communications: Profibus DP.
4. Commissioning requirements: Should be installed at 6 inches above the surface and far enough from the wall to avoid false echo. When location becomes difficult from operator or maintenance access, provide an easy to use retracting mechanism or means for staff access.
5. Preferred manufacturers: Rosemount, Vega, Endress+Hauser, Siemens, Drexelbrook.

8.2 Flow

8.2.1 Magnetic

1. Accuracy: 0.25 percent of flow rate from 10 to 100 percent of full scale for velocities ranging between 1.9 to 10 feet per second.
2. Precision: 0.25 percent of rate.
3. Communications: Profibus DP, EtherNet/IP.
4. Preferred Manufacturers: Endress+Hauser, Rosemount, Krohne.
5. Required Accessories: Provide galvanic isolation gaskets, nylon/Teflon flange bolt insulation bushings and nylon washers on all meters installed on pipes with cathodic protection.

8.2.2 Coriolis

1. Accuracy: 0.15 percent of rate.
2. Precision: 0.05 percent of rate.
3. Communications: Profibus DP, EtherNet/IP.
4. Preferred Manufacturers: Micro Motion, Endress+Hauser.

8.2.3 Thermal Mass

1. Accuracy: 1.5 percent of full scale for velocities over 2 feet per second.
2. Precision: 0.5 percent of full scale.
3. Communications: Profibus DP, 4-20mA Hart.
4. Preferred Manufacturers: Kurz Instruments, Sierra Instruments, FCI.

8.2.4 Ultrasonic

8.2.4.1 Transit Time Clamp-on

1. Application: Primary effluent, secondary effluent, all other liquid streams downstream of secondary, brine. Not to be used for streams containing more than 50 mg/l of solids.
2. Accuracy: ±0.5 percent of full-scale or ±2 percent of actual flow.
3. Communications.
4. Commissioning Requirements: Install with 10 straight pipe diameters before the meter, 5 diameters after.
5. Preferred Manufacturers: Endress+Hauser, Flexsim, GE.

8.2.4.2 Transit Time Spool

1. Application: Chemicals, digester gas.
2. Accuracy: ±0.25 percent of actual flow.
3. Communications.
4. Commissioning Requirements: Install with 10 straight pipe diameters before the meter, 5 diameters after.
5. Preferred Manufacturers: Endress+Hauser, Emerson Process Management, Krohne, Accusonic Technologies Inc.

8.2.4.3 Dual Frequency Doppler

1. Application: Primary sludge, secondary sludge, sludge processing streams. Not to be used for streams containing less than 1,000 mg/l of solids or applications requiring high accuracy (waste flow of activated sludge, for example).
2. Accuracy: ±1.5 percent of full scale.
3. Precision: ±0.5 percent.
4. Communications: Profibus DP, EtherNet/IP.
5. Commissioning Requirements: Install with 20 straight pipe diameters before the meter, 5 diameters after.
6. Preferred Manufacturers: Polysonics (Thermofisher).

8.3 Pressure

8.3.1 Direct

1. Accuracy: ±0.30 percent of calibrated span, including reference accuracy effects, static pressure and ambient temperature effects.

2. Precision: ±0.15 percent of upper range limit over 5 years.
3. Communications: Profibus PA.
4. Preferred Manufacturers: Endress+Hauser, Rosemount, Yokogawa, ABB.

8.3.2 Submersible

1. Accuracy: ±0.30 percent of range.
2. Precision: ±0.25 percent of full scale.
3. Communications: 4 – 20 mA with HART.
4. Preferred Manufacturers: Endress+Hauser, Siemens.

8.4 Analyzers

8.4.1 pH

1. Accuracy: Within 0.01 pH.
2. Precision: Within 0.01 pH.
3. Communications: Profibus PA.
4. Preferred Manufacturers: Endress+Hauser, Rosemount, ABB, Yokogawa.

8.4.2 ORP

1. Accuracy: Within 1.0 millivolt.
2. Precision: Within 1.0 millivolt.
3. Communications: Profibus PA.
4. Preferred Manufacturers: Endress+Hauser, Rosemount.

8.4.3 Residual Chlorine

8.4.3.1 Amperometric

1. Accuracy: Within 0.02 parts per million.
2. Precision: Within 5 percent or 0.005 milligrams per liters.
3. Communications: Profibus PA.
4. Preferred Manufacturers: Rosemount Analytical, Endress+Hauser, Prominent.

8.4.3.2 Colorimetric

1. Application: Not to be used as a primary control loop element due to time delay.
2. Accuracy: Within 0.02 parts per million.

3. Precision: Within 5 percent or 0.005 milligrams per liters.

4. Communications: Profibus DP.

5. Preferred Manufacturers: Hach.

8.4.4 Dissolved Oxygen

1. Accuracy: Within 0.2 ppm for values above 1 ppm. Within 0.1 ppm for values below 1 ppm.

2. Precision: Within 0.5 percent of span.

3. Communications: Profibus PA.

4. Preferred Manufacturers: Hach, Endress+Hauser.

8.4.5 Turbidity

1. Accuracy: Within 2 percent of reading or within 0.020 NTU (whichever is greater) from 0 to 40 NTU. Within 5 percent of reading from 40 to 100 NTU. Flow rate needs to be monitored to avoid settling

2. Precision: Better than within 1.0 percent of reading or within 0.020 NTU, whichever is greater.

3. Communications: Profibus PA.

4. Preferred Manufacturers: Hach, Endress+Hauser.

8.4.6 Conductivity

1. Accuracy: Within 0.01 percent of span from 0 to 100μS/cm, within 1.0 percent of span from 0 to 10,000 μS/cm.

2. Communications: Profibus PA.

3. Preferred Manufacturers: Endress+Hauser, Rosemount, Hach.

8.4.7 Total Suspended Solids (TSS) Concentration

8.4.7.1 Optical

1. Application: 5 to 30,000 milligrams per liter (mg/L). Should not be used for dark sludges (primary sludge) or sludges with concentration higher than 30,000 mg/l. Flow rate needs to be monitored to avoid settling.

2. Accuracy: 3 percent or 200 m/l, whatever is greater.

3. Precision: 1 percent or 100 mg/L, whatever is greater.

4. Communications: Profibus PA.

5. Commissioning Requirements: Open channel/sampling sink installations are preferred to in-pipe installations.

6. Preferred Manufacturers: In-site IG (for TSS > 1000 mg/L), Xylem. Hach, Cerlic.

7. Required Accessories: Many optical analyzers require automated cleaning. There are four methods of automatic cleaning available:
    a. Water or air purging.
    b. Wiping.
    c. Ultrasound.

8. Each of these cleaning methods is effective.

9. Pilot testing for TSS concentration less than 100 mg/L is required.

10. Required Calibration: Calibration, based on laboratory results, is required once a week. Laboratory testing of a sample needs to be performed in duplicates.

8.4.7.2 Microwave

1. Application: 10,000 - 200,000 mg/L.

2. Accuracy: 3 percent.

3. Precision: 1 percent.

4. Communications: Profibus PA.

5. Commissioning Requirements: None.

6. Preferred Manufacturers: Toshiba, Metso.

7. Required Accessories: None.

8. Required Calibration: In-situ calibration are not required.

8.4.8 Ultrasonic Sludge Interface Level

1. Accuracy: Standard deviation of 30 measurements made over a 30 days period versus measurements performed by a “sludge judge” should not exceed 4 inches and maximum one time difference between meter reading and “sludge judge” measurement should not exceed 6 inches.

2. Communications: Modbus RTU, Ethernet.

3. Commissioning requirements: 30 days acceptance testing is required during commissioning.

4. Preferred manufacturers: Entech Design, others vendors are acceptable upon providing to an Engineer a third party's field data that confirms that the meter can meet the accuracy specified above.

5. Required accessories: Automatic sensor cleaning is required.

8.5 Temperature

8.5.1 RTD Sensor With Transmitter

1. Accuracy: Within 0.25 percent of calibrated span.

2. Precision: 0.25 percent of full scale.

3. Communications: Profibus PA.

4. Preferred manufacturers: Endress+Hauser, Rosemount.

8.5.2 Thermocouple Sensor With Transmitter

1. Accuracy: Within 1.0 degree Fahrenheit.

2. Precision: 0.25 percent of full scale.

3. Communications: Profibus PA.

4. Preferred Manufacturers: Endress+Hauser, Rosemount.

8.6 Weight

8.6.1 Strain Gauge

1. Accuracy: Less than or equal to 0.1 percent rated output.

2. Communications: Profibus DP.

3. Preferred Manufacturers: Fairbanks Scales Inc.

9.0 CONTROL PANELS

9.1 Control Panel Standards

All Analog terminal strips should be designed so that regardless of the type of analog signals (2 wire, 3 wire and 4 wire) brought onto the field terminals in the control panel that any type of analog signal can be used without additional terminal blocks being added.

There are two standard PLC control panel sizes and configurations that should be used (48 or 96 inch), unless design requirements necessitate a custom size. Providing either a 48-inch or 90-inch wide panel allows for a wide variety of applications. Sample external and internal panel layouts are given in Appendix D (for 48-inch wide panels - Drawings IC18 and IC19 and for 90-inch wide panels - Drawings IC20 and IC21). These sample configurations include PLC network communications and a wide variety I/O modules for input and output instruments.

9.2 Power Requirements

Each PLC, Remote I/O, and Network Junction Box panel should be powered using two separate power circuits. One power source should be provided by the UPS located in the nearest Communications Cabinet, which should power the PLC, networking and instrument components. The second source of power should be provided from a lighting panel and would provide power to the cabinet lights, air conditioning, and convenience receptacles (see. Drawing IC17 in Appendix D). The systems integrator should be required to construct the control panels with in-line UPSs, fuses, and breakers.

9.3 Wiring and Loop Drawing Standards

Loop drawings should be produced to include the following:

1. Equipment being Controlled:
   a. HMI tag.
   b. Location.
   c. Device node.
2. Wire/cable identification.
3. Routing through any junction box, duct bank, marshalling panel and final destination panel (PLC enclosure, remote I/O or network junction box).
4. I/O Network Identification PLC identification:
   a. Rack identification.
   b. Card identification.
   c. Point identification.
   d. Network ID.
   e. Segment ID.

9.4 Field Wire Tagging Scheme

The field wiring scheme should be in a ‘TO-FROM’ format at either ends of the cable as shown below in Figure 1.

Figure 1 Field Wire Tagging Scheme

1. For example, a label ‘TB1-FU6’ implies that the wire originates from terminal FU6 of terminal block 1. This is the ‘FROM’ part of the label.
2. The ‘TO’ part of this wire tag could be ‘TB1-VT-OUT’ where VT is a device with its terminal ‘OUT’ in terminal block 1.
3. Insert a ‘<>’ symbol between the ‘to and from’ parts of the wire tag.
4. The complete tag at one side of this wire should look like- ‘TB1-VT-OUT<>TB1-FU6’. Note that the other end of this wire should also carry a wire label that follows the same format. See example below.
5. In instances where a wire connects directly to an I/O module, the wire should be labeled with the name of the processor (e.g., PLC80), the rack and slot numbers (e.g., 16, will imply rack 1, slot 6) and the name of the point on the module (e.g., OUT-15NO). The complete label should look like: ‘PLC80-16-OUT-15NO’.
6. In cases where a relay connects to another device like an MCC bucket, the ‘TO’ part of the wire label should be in the following format:
   a. Device name, sub-division within the device to which the wires connect, terminal block number. For example, if the wire connects to a MCC, the label should be: [MCC-RRC1-IM]-6 where ‘MCC-RRC1’ is the MCC name and IM is the bucket within the MCC and 6 is the terminal block number within the bucket.

9.5 DeviceNet Cable Tagging Scheme

The cable tagging scheme for DeviceNet cables should be as follows:

PLC(*PLC ID*)-**DN**(*DEVICENET NETWORK NUMBER*)-(*Nth PIECE OF EQUIPMENT ON NETWORK*)-(*LETTER NUMBER FOR DROP CABLES*)

Example: **PLC80-DN1-5-A.** Q is the assigned PLC letter, 1 is the assigned network number, 5 refers to the device being place 5th in the network with respect to the PLC (Note that the PLC is assigned 0) and A is the letter assigned to the drop cable from a master trunk.

9.6 Profibus DP/PA Cable Tagging Scheme

The cable tagging scheme for Profibus DP cables should be as follows:

> **PLC**(*PLC LETTER*)-**DP**(*PROFIBUS DP or PA NETWORK NUMBER*)-(PROFIBUS DP or PA SEGMENT NUMBER)-(*Nth DEVICE/CABINET ON THE SEGMENT*)

Example: **PLC80-DP1-5-3.** Q is the assigned PLC letter, 1 is the assigned network number (Note that a PA segment has same network number as DP), 5 refers to the segment number (Note that the PLC is assigned 0), 3 refers to the device being placed third within that segment (Note that multiple devices within a cabinet can be lettered 1A, 1B, 1C etc. For Profibus PA, the multi-port tap would be numbered and connected devices would be lettered as above).

9.7 Alarm Contact Monitoring

The following equipment should come with discrete fault contacts. These contacts should be monitored by the control system and alarm to the maintenance staff.

- Power Supplies:
  - 24 Vdc power supplies – fault.
  - 24 Vdc power supply diodes – fault.
- Uninterruptable Power Supplies (UPS):
  - UPS – Fault.
  - UPS - On battery
  - UPS - Maintenance Bypass – in bypass
- Ethernet Switches:
  - Ethernet switches – Power supply fault.
  - Ethernet switches – Communications fault.
- FieldBus:
  - Bridge/Gateway devices – fault.
  - Redundancy media modules – fault.
  - Deployed I/O – fault.

9.8 Protective Control Wiring

Specific control loops may require permissives and or interlocks to provide adequate equipment protection and/or fully functional control loop. A permissive is a condition that must be satisfied prior to starting a control loop. An interlock is an element that must be satisfied prior to the control loop starting and also must maintain the condition to keep the control loop running.

9.8.1 Interlocks and Permissives

Interlocks and permissives can be hardwired or use software (or a combination of both). The important distinction between a hardwired and software approach is that hardwired interlocks and permissives should work when the equipment is in hand, whereas software interlocks only provide protection when the PLC is actively controlling the control loop.

Having hardwired interlocks provides the greatest amount of protection for the equipment. The disadvantage is that maintenance staff would need to modify the control wiring to troubleshoot the equipment. This is time consuming and compromises the integrity of the controls on the equipment.

Providing software permissives allows for greater flexibility for bypasses and allows maintenance staff the ability to start the equipment in hand without the interlocks. The equipment is at risk in Hand mode, but protected under PLC control.

It should be noted even in the case where a facility chooses to do software interlocks and permissives, some hardwired interlocks would likely be required to maintain equipment warranty (submersible pumps) or staff safety such as smoke detectors, go-no-go panels and safety ropes etc.

9.8.2 Resets

The use of a hardwired permissive requires a reset to clear the condition. Typically, a reset is needed when a hardwired interlock or permissive for a field element is in state that could cause damage to the equipment. In order for the staff to safely re-start the faulted equipment, an operator needs to physically inspect the field elements for any un-safe conditions prior to requesting a restart. The reset pilot device should be located in the field adjacent to the equipment, which forces staff to perform the physical inspection.

A momentary style push button should be provided for all hardwired or permissive applications.

10.0 PROGRAMMING STANDARDS

During discussions with the ACS integrator, a document describing standard PLC programming should be developed.

10.1 PLC Standards

During discussions with the ACS integrator, a document describing standard PLC documentation, naming, alarming etc should be developed. An example table of contents for such a document is given in Appendix E.

10.2 Operator Interface Standards

During discussions with the ACS programmer, a document, which develops the standards for the facility's operator interface system, should be submitted by the programmer, which should be reviewed and approved by City staff. An example table of contents for such a document is given in Appendix E.

11.0 NETWORK AND COMMUNICATIONS

11.1 Infrastructure

Infrastructure of the control system backbone would consist of a single-mode fiber that is terminated in full height network racks distributed throughout the site. The backbone would be configured as a loop and would be placed at strategic locations throughout the facility. The fiber would be segregated into different groups, and designated by various networks. In all cases, fiber would terminate in a patch panel. There are two types of patch panels: distribution patch panels located in communication racks and control cabinet patch panels.

11.2 Definition of Networks

A four level network has been established for the WPCP. These four network levels, starting at the highest operational level and proceeding down to the field device level, would include:

- Business network.
- Process control network.
- PLC network.
- Field network.

11.3 Field Network

The simplest field network consists of discrete or analog devices wired directly to Input/Output (I/O) cards in a PLC. This method is often termed "Traditional I/O." Discrete devices, such as switches, provide binary inputs (opened, closed, running, stopped) to the discrete input cards. Discrete output cards provide binary outputs such as on, off, start, stop, open, and close. Analog input devices provide process information values such as pressure, temperature, pH and level. Analog outputs from the controller provide commands such as speed, or open to position.

While traditional I/O information is adequate for general control of a process or facility, this method of communication requires many cables and conduits running from each controller to each device. The wires also have to terminate on individual channels within the I/O card, requiring at least one channel per field device input or output, and increasing the size of control cabinets to accommodate.

In order to expand the breadth of the of the control system, an economical system was developed called extended I/O. Typically referred to as Fieldbus, it is used for process control to link smart field instruments to each other and to high-level control systems.

In addition to the extended dataset information provided, sensor networks are typically deployed to reduce installation cost by reduction or elimination of direct wiring to connect these simple devices. To realize the benefits of Fieldbus, these networks should be utilized throughout the WPCP only where they make economical sense as follows:

- Devices clustered at one location.
- Devices clustered at several locations in a process area.
- Devices distributed along the length of a process train.
- Devices clustered at several locations along the length of a process train.
- Devices that may not meet the above criteria, but where Fieldbus connections would transmit valuable information to operators or maintenance staff.

To reduce the added cost of the network interface. intelligent MCCs should be utilized for starting, stopping, and control of motors through a Fieldbus network.

HART should be utilized on analog field devices where a Fieldbus connection is not cost effective. HART protocol should be implemented by mixing a logic level digital current loop signal with the 4-20 mA DC primary value signal. Exercise caution when bringing back lots of information over HART, due to several factors this can really slow down the response time of the PLC reading the data.

As Fieldbus networks are implemented, coordination with plant staff and management should take place to see that the appropriate amount of data is transmitted to the control and business systems so that the information is useful and not overly burdensome.

Provisions for training of plant staff on Fieldbus devices and networks should be provided as part of the construction contract requirements.

Ideally, field networks using Ethernet/IP equipment and instruments should not utilize a switch but connect directly to the PLC instead. Elements like UPS's power monitors etc. will route to a switch.

11.4 PLC Network

The intended use of control networks is to link controllers to host systems and to each other. Therefore, control networks must also be deterministic and meet the time-dependent real-time needs of their intended applications.

11.5 PCS Network

The process control network is used HMI traffic. All ACS servers, thick clients, zero and thin clients reside on this network. Other ACS components will likely include the historian, NAS or potentially a SAN.

11.6 Business Network

All business applications, Internet access, e-mail, printing applications should remain on this network. A DMZ should be included along with an enterprise level historian.

12.0 PCS HARDWARE AND SOFTWARE

PLC control system is based installation of the Rockwell's Logix family. The control system controller should be ControlLogix or CompactLogix based. The ControlLogix platform should be utilized for all medium and large PLC cabinets. CompactLogix platform should be implemented where less than 40 I/O points are in the system.

12.1 PLC Modules

The following PLC modules should be used in the control system.

1. Controllogix:
    a. 1763-L773 Processor
    b. 1756-EN2T EtherNet/IP Scanner
    c. 1756-EN2TR DLR EtherNet/IP Scanner
    d. 1756-DNB DeviceNet Scanner
    e. 1756-EN2F EtherNet/IP module
    f. MVI56E-MCM Modbus RTU Master/Slave ProSoft
    g. PROFIBUS-DP-V1 Profibus Scanner ProSoft
    h. 1756-IF8H Analog Input (HART)
    i. 1756-OF8 Analog Output
    j. 1756-IA16 Discrete Input 120 V
    k. 1756-OW16I Discrete Output 120 V Isolated
    l. 1756-HISTORIAN ME Machine Edition Historian 2GB
    m. 1756-TIME Time Synchronization module.
2. CompactLogix:
    a. 1769-L33 Processor with DLR
    b. 1768-ENBT EtherNet/IP Scanner
    c. 1769-SDN DeviceNet Scanner

d.	1769-AND	DeviceNet Adapter
e.	MVI69-DFNT	ENET/IP client for MicroLogix ProSoft
f.	PS69-PDPMV1	Profibus DP Module ProSoft
g.	MVI69-MCM	MODBUS client
h.	MVI69-MNET	Modbus TCP/IP Interface Module ProSoft
i.	1769sc-IF4IH	Analog Input (HART) Spectrum Controls
j.	1769-OF8	Analog Output
k.	1769-IA16	Discrete Input 120 V
l.	1769-OW16	Discrete Output 120 V Isolated

12.2 PLC Software

Rockwell Studio 5000 should be used to program the PLCs. The intent is to use as much of Rockwell PAX certified add on instructions and faceplates as possible. The system should be design to allow programming of all plant PLCs from a development workstation located on-site.

Version control should also be implemented on all PLC application software. A package like Rockwell AssetCentre with Disaster Recovery, or some similar software package should be utilized. If Rockwell FactoryTalk View is used as the HMI software, AssetCentre can also back up the HMI application development software.

12.3 HMI Software

The HMI software should be object based (either Allen-Bradley FactoryTalk View SE or Wonderware System Platform are acceptable). Consistency in the approach for programming, data sets, control, navigation, colors, actions, process symbols, trending and alarming and should be documented and maintained. In conjunction with the HMI Software, a software package should be used which would integrate alarming with handheld devices and mobile phones. Win911 would be acceptable alarm management software.

Faceplates should be saved in a library or add on profile so they can be easily re-used from project to project. Deviations from the existing faceplate library should be approved by City staff prior to implementation.

Common trends should be saved so any workstation or thin client can pull up any of the saved trends.

A local Historian to the HMI should be provided to capture all instantaneous data. A second Historian should be located on the business network, which would provide all information for reporting purposes.

12.4 Data Management and Reporting Business Software

Computerized Maintenance Management System (CMMS) for tracking, organizing, and reporting maintenance information will be the Maintenance Connection software package. LIMS software for laboratory information will be WIMS (water information management system) by Hach. Assets listed in both of these software packages shall follow the same tag of the instrument or equipment located on the drawings. Aliasing of tags in these packages is not allowed. All parties shall use the process tag as the key/common field.

12.5 Alarm Philosophy

The goal of the modern facilities is to have less than 100 alarms per eight (8) hour shift. To meet this goal, alarms in the system should be clearly defined and root cause alarms set to eliminate multiple alarms indicating the same failure. The alarms should be grouped so that plant staff has an indication when equipment has failed or unavailable, while maintenance staff should get alarms indicating pre-failures and status.

12.6 HMI Remote Access

Remote access into the control system would typically be accomplished using a VPN service such as Citrix to Remote Desktop Protocol to access the HMI software. Other remote access options are available from the HMI software manufacturers, but should be evaluated at the time of implementation for capabilities and costs.

13.0 NETWORK HARDWARE

Communications backbone through out the site should be single mode fiber. The fiber distribution should route and terminate each leg in a patch panel. The control system backbone should be a loop and use independent paths in and out of structures where possible.

13.1 Network Communication Cabinets

The network communication cabinets should have standard layouts be located in each of the major process areas. The cabinets should be located in the electrical room or dedicated network closets. The communication cabinets should use the same components and have the same layout in each location.

Fiber should be patched through the entire system in the same order through every cabinet, and every strand should be labeled and terminated to a patch panel throughout the entire system. PLCs can be patched through depending on fiber budget loss and plant layout.

Layer 3 Managed Switches should be used for both the control system and business system. Patching to these devices should be consistent throughout the system.

Backup power (UPS) should be provided in each communication cabinet. This UPS should be sized to provide power to the PLC cabinets in the vicinity. The UPS should be equipped with both relay option cards and Ethernet TCP/IP communications. The relay cards should be wired directly to nearest PLC where general alarms would be monitored. The Ethernet TCP/IP communications would route over the business network for more detailed troubleshooting. Each UPS should be equipped with a maintenance bypass switch (switch position would also be monitored).

13.2 PLC Switches

An Ethernet switch should be installed in each PLC cabinet. This switch would facilitate connection to the PLC, and possibly any other Ethernet traffic than needs to find its way back to the control system. The intent is to connect the field networks directly to the PLC and not though the PLC switch, with another sub network provided for the PLC-to-field network connections.

Communications between the PLCs should be accomplished using switches connected in a loop configuration. These managed switches should be either an N-Tron 7018 or a Hirschmann RS20. The two models selected are Layer 2 and have features such as gigabit throughput, very low latency, full SNMP and web browser management, VLAN capabilities, QoS, trunking, and port mirroring. Configuration options are slightly more limited with these switches as compared to the switches inside the communications cabinets. However, security and robustness are more than sufficient for the PLC network. The N-Tron units offer auto-negotiating IGMP, which helps manage the multicast traffic and requires less configuration work from staff.

13.3 Enterprise Switches

Fiber optic cables should be used to transmit data for either the business or PLC networks between communications cabinets. Inside the communications cabinet, the fiber strands with business network data should be terminated on one patch panel, while the PLC network fiber optics should be terminated on another. Each section of the cabinet should have it’s own Ethernet switch to connect equipment to that network. These Ethernet switched should be either an N-Tron NT24k or a Hirschmann Mach series (both are Layer 3 managed switches). The N-Tron units have auto negotiated IGMP and snooping capabilities, and very low latency. Both N-Tron and Hirschmann units have software configuration features such as port monitoring, remote switch management, port security, switch meshing, and rapid spanning tree protocols. These features provide a more secure communications backbone with capabilities to prevent broadcast storms and other faulty equipment signals from bringing down the entire parts of the networks.

13.4 Network Labeling

All network components should be labeled, which includes all patch panels, switches, media convertors, and all associated cables.

Network components located in PLC enclosures should have the PLC cabinet designation in the name. Network components located in the communication cabinets should follow a similar naming convention.

All fiber cables should be labeled, indicating the origin patch panel followed by the destination patch panel. Strand identification should be based on color alone. All backbone fiber should be installed so that the same strand color would be the same throughout the entire ring. Spur fiber cables should also utilize the same distribution so that a particular color is the same throughout the spur or sub-ring.

All copper Ethernet cabling will follow a color standard to separate the various networks. Final color selection to be made during the Headwork project.

14.0 CONSTRUCTION COORDINATION MEETINGS

Construction coordination is a key aspect to maintaining the standards. City staff needs to be the gatekeepers of the standards especially during the implementation process.

PLC and HMI development meetings are crucial in combination with following project standards. The goal of the following meetings are to provide interaction between staff and programmers so that the process control expectations can be understood by the programmers and the staff can approve and confirm that the building blocks of the control system are correct so the contractor can avoid rework.

14.1 System Configuration (PLC and HMI) Meetings

Preliminary Meeting – prior to work on the system beginning, agreement on symbols, colors, displays, other display symbols, reports and maintenance displays.

PLC Code Development meeting – PLC annotation, alarm annotation, PLC coding, structure and annotation, review the naming structure of all the alarm, processes, sub routines etc. Provide documentation of all function block programming.

Intermediate Meeting – Review of the database, review of actual functioning screen, review of sample reports, demonstration of alarm handling including shelving, out of service and validate process alarms.

Maintenance Meeting – Review run time reset, instrument calibration, PLC Communication, Power monitoring, PLC cabinet ancillary component monitoring, UPS monitoring and

Maintenance alarms, validate alarm prioritization for all of the maintenance alarms. Operations staff should be in attendance as well as maintenance staff.

Final Review Meeting – This meeting is to be held after the factory acceptance test (FAT), demonstrating all functionality. Table 5 describes who should be in attendance at each meeting.

Table 5 System Configuration Meetings
Instrumentation and Control Design Standards
City of Sunnyvale

Meeting	Process Control Team	Consultant	Operations or Maintenance	Contractor	Programmer
Preliminary Meeting	Ongoing – Typical	Required	Operations	Required	Required
PLC Code Development Meeting	Required	Required	Operations and Maintenance	Required	Required
Intermediate Meeting	Ongoing – Typical	Required	Operations	Required	Required
Maintenance Meeting	Required	Required	Operations and Maintenance	Required	Required
FAT – Factory Acceptance Test	Ongoing – Typical	Required	Maintenance	Required	Required
Final Review Meeting	Required	Required	Operations and Maintenance	Required	Required

15.0 STARTUP ACTIVITIES

In order for a successful completion of a project, a coordinated set of startup activities must be completed. As indicated in Table 6, the following activities must be detailed in contract specifications and included in the construction schedule. For testing activities listed, the contract specifications shall require the testing contractor to submit their qualifications prior to selection.

These elements must take place regardless of who is performing the programming (City staff or contractor). Each step must be witnessed and/or performed by the contractor, programmer, and controls team.

**Table 6 Startup Activities
Instrumentation and Control Design Standards
City of Sunnyvale**

Activity	Review Topics / Deliverables
Detailed Submittal Review	Review all control system components submittal. Topics include instruments, control panel, servers, software, schematics control interface to all networked equipment like MCCs, UPSs, etc.
Review Programming Standards	Review the programming standards with the programmer. This includes program documentation, screen layouts, navigation, colors, PLC code structure, function blocks etc.
Review Programmers Understanding of Control Strategies	Review with the programmer the functionality of each loop, have operations and the Controls Team present in the discussion.
Confirm Coordination with Vendor Control Systems	Review controls and connectivity with the packaged vendor control equipment, and the verify the desired data is being shared.
Control System Factory Acceptance Test	Verify at the programmers/integrators facility to prove out communications and hardware functionality of the control system. This effort includes communication to each representative type of field network in each PLC.
Software Acceptance Test	Perform a software acceptance test prior to the application software being installed in the control system. Verify programming standards have been followed, check navigation, run using a simulator test the logic. Review setpoint clamps, alarms, trends and reports.
Alarm Rationalization	Review the alarms prioritization and categorization. Assign call out alarms.
Field Device Calibration	Verify or witness calibration of the all the field instruments and equipment.
Network Testing	Third party testing of the LAN, switch configurations, patch- panels and server connectivity.
Industrial Network Testing	Third party testing of all Field networks including waveform captures, voltage, current and time testing
Complete End-to-End Test	Verify all wiring of traditional instrument through the entire system into the HMI.
Manual Testing	Run equipment in Local/Hand mode, verify all interlocks and permissives. Open and close or modulate all actuators. Start and stop all driven equipment and modulate speeds of all VFD driven equipment.
Control Strategy Testing	Test each control strategy though the HMI, test running, and all failed conditions.
Operations and Maintenance Manuals	Verify the controls system and instrumentation components are all complete and current.

Table 6 Startup Activities Instrumentation and Control Design Standards City of Sunnyvale	
Activity	**Review Topics / Deliverables**
Training	Train staff in the new process and control system components; verify all reports and trends, alarms and reports are working correctly.
Record Documentation	Verify all record documents are complete and any changes that occurred during constructions have been captured. Correct the master documents for the control system and update any standards if necessary. This includes P&IDs, Loop drawings, Control Descriptions, schematics, control panel and network drawings.
Optimization	After the process has matured go back through the system and see if setpoints and control can be tightened up to reduce chemical and water usage, and energy costs.

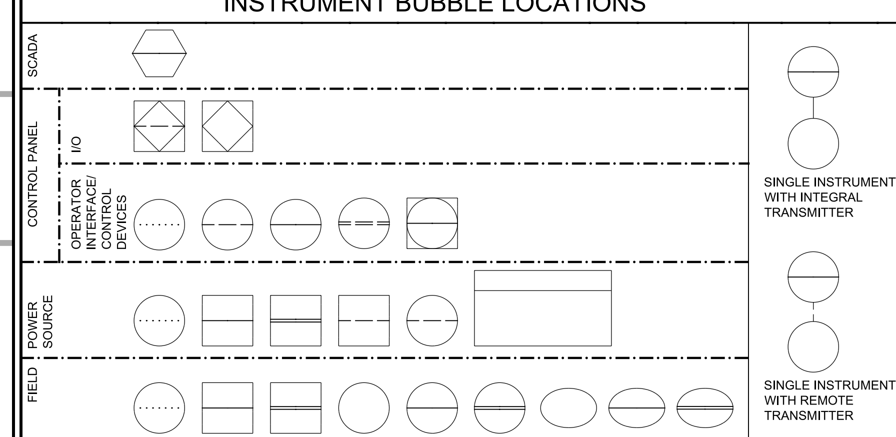
APPENDIX A – DELIVERABLE DOCUMENTS

APPENDIX A1 – P&ID STANDARDS

SYMBOL	DRAWING VISIBLE FIELDS	FIELD - 1	FIELD - 2	FIELD - 3	FIELD - 4	FIELD - 5	FIELD - 6
SCADA SYSTEM OPERATOR INTERFACE TERMINAL 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - DESCRIPTION 5 - DESCRIPTION 6 - NOT IN PROJECT	REFER 1 2	REFER 3	ACTION ALARM NUM - NUMERIC SP - SET POINT STATUS TREND	DESCRIPTION 2 5	DESCRIPTION	E - EXISTING F - FUTURE
HARDWIRED I/O POINT 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - DESCRIPTION 5 - LOCATION 6 - NOT IN PROJECT	REFER 1 2 4	REFER 3	AI - ANALOG INPUT AO - ANALOG OUTPUT DI - DISCRETE INPUT DO - DISCRETE OUTPUT HSC - HIGH SPEED COUNTER INPUT RTD - RTD INPUT	DESCRIPTION	PAC - PROGRAMMABLE AUTOMATION CONTROLLER NO. PLC - PROGRAMMABLE LOGIC CONTROLLER NO. RIO - REMOTE I/O VCP - VENDOR CONTROL PANEL NO.	E - EXISTING F - FUTURE
DIGITAL BUS I/O REGISTER (FIELDBUS I/O) 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - DESCRIPTION 5 - LOCATION 6 - NOT IN PROJECT	REFER 1 2	REFER 3	BUS ID CNET - CONTROLNET DNET - DEVICENET ENET - ETHERNET/IP FF - FOUNDATION FIELDBUS MB - MODBUS RTU MB+ - MODBUS PLUS MBTCP - MODBUS TCP DP - PROFIBUS DP PA - PROFIBUS PA PNET - PROFINET SERIAL - PROPRIETARY PROTOCOL	DESCRIPTION	PAC - PROGRAMMABLE AUTOMATION CONTROLLER NO. PLC - PROGRAMMABLE LOGIC CONTROLLER NO. RIO - REMOTE I/O VCP - VENDOR CONTROL PANEL NO.	E - EXISTING F - FUTURE
HUMAN MACHINE INTERFACE 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - DESCRIPTION 5 - LOCATION 6 - NOT IN PROJECT	REFER 1 2	REFER 3	ACTION ALARM NUM - NUMERIC SP - SET POINT STATUS	DESCRIPTION 2 5	HMI - HUMAN MACHINE INTERFACE NO. LCP - LOCAL CONTROL PANEL NO. PCM - PROCESS CONTROL MODULE NO. VCP - VENDOR CONTROL PANEL NO.	E - EXISTING F - FUTURE
PILOT DEVICE OPERATOR INTERFACE 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - DESCRIPTION 5 - LOCATION 6 - NOT IN PROJECT	REFER 1 2	REFER 3	AM - AUTO/MANUAL BYPASS - BYPASS CL - CLOSE E-STOP - EMERGENCY STOP FRLR - FIXED RATE/LEVEL RATE HOA - HAND /OFF/AUTO JOHC - JOG OPEN/HOLD/CLOSE JOJC - JOG OPEN/JOG CLOSE LH - LOW/HIGH LOR - LOCAL/OFF/REMOTE LOS - LOCK OUT STOP LS - LEAD/STANDBY LSR - LOCAL/STOP/REMOTE NOOT - NO OFFLINE/OFFLINE TRANSITION OC - OPEN/CLOSE OLOL - ON LINE/OFF LINE OO - OFF/ON OP - OPEN OSC - OPEN/STOP/CLOSE RST - RESET SAAM - SEMI AUTO/AUTO/MANUAL SEL - SELECT SP - STOP SPD - SPEED SS - START/STOP ST - START	DESCRIPTION	LCP - LOCAL CONTROL PANEL NO. MCC - MOTOR CONTROL CENTER NO. PCM - PROCESS CONTROL MODULE NO. RVSS - REDUCED VOLTAGE SOLID STARTER NO. VCP - VENDOR CONTROL PANEL NO. VFD - VARIABLE FREQUENCY DRIVE NO.	E - EXISTING F - FUTURE
POWER DEVICE PRIMARY FUNCTION OPERATOR ACCESSIBLE 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - VOLTAGE/PHASE 5 - LOCATION 6 - NOT IN PROJECT	CB - CIRCUIT BREAKER DISC - DISCONNECT FU - FUSE	REFER 3	TM - THERMAL MAGNETIC CIRCUIT BREAKER	24VDC - 1P 120VAC - 1P 208VAC - 2P 208VAC - 3P 240VAC - 2P 240VAC - 3P 480VAC - 3P 2400VAC - 3P 4160VAC - 3P	DP - DISTRIBUTION PANEL NO. LCP - LOCAL CONTROL PANEL NO. LP - LIGHTING PANEL NO. MCC - MOTOR CONTROL CENTER NO. PCM - PROCESS CONTROL MODULE NO. PP - POWER PANEL NO. VCP - VENDOR CONTROL PANEL NO.	E - EXISTING F - FUTURE
POWER DEVICE AUXILIARY FUNCTION FOR OPERATOR ACCESSIBLE DEVICES 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - DESCRIPTION 4 - DESCRIPTION 5 - DESCRIPTION 6 - NOT IN PROJECT	DISC - DISCONNECT	REFER 3	DESCRIPTION	DESCRIPTION	DESCRIPTION	E - EXISTING F - FUTURE
POWER DEVICE PRIMARY FUNCTION OPERATOR INACCESSIBLE 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - VOLTAGE/PHASE 5 - LOCATION 6 - NOT IN PROJECT	CB - CIRCUIT BREAKER FU - FUSE	REFER 3	MCP - MOTOR CIRCUIT PROTECTOR SS - SOLID STATE CIRCUIT BREAKER TM - THERMAL MAGNETIC CIRCUIT BREAKER	24VDC - 1P 120VAC - 1P 208VAC - 2P 208VAC - 3P 240VAC - 2P 240VAC - 3P 480VAC - 3P 2400VAC - 3P 4160VAC - 3P	DP - DISTRIBUTION PANEL NO. LCP - LOCAL CONTROL PANEL NO. LP - LIGHTING PANEL NO. MCC - MOTOR CONTROL CENTER NO. PCM - PROCESS CONTROL MODULE NO. PP - POWER PANEL NO. VCP - VENDOR CONTROL PANEL NO.	E - EXISTING F - FUTURE

SYMBOL	DRAWING VISIBLE FIELDS	FIELD - 1	FIELD - 2	FIELD - 3	FIELD - 4	FIELD - 5	FIELD - 6
INSTRUMENT PRIMARY ELEMENT 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - FURNISHED BY 5 - LOCATION 6 - NOT IN PROJECT	REFER 1	REFER 3	DESCRIPTION 5	DESCRIPTION 6	AREA NO. BUILDING NO. ROOM NO.	E - EXISTING F - FUTURE
INSTRUMENT/CONTROL ELEMENT PRIMARY FUNCTION OPERATOR ACCESSIBLE 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - FURNISHED BY 5 - DESCRIPTION 6 - NOT IN PROJECT	REFER 1	REFER 3	DESCRIPTION 5	DESCRIPTION 6	DESCRIPTION	E - EXISTING F - FUTURE
INSTRUMENT/CONTROL ELEMENT AUXILIARY FUNCTION OPERATOR ACCESSIBLE 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - FURNISHED BY 5 - DESCRIPTION 6 - NOT IN PROJECT	REFER 1	REFER 3	DESCRIPTION	DESCRIPTION 6	DESCRIPTION	E - EXISTING F - FUTURE
INSTRUMENT/CONTROL ELEMENT PRIMARY FUNCTION OPERATOR INACCESSIBLE 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - FURNISHED BY 5 - LOCATION 6 - NOT IN PROJECT	REFER 1 3 XR - PROTECTION RELAY CR - CONTROL RELAY IR - INTERPOSING RELAY	REFER 3	DESCRIPTION	DESCRIPTION 6	LCP - LOCAL CONTROL PANEL NO. MCC - MOTOR CONTROL CENTER NO. PCM - PROCESS CONTROL MODULE NO. VCP - VENDOR CONTROL PANEL NO.	E - EXISTING F - FUTURE
INSTRUMENT/CONTROL ELEMENT AUXILIARY FUNCTION OPERATOR INACCESSIBLE 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - FURNISHED BY 5 - LOCATION 6 - NOT IN PROJECT	REFER 1 3 XR - PROTECTION RELAY CR - CONTROL RELAY IR - INTERPOSING RELAY	REFER 3	DESCRIPTION	DESCRIPTION 6	LCP - LOCAL CONTROL PANEL NO. MCC - MOTOR CONTROL CENTER NO. PCM - PROCESS CONTROL MODULE NO. VCP - VENDOR CONTROL PANEL NO.	E - EXISTING F - FUTURE
FIELD EQUIPMENT NON-POWERED 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION/SIZE 4 - FURNISHED BY 5 - LOCATION 6 - NOT IN PROJECT	REFER 3	REFER 3	DESCRIPTION	DESCRIPTION 6	AREA NO. BUILDING NO. ROOM NO.	E - EXISTING F - FUTURE
FIELD EQUIPMENT PRIMARY FUNCTION POWERED 1 2 3 4 5 6	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - FURNISHED BY 5 - LOCATION 6 - NOT IN PROJECT	REFER 3	REFER 3	DESCRIPTION	DESCRIPTION 6	AREA NO. BUILDING NO. ROOM NO.	E - EXISTING F - FUTURE
FIELD EQUIPMENT AUXILIARY FUNCTION POWERED 1 2 3 4 5	1 - TAG 2 - LOOP NUMBER 3 - FUNCTION 4 - FURNISHED BY 5 - DESCRIPTION 6 - NOT IN PROJECT	MWH - MOTOR WINDING HEATER TSH - TEMPERATURE SWITCH XSH - TORQUE SWITCH	REFER 3	DESCRIPTION	DESCRIPTION 6	DESCRIPTION	E - EXISTING F - FUTURE
FIELD EQUIPMENT STARTER/DRIVE CUBICLE/CABINET 6 1 - 2 3 4 5	1 - TAG 2 - LOOP NUMBER 3 - TYPE 4 - VOLTAGE/PHASE 5 - LOCATION 6 - NOT IN PROJECT	MS - MOTOR STARTER RVAT - REDUCED VOLTAGE AUTO TRANSFORMER STARTER RVSS - REDUCED VOLTAGE SOLID STATE STARTER VFD - VARIABLE FREQUENCY DRIVE	REFER 3	FVNR - FULL VOLTAGE NON-REVERSING STARTER FVR - FULL VOLTAGE REVERSING STARTER PWS - PART-WINDING STARTER RVAT - REDUCED VOLTAGE AUTO TRANSFORMER STARTER RVSS - REDUCED VOLTAGE SOLID STATE STARTER TS1W - TWO SPEED SINGLE WINDING TS2W - TWO SPEED TWO WINDINGS VFD - VARIABLE FREQUENCY DRIVE	120VAC - 1P 208VAC - 2P 208VAC - 3P 240VAC - 2P 240VAC - 3P 480VAC - 3P 2400VAC - 3P 4160VAC - 3P	LCP - LOCAL CONTROL PANEL NO. MCC - MOTOR CONTROL CENTER NO. PCM - PROCESS CONTROL MODULE NO. VCP - VENDOR CONTROL PANEL NO.	E - EXISTING F - FUTURE

INSTRUMENT BUBBLE LOCATIONS



NOTES

1. INSTRUMENT TAG IDENTIFICATION LETTERS TABLE
2. OPERATOR PILOT DEVICE LEGEND
3. EQUIPMENT TAGGING TABLE
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5. INSTRUMENT TYPE DESIGNATIONS TABLE
6. FURNISHED BY: FBO FURNISHED BY OWNER
   FBV FURNISHED BY VENDOR

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

CITY OF SUNNYVALE CALIFORNIA

CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE SYMBOLS & ABBREVIATIONS - I

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC01
SHEET NO. OF XX

Plot Date: 28-MAY-2014 3:33:19 PM
User: BRoepken
Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1
LAST SAVED BY: abuffone

PROJECT NO. 9265A00 FILE NAME: 9265A00IC01.dgn

INSTRUMENT TAG IDENTIFICATION LETTERS

MEASURED VARIABLE \ INSTRUMENT FUNCTION		ELEMENT	TRANSMITTER	INDICATING TRANSMITTER	CONVERTER TRANSDUCER, RELAY SPECIAL DEVICES	INDICATOR	RECORDER	CONTROLLER	INDICATING CONTROLLER	RECORDING CONTROLLER	SWITCH	SWITCH LOW LOW	SWITCH LOW	SWITCH HIGH	SWITCH HIGH HIGH	SWITCH COMBINATION HIGH LOW	ACTION	ALARM LOW LOW	ALARM LOW	ALARM HIGH	ALARM HIGH HIGH	TOTALIZE INDICATOR TRANSMITTER	VALVE	GAUGE	LIGHT	SPEED SETTING
A	ANALYSIS	AE	AT	AIT	AY	AI	AR	AC	AIC	ARC	AS	ASLL	ASL	ASH	ASHH	ASHL		AALL	AAL	AAH	AAHH				AL	
B	BURNER FLAME	BE	BT	BIT	BY	BI	BR	BC	BIC	BRC	BS	BSLL	BSL	BSH	BSHH			BALL	BAL	BAH	BAHH				BL	
C	CONDUCTIVITY	CE	CT	CIT	CY	CI	CR	CC	CIC	CRC	CS	CSLL	CSL	CSH	CSHH	CSHL		CALL	CAL	CAH	CAHH				CL	
D	DENSITY	DE	DT	DIT	DY	DI	DR	DC	DIC	DRC	DS	DSLL	DSL	DSH	DSHH	DSHL		DALL	DAL	DAH	DAHH				DL	
E																										
F	FLOW	FE	FT	FIT	FY	FI	FR	FC	FIC	FRC	FS	FSLL	FSL	FSH	FSHH	FSHL		FALL	FAL	FAH	FAHH	FQI	FCV	FG	FL	
FF	FLOW RATIO				FFY	FFI		FFC	FFIC		FFS														FFL	
G	GAUGING (DIMENSION)																									
H	HAND (MANUAL)*							HC			HS*						HA*						HV		HL	HSS
I	CURRENT		IT	IIT	IY	II	IR	IC	IIC	IRC	IS	ISLL	ISL	ISH	ISHH			IALL	IAL	IAH	IAHH				IL	
J	POWER																									
K	TIME				KY	KI	KR	KC	KIC	KRC	KS	KSLL	KSL	KSH	KSHH			KALL	KAL	KAH	KAHH		KV		KL	
L	LEVEL	LE	LT	LIT	LY	LI	LR	LC	LIC	LRC	LS	LSLL	LSL	LSH	LSHH	LSHL		LALL	LAL	LAH	LAHH		LCV	LG	LL	
M	MOISTURE OR HUMIDITY	ME	MT	MIT	MY	MI	MR	MC	MIC	MRC	MS	MSLL	MSL	MSH	MSHH			MALL	MAL	MAH	MAHH				ML	
N	EMERGENCY SHUTDOWN																									
O																										
P	PRESSURE OR VACUUM	PE	PT	PIT	PY	PI***	PR	PC	PIC	PRC	PS****	PSLL	PSL	PSH	PSHH	PSHL		PALL	PAL	PAH	PAHH		PCV		PL	
PD	DIFFERENTIAL PRESSURE		PDT	PDIT	PDY	PDI	PDR	PDC	PDIC	PDRC	PDS	PDSLL	PDSL	PDSH	PDSHH			PDALL	PDAL	PDAH	PDAHH		PDCV		PDL	
Q	QUANTITY	QE	QT	QIT	QY	QI	QR				QS	QSLL	QSL	QSH	QSHH			QALL	QAL	QAH	QAHH					
R	RADIOACTIVITY																									
S	SPEED	SE	ST	SIT	SY	SI	SR	SC	SIC	SRC	SS	SSLL	SSL	SSH	SSHH			SALL	SAL	SAH	SAHH					
T	TEMPERATURE	TE	TT	TIT	TY	TI	TR	TC	TIC	TRC	TS	TSLL	TSL	TSH	TSHH	TSHL		TALL	TAL	TAH	TAHH		TCV		TL	
TD	DIFFERENTIAL TEMPERATURE		TDT	TDIT	TDY	TDI	TDR	TDC	TDIC	TDRC	TDS	TDSLL	TDSL	TDSH	TDSHH			TDALL	TDAL	TDAH	TDAHH		TDCV		TDL	
U	MULTIVARIABLE					UI	UR	UC	UIC	URC	US														UL	
V	VISCOSITY	VE	VT	VIT	VY	VI	VR	VC	VIC	VRC	VS	VSLL	VSL	VSH	VSHH			VALL	VAL	VAH	VAHH				VL	
W	WEIGHT	WE	WT	WIT	WY	WI	WR				WS	WSLL	WSL	WSH	WSHH			WALL	WAL	WAH	WAHH					
X	UNCLASSIFIED	XE	XT	XIT	XY	XI	XR	XC	XIC	XRC	XS	XSLL	XSL	XSH	XSHH			XALL	XAL	XAH	XAHH		XCV	XG	XL	
XV	VIBRATION	XVE	XVT		XVY	XVI	XVR				XVS			XVSH	XVSHH					XVAH	XVAHH				XVL	
Y	STATUS***					YI***																			YL	
Z	POSITION	ZE	ZT	ZIT	ZY	ZI					ZS**												ZV		ZL**	

* REFER TO OPERATOR PILOT DEVICE LEGEND
** LETTER INDICATES POSITION (O=OPEN, C=CLOSED, R=RAISE, L=LOWER, ETC)
*** PI# # = 1,2,3 ETC. AND REPRESENTS A UNIQUE IDENTIFIER AND IS APPLICABLE TO ALL ITEMS IN THE TABLE ABOVE
**** COULD ALSO BE PIS - FOR PRESSURE INDICATING SWITCH

OPERATOR PILOT DEVICE LEGEND

DEVICE TYPE \ PILOT DEVICE FUNCTION	PILOT DEVICE TAG (HAND SWITCHES)	SCADA/HMI TAG (HAND ACTION)
LOCAL-OFF-REMOTE (LOR) OR LOCAL-STOP-REMOTE (LSR)	HSA*	HAA
STOP (SP)	HSB	HAB
START (ST)	HSC	HAC
HAND-OFF-AUTO (HOA)	HSD*	HAD
OFF-ON (OO)	HSE	HAE
SELECT (SEL)	HSF	HAF
OPEN-STOP-CLOSE (OSC)	HSG*	HAG
JOG OPEN-HOLD-CLOSE (JOHC)	HSH*	HAH
SEMIAUTO-AUTO-MANUAL (SAAM)	HSI	HAI
LEAD-LAG-STANDBY (LLGS)	HSJ*	HAJ
JOG OPEN-JOG CLOSE (JOJC)	HSK*	HAK
ONLINE-OFFLINE (OLOF)	HSL*	HAL
AUTO-MANUAL (AM)	HSM*	HAM
FIXED RATE-LEVEL RATE (FRLR)	HSN	HAN
OPEN-CLOSE (OC)	HSO*	HAO
NO OFFLINE-OFFLINE TRANSITION (NOOT)	HSP	HAP
LOW-HIGH (LH)	HSQ*	HAQ
RESET (RST)	HSR	HAR
SPEED (SPD)	HSS	HAS
START-STOP (STSP)	HST*	HAT
E-STOP (E-SP)	HSU	HAU
BYPASS (BYP)	HSV	HAV
	HSW	HAW
	HSX	HAX
	HSY	HAY
POSITION (POS)	HSZ	HAZ

HSA* SELECTOR SWITCH POSITION EG: HSA(R) R = REMOTE, HSD(A) A = AUTO, ETC

I/O TYPE DESIGNATIONS

AUX1	RUNNING	MSC	VALVE CLOSE
AUX2	FAILED/FAULT	MSF	MOTOR START FORWARD
AUXF1	RUNNING FORWARD	MSH	MOTOR START HIGH
AUXH1	RUNNING HIGH	MSL	MOTOR START LOW
AUXL1	RUNNING LOW	MSM	VALVE MODULATE
AUXR1	RUNNING REVERSE	MSO	VALVE OPEN
AUX3	RUN LATCH	MSP	MOTOR STOP
SVC	SOLENOID VALVE CLOSE	MSR	MOTOR START REVERSE
SVO	SOLENOID VALVE OPEN	MST	MOTOR START
MS	RUN	SS	SPEED SIGNAL

N-02

INSTRUMENT TYPE DESIGNATIONS

AM	AMMONIA	O3	OZONE	SC	STREAMING CURRENT
CAP	CAPACITANCE	ORP	OXIDATION REDUCTION POTENTIAL	SH	SODIUM HYPOCHLORITE
CG	COMBUSTIBLE GAS	P	PRESSURE	TDR	TIME DOMAIN REFLECTOMETRY
CL	CHLORINE	P-SUB	PRESSURE SUBMERSIBLE	TH	THERMAL
COND	CONDUCTIVITY	PC	PARTICLE COUNTER	TSS	TOTAL SUSPENDED SOLIDS
DO	DISSOLVED OXYGEN	PO	PHOSPHOROUS	TURB	TURBIDITY
FMCW	FREQ. MODULATED CONT. WAVE	PTOF	PULSE TIME OF FLIGHT	US	ULTRASONIC
HSF	FLUORIDE	R/I	RESISTANCE TO CURRENT	UVI	UV INTENSITY
IS	INTRINSIC SAFETY BARRIER	ROT	ROTAMETER	UVT	UV TRANSMITTANCE
LEL	LOWER EXPLOSIVE LIMIT	RTD	RESISTANCE TEMP DETECTOR	VAC	VACUUM
MAG	MAGNETIC				

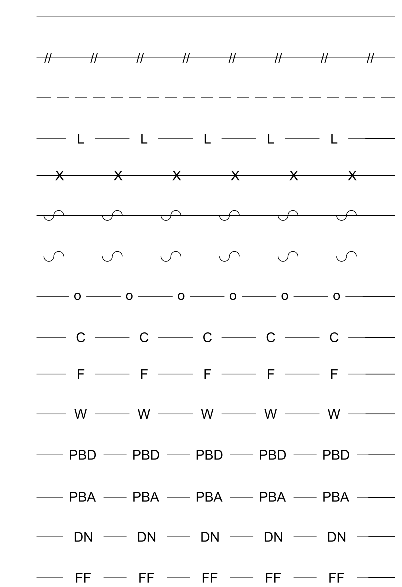
SPECIFIC ABBREVIATIONS

APH	A PHASE	MWH	MOTOR WINDING HEATER
BPH	B PHASE	SSG	SECONDARY SWITCHGEAR
BRB	BEARING BOTTOM	SV*	SOLENOID VALVE
BRT	BEARING TOP	SPD	SURGE PROTECTIVE DEVICE
BTFLY	BUTTERFLY	UPS	UNINTERRUPTIBLE POWER SUPPLY
CPH	C PHASE	YA	STATUS AUTO
CC*	CALIBRATION COLUMN * = 1, 2, 3, ETC.	YR	STATUS REMOTE
HTR	HEATER	Y1	STATUS RUNNING
HTU	HEAT TRACE UNIT	Y2	ALARM FAILED/FAULT

* CC# AND SV# # = 1, 2, 3 ETC. AND REPRESENTS A UNIQUE IDENTIFIER

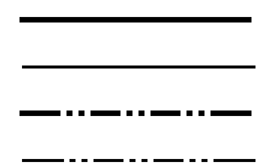
INSTRUMENT LINE SYMBOLS

INSTRUMENT OR CONNECTION TO PROCESS
PNEUMATIC SYMBOL
ELECTRIC SYMBOL
HYDRAULIC SYMBOL
CAPILLARY TUBE
ELECTROMAGNETIC OR SONIC SIGNAL (GUIDED)
ELECTROMAGNETIC OR SONIC SIGNAL (NOT GUIDED)
INTERNAL SYSTEM LINK (SOFTWARE OR DATA LINK)
COPPER ETHERNET
FIBER OPTIC ETHERNET
WIRELESS ETHERNET
PROFIBUS DP
PROFIBUS PA
DEVICENET
FOUNDATION FIELDBUS

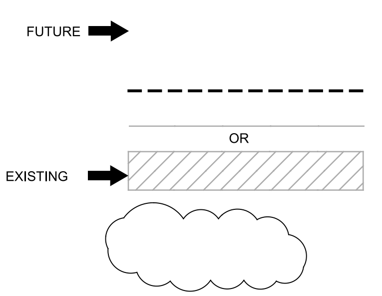


PROCESS LINE SYMBOLS

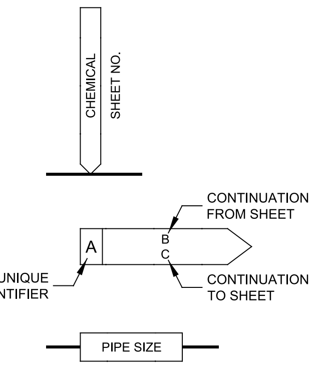
PRIMARY PROCESS FLOW IN PIPE
SECONDARY PROCESS FLOW IN PIPE
PRIMARY PROCESS FLOW IN CHANNEL
SECONDARY PROCESS FLOW IN CHANNEL



DESIGNATIONS



MISCELLANEOUS P&ID SYMBOLS



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SAMPLE SYMBOLS & ABBREVIATIONS - II

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ACTUATORS

- DIAPHRAGM
- ELECTRIC DISCRETE
- ELECTRIC MODULATING
- ELECTRIC HYDRAULIC
- HAND
- HYDRAULIC
- PNEUMATIC
- SOLENOID
- HYDRAULIC MODULATING
- PNEUMATIC SINGLE SOLENOID OPEN/CLOSE
- PNEUMATIC SINGLE SOLENOID w/ SPEED CONTROL
- PNEUMATIC DUAL SOLENOID OPEN/CLOSE
- PNEUMATIC DUAL SOLENOID OPEN/HOLD/CLOSE
- PNEUMATIC DUAL SOLENOID OPEN/CLOSE w/ SPEED CONTROL
- PNEUMATIC MODULATING
- PNEUMATIC MODULATING OPEN/CLOSE w/ SPEED CONTROL

PIPING

- AIR GAP
- BLIND FLANGE
- CAPPED OR PLUGGED
- CONCENTRIC INCREASER
- CONCENTRIC REDUCER
- DRAIN
- ECCENTRIC INCREASER
- ECCENTRIC REDUCER
- EXPANSION COUPLING
- EXPANSION JOINT VIBRATION CENTER
- FLEXIBLE CONNECTION
- QUICK DISCONNECT
- TEE
- UNION

PUMPS

- AIR DRIVEN
- CENTRIFUGAL
- CHEMICAL FEED DIAPHRAM
- DIAPHRAGM
- GEAR
- PERISTALTIC OR HOSE
- PISTON
- PROGRESSIVE CAVITY
- SUBMERSIBLE
- VERTICAL TURBINE
- VERTICAL CHOPPER
- WATER CHAMP

BLOWERS/ COMPRESSORS

- CENTRIFUGAL SINGLE STAGE BLOWER
- CENTRIFUGAL MULTI STAGE BLOWER
- RECIPROCATING COMPRESSOR
- SCREW COMPRESSOR
- FAN
- LIQUID RING COMPRESSOR
- ROTARY LOBE BLOWER

MISC

- AIR DAMPER
- AIR/ CHEMICAL DIFFUSER
- ANNULAR SEAL
- BASKET STRAINER
- BLOW-OFF SILENCER
- CALIBRATION COLUMN
- COALESCER
- DESICCANT DRYER
- EDUCTOR/EJECTOR
- EYEWASH
- EXHAUST FAN
- FILTER
- FILTER SEPARATOR
- FINE FILTER
- FIRE ALARM/SENSOR
- FLAME ARRESTER
- FLAME ARRESTER w/THERMALLY OPERATED VALVE
- FLOW CONDITIONER
- GAS CANNON
- GRINDER
- HEAT EXCHANGER
- HOIST
- HORIZONTAL MIXER
- HOSE CONNECTION
- INLET STRAINER
- INLINE STATIC MIXER
- MATERIAL CHANGE
- MIXER
- MOTOR
- NOZZLE
- ORIFICE RESTRICTION
- PERISTALTIC COMPOSITE SAMPLER
- OR
- PULSATION DAMPENER
- REFRIGERATED DRYER
- RUPTURE DISK
- SAMPLE PORT
- SIGHT TUBE
- SMOKE DETECTOR
- STRAINER - MECHANICALLY CLEANED
- STRAINER WITH BLOW OFF
- STRAINER WYE TYPE
- VAPOR HEATER
- VAPORIZER
- VENT TO ATMOSPHERE

CHECK VALVES

- BACK FLOW PREVENTOR
- BALL
- DIAPHRAGM CHECK
- DOUBLE FLAP
- FLAPPER
- SPRING LOADED GENERAL
- SPRING LOADED SWING
- SWING

PRESSURE VALVES

- BACKPRESSURE REGULATING SELF CONTAINED
- BACKPRESSURE REGULATING EXTERNAL TAP
- PRESSURE REDUCING SELF CONTAINED
- PRESSURE REDUCING EXTERNAL PRESSURE TAP
- REGULATING
- PRESSURE RELIEF
- VACUUM RELIEF

VALVES

- 3-WAY
- 3-WAY PLUG
- 4-WAY
- AIR-RELIEF
- ANGLE
- BALL
- BALL V-NOTCH
- BUTTERFLY
- BUTTERFLY-BURIED VALVE BOX
- CONE
- DIAPHRAGM
- GATE
- GATE-BURIED VALVE BOX
- GLOBE
- HOSE
- MUD
- NEEDLE
- PINCH
- PLUG ECCENTRIC
- PLUG ECCENTRIC w-VALVE BOX
- PLUG ECCENTRIC LUBRICATED
- PLUG ECCENTRIC LUBRICATED BURIED VALVE BOX
- PLUG CONCENTRIC
- PLUG CONCENTRIC -BURIED VALVE BOX
- PLUG CONCENTRIC LUBRICATED
- PLUG CONCENTRIC LUBRICATED BURIED VALVE BOX
- PUMP DISCHARGE
- TELESCOPING

VALVE DESIGNATIONS	
NO	NORMALLY OPEN
NC	NORMALLY CLOSED
FO	FAIL OPEN
FC	FAIL CLOSE
FLP	FAIL LAST POSITION

N-03

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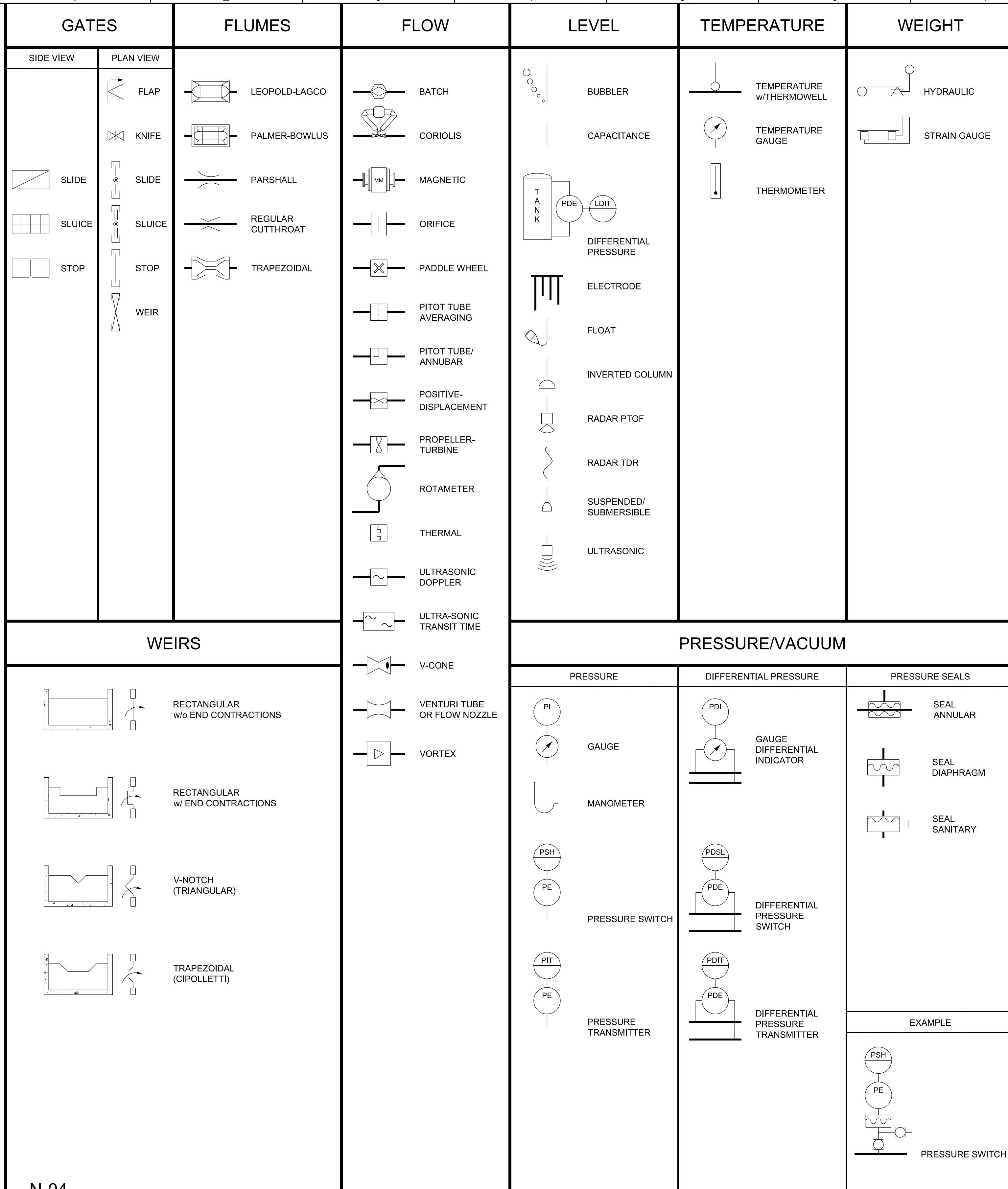
SHEET NO. OF XX



N-04

REV	DATE	BY	DESCRIPTION

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SAMPLE SYMBOLS & ABBREVIATIONS - IV

VERIFY SCALES

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JOB NO. 9265A.00

DRAWING NO. IC04

SHEET NO. OF XX

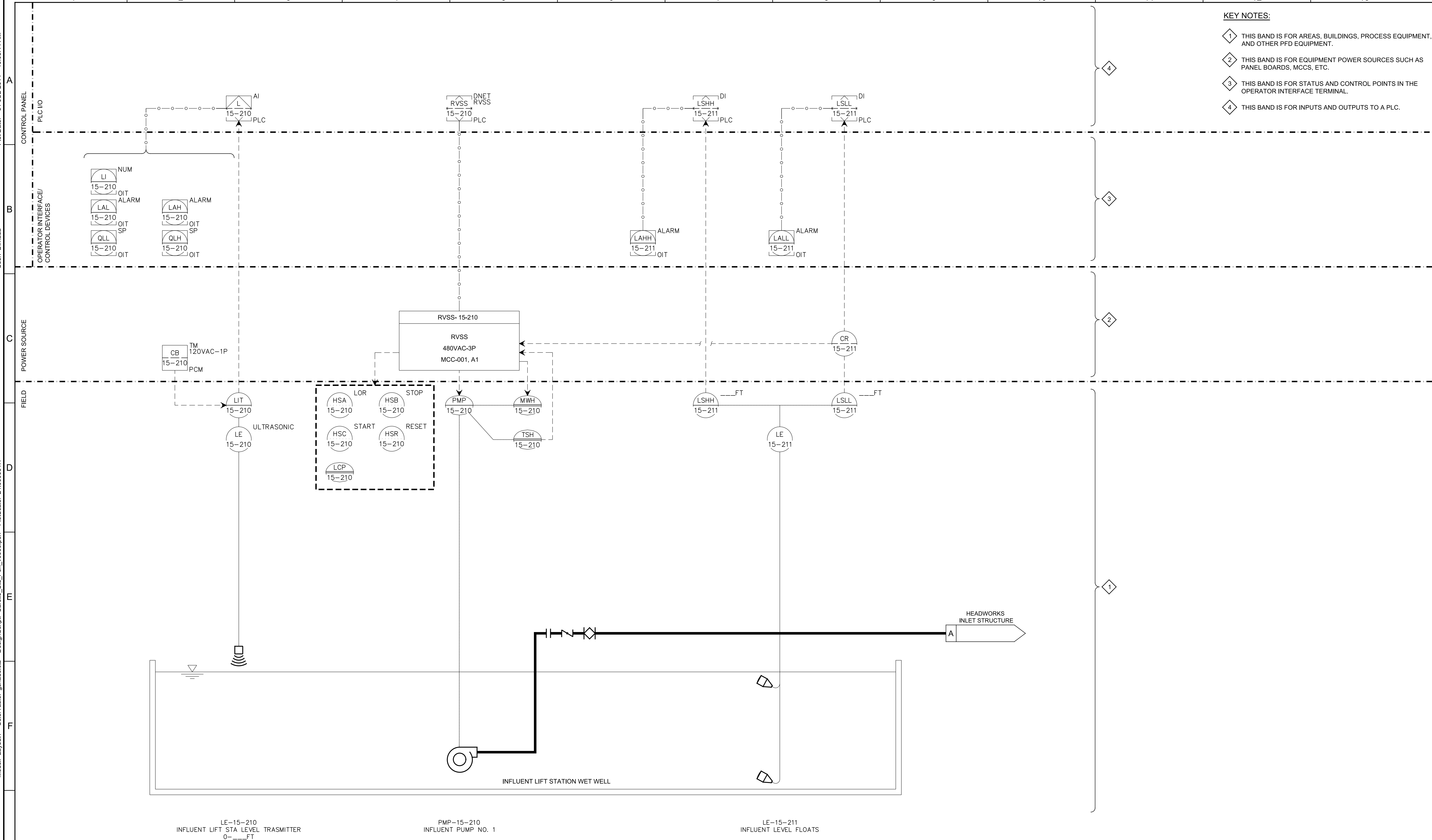
PROJECT NO. 9265A00 FILE NAME: 9265A00IC04.dgn

Plot Date: 28-MAY-2014 3:34:54 PM

User: BRoepken

Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1

LAST SAVED BY: abuffone



KEY NOTES:

1. THIS BAND IS FOR AREAS, BUILDINGS, PROCESS EQUIPMENT, AND OTHER PFD EQUIPMENT.
2. THIS BAND IS FOR EQUIPMENT POWER SOURCES SUCH AS PANEL BOARDS, MCCS, ETC.
3. THIS BAND IS FOR STATUS AND CONTROL POINTS IN THE OPERATOR INTERFACE TERMINAL.
4. THIS BAND IS FOR INPUTS AND OUTPUTS TO A PLC.

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SAMPLE P&ID

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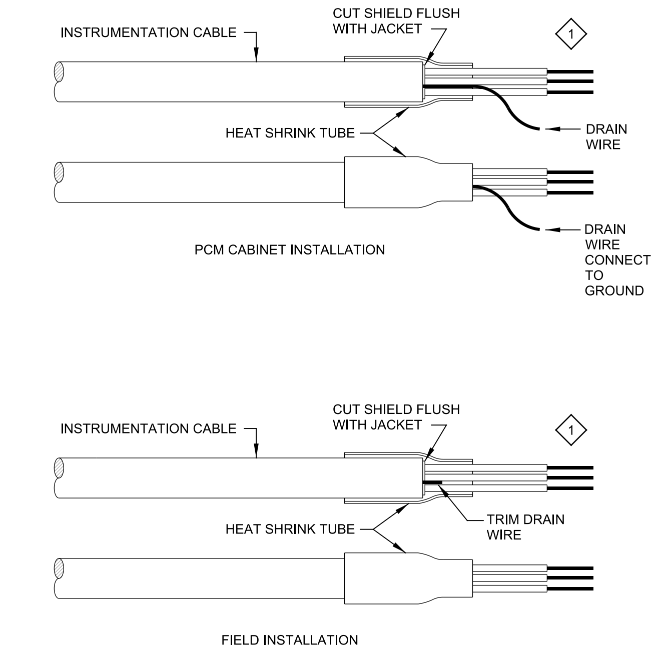
JOB NO. 9265A.00
DRAWING NO. IC05
SHEET NO. OF XX

PROJECT NO. 9265A00 FILE NAME: 9265A00IC05.dwg

Plot Date: 31-JUL-2014 10:08:44 AM User: Dlmada PlotScale: 24.000001:1 DesignScript: Carollo_Std_Pen_v0905.pen ColorTable: gshade.ctb Model: Layout1 LAST SAVED BY: dlmada

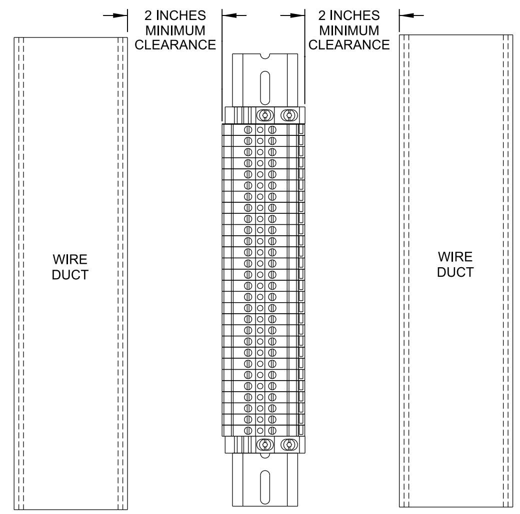
APPENDIX A2 – WIRING AND LOOP DRAWING STANDARDS



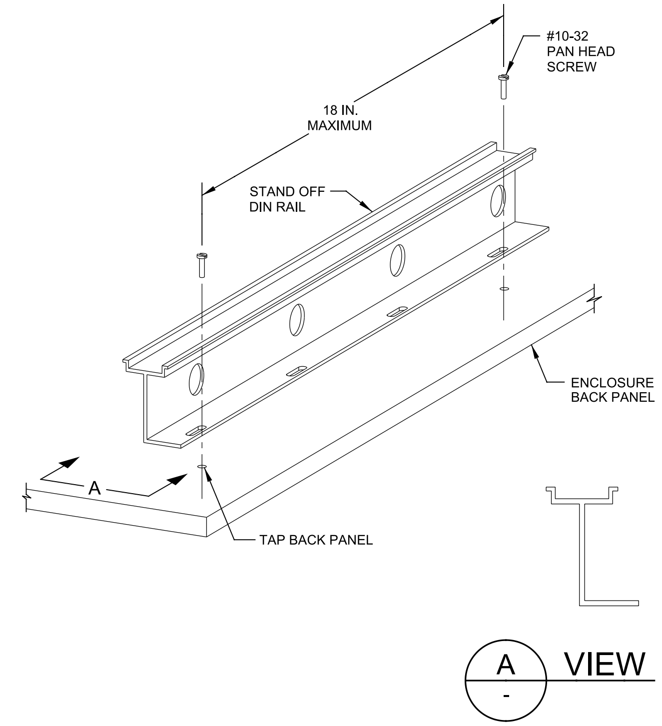
KEY NOTES:

1 SIMILAR FOR 2-CONDUCTOR SHIELDED CABLE

TERMINATION DETAILS
INSTRUMENTATION SHIELDED CABLE



TERMINAL BLOCK CLEARANCE



RAISED DIN RAIL MOUNTING

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INSTRUMENTATION
SAMPLE TERMINATION AND TERMINAL MOUNTING DETAILS

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DRAWING NO. IC06
SHEET NO. OF XX

Plot Date: 28-MAY-2014 3:35:05 PM User: BRoepken
Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1
LAST SAVED BY: abuffone

PROCESS SWITCHES

- FLOAT SWITCH CLOSE ON RISING LEVEL
- FLOAT SWITCH OPEN ON RISING LEVEL
- PRESSURE SWITCH CLOSE ON RISING PRESSURE
- PRESSURE SWITCH OPEN ON RISING PRESSURE
- TEMPERATURE SWITCH CLOSE ON RISING TEMPERATURE
- TEMPERATURE SWITCH OPEN ON RISING TEMPERATURE
- FLOW SWITCH CLOSE ON INCREASE IN FLOW
- FLOW SWITCH OPEN ON INCREASE IN FLOW
- VIBRATION SWITCH OPEN ON RISING VIBRATION
- VIBRATION SWITCH CLOSE ON RISING VIBRATION
- TORQUE SWITCH OPEN ON HIGH TORQUE
- TORQUE SWITCH CLOSE ON HIGH TORQUE
- NORMALLY CLOSED LIMIT SWITCH
- NORMALLY CLOSED HELD OPEN LIMIT SWITCH
- NORMALLY OPEN LIMIT SWITCH
- NORMALLY OPEN HELD CLOSED LIMIT SWITCH

HAND SWITCHES

- NORMALLY OPEN MOMENTARY PUSHBUTTON
- NORMALLY CLOSED MOMENTARY PUSHBUTTON
- xoo — THREE POSITION SELECTOR SWITCH; x - DENOTES POSITION CONTACTS CLOSED IN
- xo — TWO POSITION SELECTOR SWITCH; x - DENOTES POSITION CONTACTS CLOSED IN
- MUSHROOM HEAD PUSHBUTTON
- PUSH-PULL PUSHBUTTON MAINTAINED CONTACT
- xox — PADLOCK SWITCH; x - DENOTES POSITION CONTACTS CLOSED IN
- PULL CORD SWITCH
- STOP-LOCKOUT PUSHBUTTON
- xoo — SPRING-RETURN; x - DENOTES POSITION CONTACTS CLOSED IN

PILOT LIGHTS

PILOT LIGHT
a = LENS COLOR
R = RED
G = GREEN
W = WHITE
A = AMBER

RELAYS

RELAY COIL (d, a, b, c)
a = TYPE
- CR - CONTROL RELAY
- TD - TIME DELAY RELAY
- M - MOTOR STARTER COIL
- L - MOTOR STARTER COIL - LOW SPEED
- H - MOTOR STARTER COIL - HIGH SPEED
- F - MOTOR STARTER COIL - FORWARD
- R - MOTOR STARTER COIL - REVERSE

b = TDON - TIME DELAY ON ENERGIZATION
TDOFF - TIME DELAY ON DEENERGIZATION

c = TIMING RANGE/SETTING
d = DESCRIPTION

- NORMALLY OPEN CONTROL CONTACT
- NORMALLY CLOSED CONTROL CONTACT
- NOTC — TIME DELAY CONTACT NORMALLY OPEN TIMED CLOSING
- NCTO — TIME DELAY CONTACT NORMALLY CLOSED TIMED OPENING
- NOTO — TIME DELAY CONTACT NORMALLY OPEN TIMED OPENING
- NCTC — TIME DELAY CONTACT NORMALLY CLOSED TIMED CLOSING

TERMINAL BLOCKS

- TERMINAL IN PLC/PCM PANEL
- TERMINAL IN MOTOR CONTROL CENTER
- TERMINAL IN LOCAL STARTER CONTROL PANEL
- TERMINAL AT FIELD DEVICE
- TERMINAL IN RTU
- TERMINAL IN FIELD PANEL
- TERMINAL IN (USER CHOICE)
- DIGITAL BUS CONNECTOR
  - * = D - DEVICENET
  - * = PA - PROFIBUS PA
  - * = DP - PROFIBUS DP
  - * = H1 - FOUNDATION FIELDBUS H1
  - * = H2 - FOUNDATION FIELDBUS H2

I/O

- (a) PLC DISCRETE; a = INPUT OR OUTPUT AS INDICATED
- (ANALOG / a) PLC ANALOG; a = INPUT OR OUTPUT AS INDICATED
- (DIGITAL / BUS) DIGITAL BUS

MISC

- SOLENOID
- (M) METER UNIT; M = TYPE
- (HP) MOTOR
- CIRCUIT BREAKER
- DISCONNECT
- FUSE
- TRANSIENT SURGE PROTECTION
- (MWH-*) MOTOR WINDING HEATER; * - MOTOR TAG I.D.
- SPACE HEATER
- VARISTOR
- CAPACITOR
- RESISTOR
- BATTERY
- DIODE
- MOTOR OVERLOAD HEATERS
- OVERLOAD CONTACT
- DRAWOUT CONNECTION
- GROUND
- LIGHTNING ARRESTOR
- (H1, H3, H2, H4, X1, X2) CONTROL POWER TRANSFORMER
- (KI-*, ETM) ELAPSED TIME METER

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SAMPLE SCHEMATIC SYMBOLS

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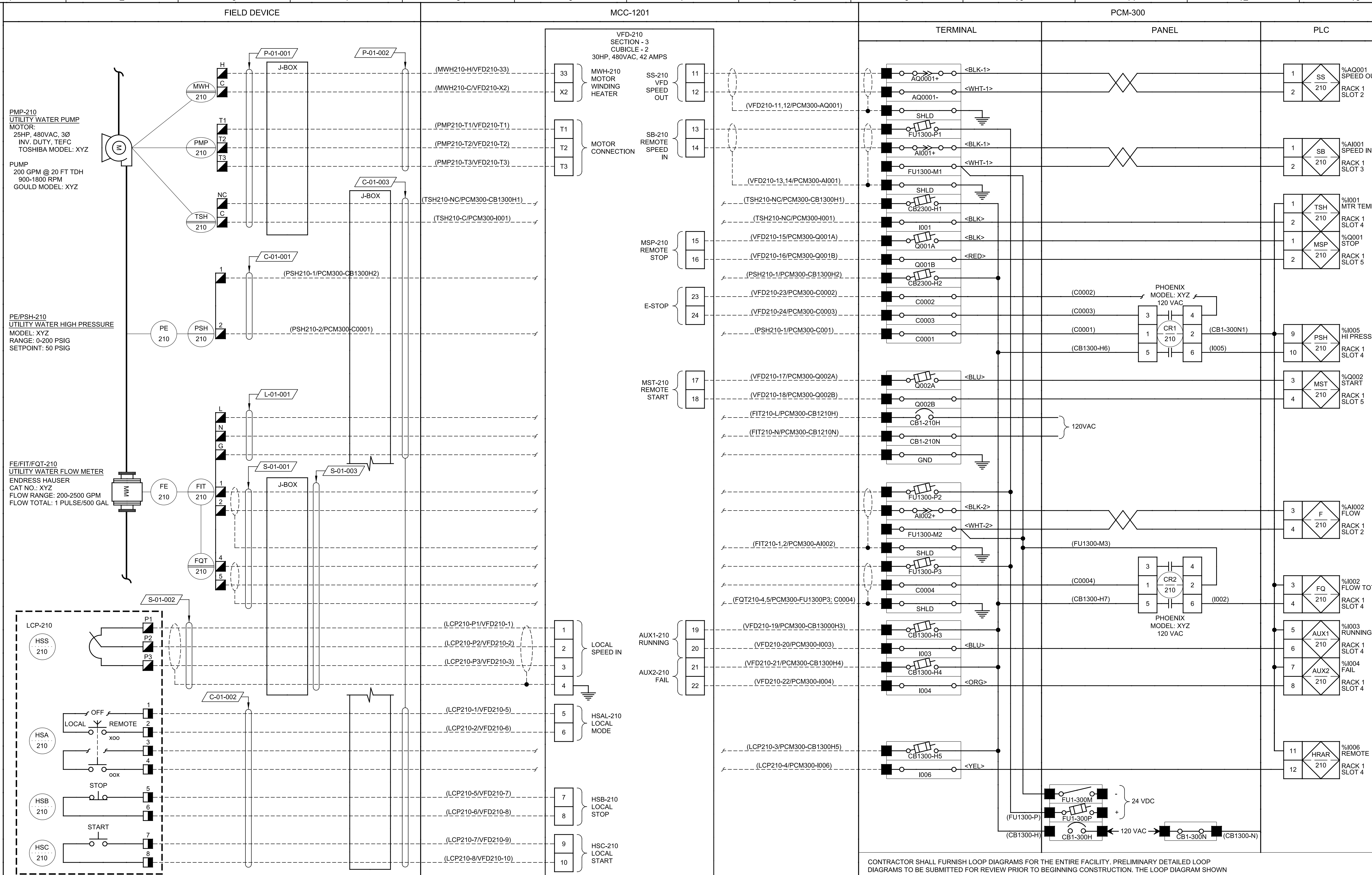
JOB NO. 9265A.00
DRAWING NO. IC07
SHEET NO. OF XX

PROJECT NO. 9265A00 FILE NAME: 9265A00IC07.dgn



CONTRACTOR SHALL FURNISH LOOP DIAGRAMS FOR THE ENTIRE FACILITY. PRELIMINARY DETAILED LOOP DIAGRAMS TO BE SUBMITTED FOR REVIEW PRIOR TO BEGINNING CONSTRUCTION. THE LOOP DIAGRAM SHOWN ABOVE DISPLAYS THE LEVEL OF EXPECTED DETAIL.

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SAMPLE LOOP DRAWING

VERIFY SCALES
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JOB NO. 9265A.00
DRAWING NO. IC08
SHEET NO. OF XX

LAST SAVED BY: abuffone Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1 User: BRoepken Plot Date: 28-MAY-2014 3:35:28 PM

APPENDIX A3 – CONTROL STRATEGY STANDARDS

Control Description – Guideline

This document serves as the guideline for writing specific control descriptions. The format and content as described here is to be followed on all projects.

Format

A. System Title:
   1. References:
      a. Drawings:
         1) ***__FILL-IN__***.
         2) ***__FILL-IN__***.
   2. Abstract:
      a. ***__FILL-IN__***.
   3. Hardwired interlocks:
      a. ***__FILL-IN__***.
   4. Hardwired control:
      a. ***__FILL-IN__***.
   5. PLC control:
      a. ***__FILL-IN__***.
   6. Software Interlocks:
      a. ***__FILL-IN__***.
   7. OIT control:
      a. ***__FILL-IN__***.
   8. HMI control:
      a. ***__FILL-IN__***.
   9. Indicators and alarms:
      a. ***__FILL-IN__***.
   10. PLC/HMI Logic:
      a. Add-on instruction (AOI) or Defined function block (DFB):
      b. Add-on Procedure (AOP):

Content

A. System Title:

For each system, enter a corresponding title. Example – ‘Centrifuge’.

A.1. References:

- Include all drawing references for this loop “a. Drawings”.
    - Example – ’51-N-001’.

A.2. Abstract:

Describe the process function associated with this loop. Control details should not be included in this Section.

A.3. Hardwired Interlocks:

Include details on specific hardwired interlocks, permissives, and shutdowns for the corresponding equipment described in this loop. This is required for the PLC programmer to implement “fail to run” alarms.

A.4. Hardwired Control:

Include details on specific hardwired control functions for the corresponding equipment described in this loop.

A.5. PLC Control:

This paragraph of the control description section should discuss the automatic control system of the corresponding equipment. Provide details on when the PLC controls will be enabled (HMI/OIT’s software HOA function in AUTO mode).

Include the following: software controls and software permissives.

General control specifications should contains programming requirements for common functions such as VFD speed control, chemical flow pacing, etc. Include other specific programming requirements that are not included in the general control specifications.

A.6. Software Interlocks:

Include details on specific software interlocks and shutdowns for the corresponding equipment described in this loop. This is required for the PLC programmer to implement in the PLC logic.

A.7. OIT Control:

OIT controls refer to controls from an operator interface located in front of a control panel. These operator interfaces communicate only with one PLC, and can only be programmed (using an OIT programming software) such that the operator interface displays the status, controls, and alarms of devices that communicate with the corresponding PLC. In short, an OIT is a PLC-based operator interface.

Provide details on when the OIT controls will be enabled (e.g. selector switch in the field or MCC, is in REMOTE or AUTO position). Include details on manual controls from the OIT (e.g. software HOA function in HAND mode) and the required setpoints/values at these locations. The PLC Controls paragraph should include the specific control functions required from these locations.

A.8. HMI Control:

HMI controls refer to controls from a human-machine interface located in front of a control panel. These operator interfaces communicate with the overall HMI network, and can be programmed (using the same HMI programming software as used on the HMI workstations) such that the human-machine interface displays the status, controls, trends and alarms for all devices in a facility. In short, an HMI is a PC-based operator interface.

Provide details on when the HMI controls will be enabled (e.g. selector switch in the field or MCC, is in REMOTE or AUTO position). Include details on manual controls from the HMI (e.g. software HOA function in HAND mode) and the required setpoints/values at these locations. The PLC Controls paragraph should include the specific control functions required from these locations.

A.9. Indicators and Alarms:

Include details of all software indications and alarms that are required in the HMI or OIT.

A.10. PLC/HMI Logic:

Include names and descriptions of PLC logic blocks such as add-on instructions (AOIs) or defined function blocks (DFBs) or add-on procedures used in the program for the loop. This section will not be provided during design, but should be included by the contractor with the updated control descriptions in the project record drawings.

Example

B. Flash Mix Pump:
  1. References:
     a. Drawings:
        1) N101.
        2) N102.
  2. Abstract:
     a. The flash mix pump provides mixing water at the point of chemical injection. The flash mix pump can be controlled locally by the operator via the LCP.
  3. Hardwired interlocks:
     a. The flash mix pump is stopped and prohibited from starting if:
     b. Pump discharge pressure switch is activated.
  4. Hardwired control:
     a. With the LOR switch in LOCAL position, the flash mix pump is controlled by the start and stop pushbuttons.
     b. The flash mix seal water solenoid is energized when the flash mix pump is running.
  5. PLC control:
     a. In PCIS AUTO, the flash mix pump is controlled via the PLC:
        1) Start the flash mix pump when the plant influent flow is greater than the plant flow started setpoint.
        2) Stop the flash mix pump when the plant influent flow is less than the plant flow started setpoint.
  6. Software interlocks:
     a. Prohibit the flash mix pump from running when:
        1) The plant influent valve is closed.
  7. OIT control:
     a. Start/Stop
     b. Reset elapsed time
  8. HMI control:
     a. Start/Stop

b. Reset elapsed time

9. Indicators and alarms:
   a. Elapsed time number
   b. Software HOA
   c. Running status
   d. Failed alarm
   e. Remote status
10. PLC Logic:
    a. Flash_mix_pump.aoi

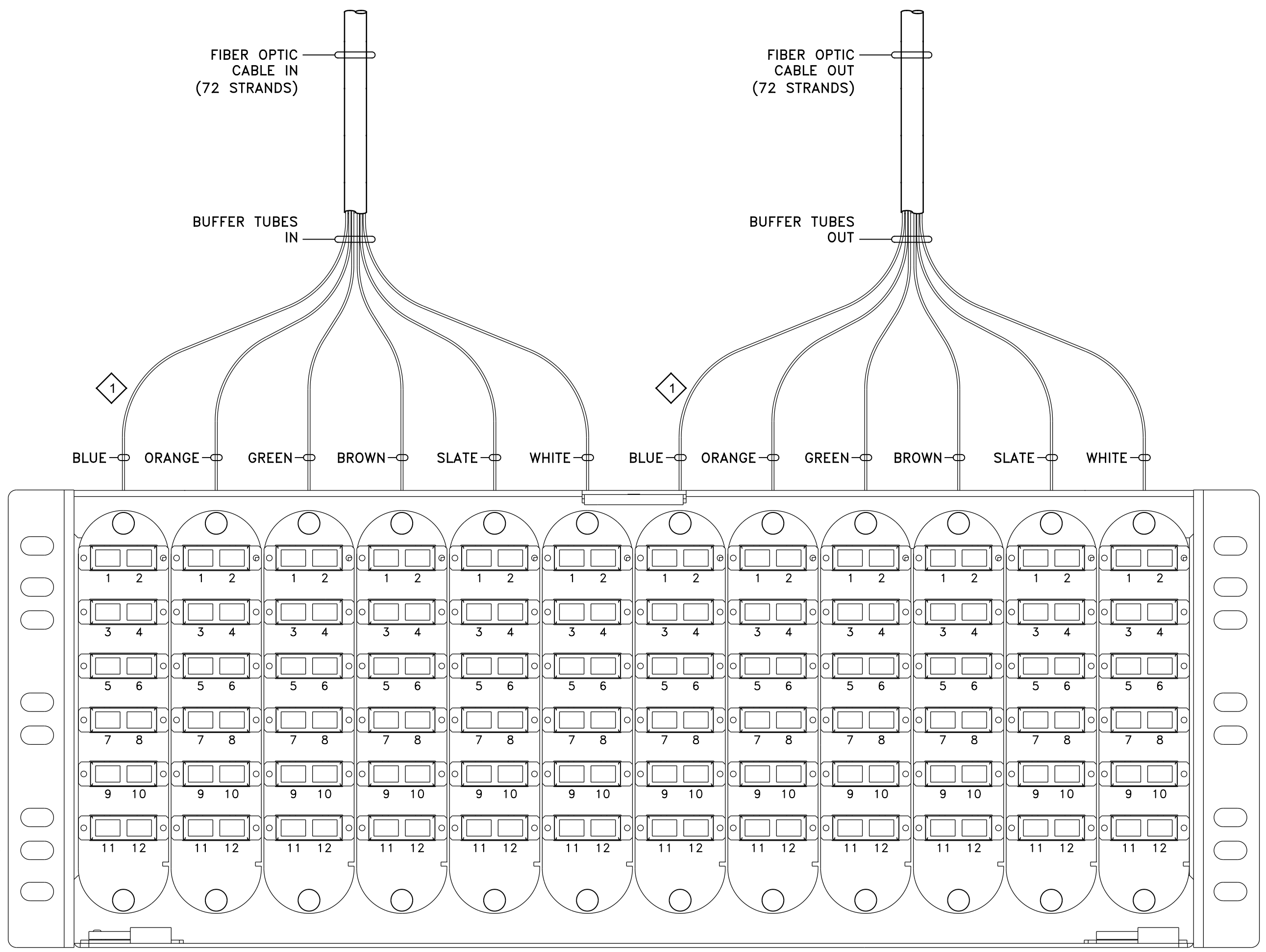
APPENDIX A4 – FIBER PATCHING DIAGRAMS

KEY NOTES:

1. EACH BUFFER TUBE CONTAINED WITHIN THE FIBER OPTIC CABLE HAS 12 FIBER OPTIC STRANDS WITHIN IT THAT ARE COLOR CODED AS SHOWN IN TABLE NO. 1.

PORT NO.	STRAND COLOR	PORT NO.	STRAND COLOR
1	BLUE	2	ORANGE
3	GREEN	4	BROWN
5	SLATE	6	WHITE
7	RED	8	BLACK
9	YELLOW	10	VIOLET
11	ROSE	12	AQUA

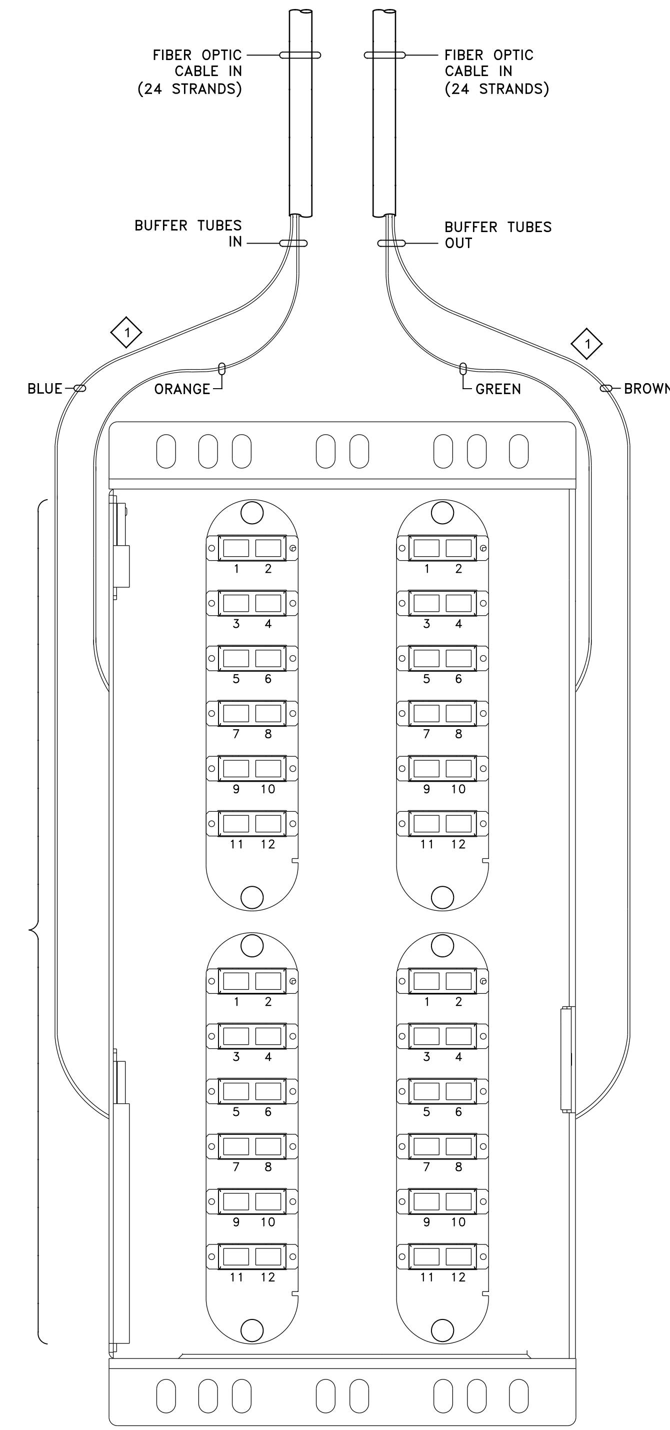
TABLE NO. 1



A FIBER OPTIC BACKBONE PATCH PANEL
FILE: 9265A00672.2dm

PORT NO.	STRAND COLOR	PORT NO.	STRAND COLOR
1	BLUE	2	ORANGE
3	GREEN	4	BROWN
5	SLATE	6	WHITE
7	RED	8	BLACK
9	YELLOW	10	VIOLET
11	ROSE	12	AQUA

TABLE NO. 1



B PLC PATCH PANEL
FILE: 9265A00672.2dm

Plot Date: 28-MAY-2014 3:35:40 PM User: BRoepken PlotScale: 2:1 DesignScript: Carollo_Std_Pen_v0905.pen ColorTable: gshade.ctb Model: Layout1

LAST SAVED BY: awulff

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SAMPLE FIBER OPTIC PATCH PANEL DETAIL

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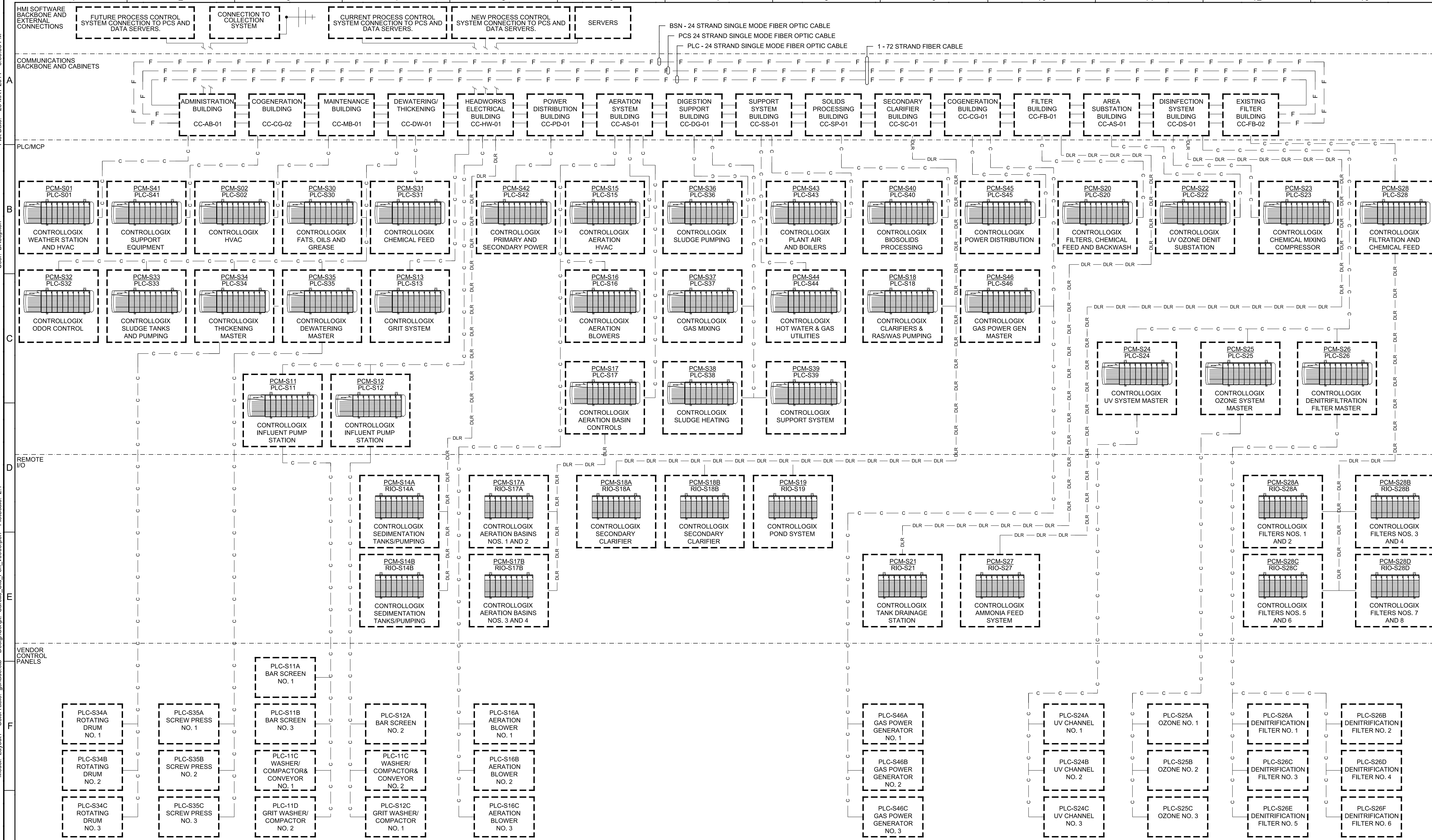
PROJECT NO. 9265A00 FILE NAME: 9265A00IC09.dgn

APPENDIX B – NETWORK AND COMMUNICATIONS



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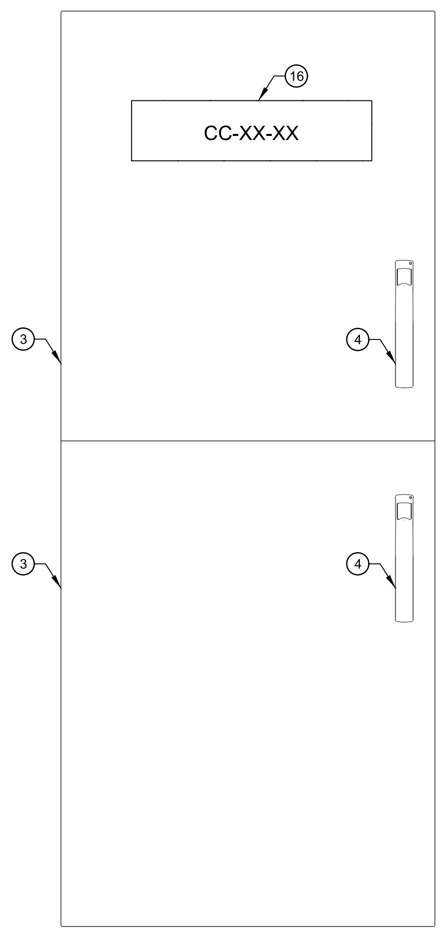
PROCESS CONTROL SYSTEM BLOCK DIAGRAM

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

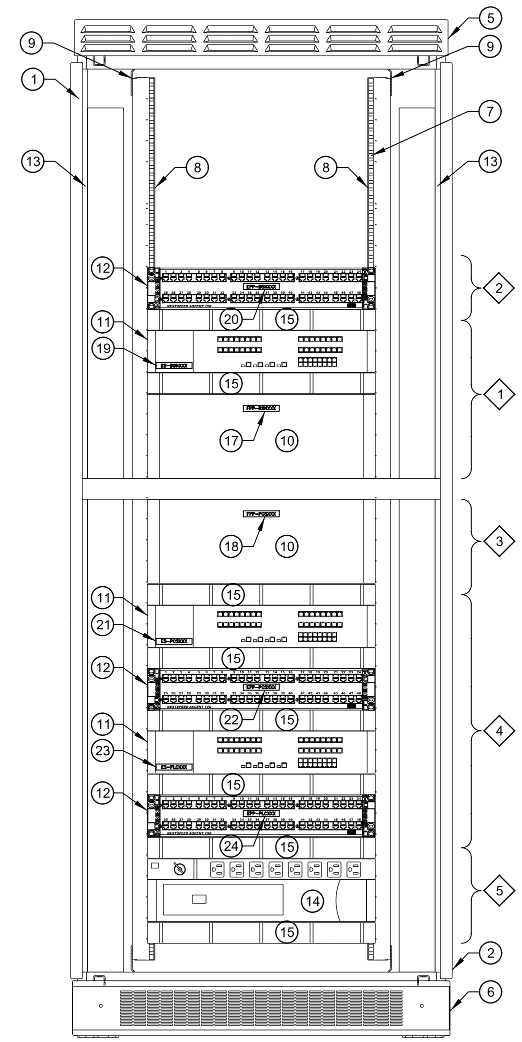
JOB NO. 9265A.00
DRAWING NO. IC10
SHEET NO. OF XX

LAST SAVED BY: crollins Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1 User: BRoepken Plot Date: 28-MAY-2014 3:35:53 PM

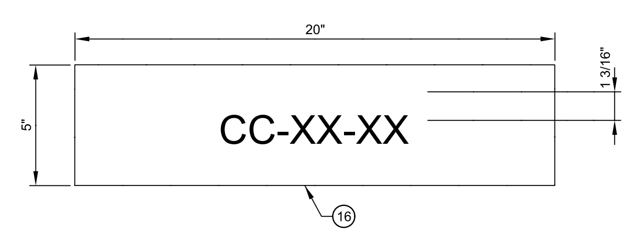
Plot Date: 28-MAY-2014 3:36:07 PM User: BRoepken PlotScale: 2:1 DesignScript: Carollo_Std_Pen_v0905.pen ColorTable: gshade.ctb Model: Layout1



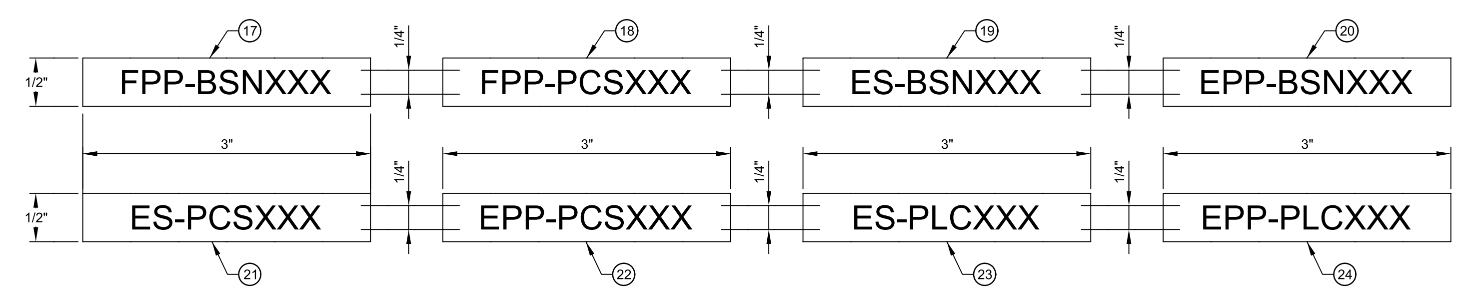
A FRONT PANEL
FILE: 9265A00N670.2dm



B FRONT INTERIOR
FILE: 9265A00N670.2dm



C NAMEPLATES
FILE: 9265A00N670.2dm



GENERAL NOTES:

1. ENCLOSURE DRAWING INDICATES DESIGN INTENT. CONTRACTOR WILL SUPPLY AS-BUILT DRAWINGS SHOWING ACTUAL ENCLOSURE LAYOUT WITH EQUIPMENT MANUFACTURER, PART NUMBER AND PART COUNT.
2. REFER TO RELATED ELECTRICAL DRAWINGS FOR LOCATION OF ENCLOSURE.
3. SECURE ENCLOSURE TO FLOOR FOLLOWING MANUFACTURER'S RECOMMENDATIONS.
4. RIGHT SIDE OF ENCLOSURE HAS THE FOLLOWING ITEMS: RIGHT-HAND RACK ANGLES, RIGHT-HAND ADJUSTABLE RACK MOUNTING RAIL, RIGHT-HAND VERTICAL 3"X3" WIREWAYS ARE NOT SHOWN FOR DRAWING CLARITY.
5. PROVIDE ANY ADDITIONAL ASSEMBLY HARDWARE, BOLTS, CAGE NUTS, SCREWS, MOUNTING PLATES, ETC.., NEEDED TO COMPLETE THIS ENCLOSURE.

KEY NOTES:

- 1 BUSINESS NETWORK FIBER
- 2 BUSINESS NETWORK ETHERNET
- 3 PCS AND PLC NETWORK FIBER
- 4 PCS AND PLC NETWORK ETHERNET
- 5 POWER DISTRIBUTION

BILL OF MATERIALS

ITEM	DESCRIPTION
1	ENCLOSURE FRAME
2	SIDE, SOLID
3	DOOR, SOLID
4	HANDLE, KEY LOCKING FLUSH
5	VENTED TOP WITH INTEGRAL 3 - FAN KIT
6	PLINTH BASE WITH VENTED COVERS
7	POWER DISTRIBUTION UNIT, 120VAC VERTICAL MOUNT
8	19" RACK ANGLES, SQUARE HOLES
9	ADJUSTABLE RACK MOUNTING RAILS
10	FIBER OPTIC PATCH PANEL
11	ETHERNET SWITCH
12	CAT 6 PATCH PANEL
13	SLOTTED WIRE DUCT WITH COVER
14	UPS, RACK MOUNTED
15	WIRE MANAGEMENT SYSTEM
16	NAMEPLATE
17	NAMEPLATE
18	NAMEPLATE
19	NAMEPLATE
20	NAMEPLATE
21	NAMEPLATE
22	NAMEPLATE
23	NAMEPLATE
24	NAMEPLATE

REV	DATE	BY	DESCRIPTION

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CHECKED
DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

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CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE FIBER CABINET ENCLOSURE DETAIL
CLOSED CABINET

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC11
SHEET NO. OF XX

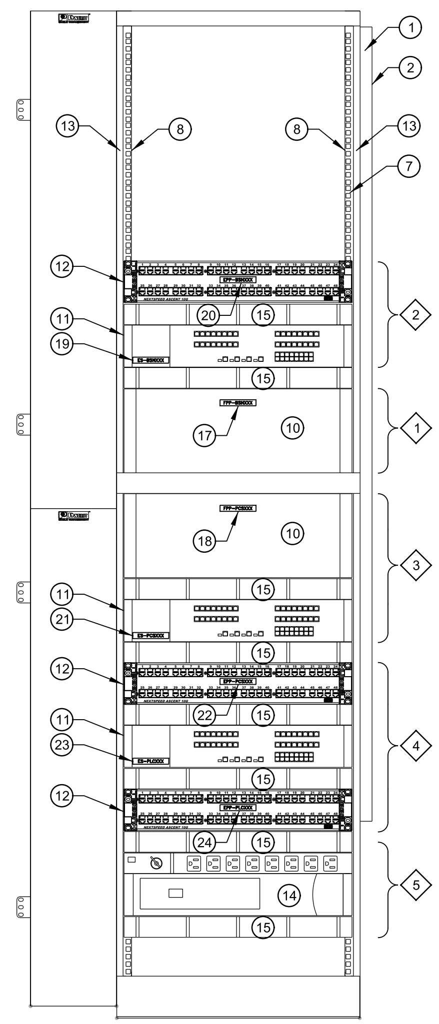
LAST SAVED BY: abuffone

PROJECT NO. 9265A00 FILE NAME: 9265A00IC11.dgn

Plot Date: 28-MAY-2014 3:36:21 PM User: BRoepken PlotScale: 2:1 DesignScript: Carollo_Std_Pen_v0905.pen ColorTable: gshade.ctb Model: Layout1

GENERAL NOTES:

1. ENCLOSURE DRAWING INDICATES DESIGN INTENT. CONTRACTOR WILL SUPPLY AS-BUILT DRAWINGS SHOWING ACTUAL ENCLOSURE LAYOUT WITH EQUIPMENT MANUFACTURER, PART NUMBER AND PART COUNT.
2. REFER TO RELATED ELECTRICAL DRAWINGS FOR LOCATION OF THE JUNCTION BOX.
3. SECURE RACK TO FLOOR FOLLOWING MANUFACTURER'S RECOMMENDATIONS USING APPROVED ANCHORS AND EPOXY.



A **FRONT PANEL**

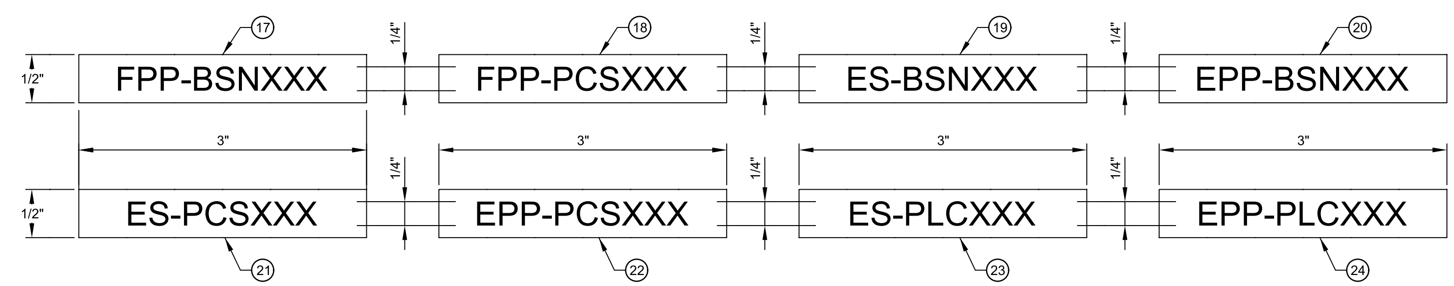
FILE: 9265A00N671.2dm

BILL OF MATERIALS

ITEM	DESCRIPTION
1	ENCLOSURE FRAME
2	SIDE, SOLID
3	NOT USED
4	NOT USED
5	NOT USED
6	NOT USED
7	POWER DISTRIBUTION UNIT, 120VAC VERTICAL MOUNT
8	19" RACK ANGLES, SQUARE HOLES
9	NOT USED
10	FIBER OPTIC PATCH PANEL
11	ETHERNET SWITCH
12	CAT 6 PATCH PANEL
13	SLOTTED WIRE DUCT WITH COVER
14	UPS, RACK MOUNTED
15	WIRE MANAGEMENT SYSTEM
16	NOT USED
17	NAMEPLATE
18	NAMEPLATE
19	NAMEPLATE
20	NAMEPLATE
21	NAMEPLATE
22	NAMEPLATE
23	NAMEPLATE
24	NAMEPLATE

KEY NOTES:

1. BUSINESS NETWORK FIBER
2. BUSINESS NETWORK ETHERNET
3. PCS AND PLC NETWORK FIBER
4. PCS AND PLC NETWORK ETHERNET
5. POWER DISTRIBUTION



B **NAMEPLATES**

FILE: 9265A00N671.2dm

REV	DATE	BY	DESCRIPTION

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PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

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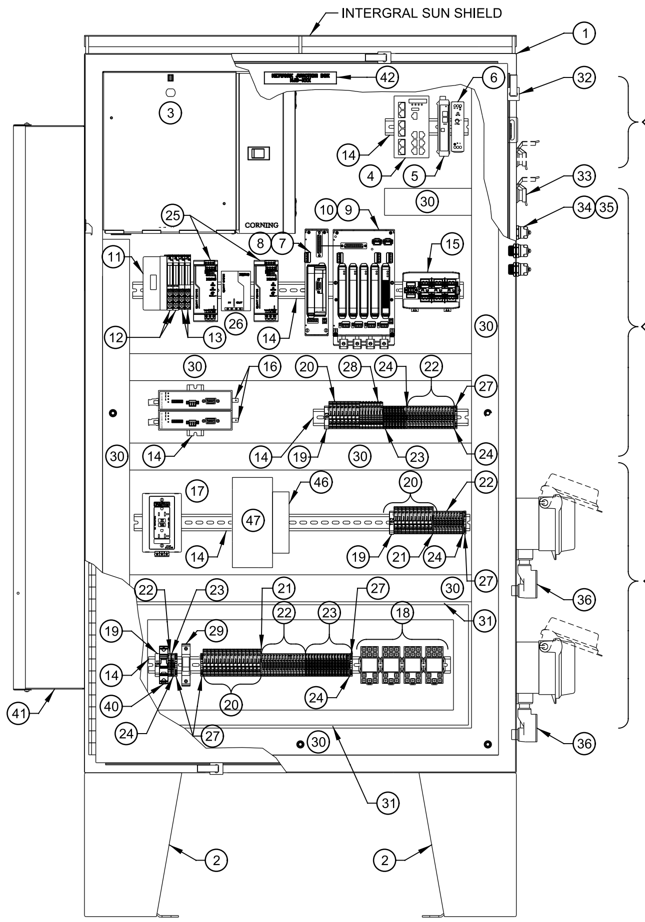
CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE FIBER CABINET ENCLOSURE DETAIL
OPEN CABINET

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC12
SHEET NO. OF XX

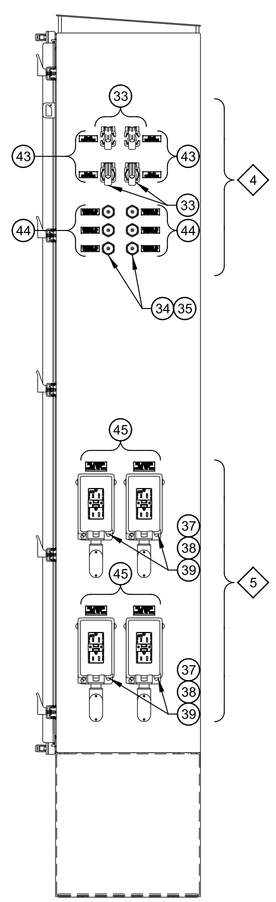
LAST SAVED BY: abuffone

PROJECT NO. 9265A00 FILE NAME: 9265A00IC12.dgn



A PANEL LAYOUT

FILE: 9265A00N673.2dm



B RIGHT SIDE LAYOUT

FILE: 9265A00N673.2dm

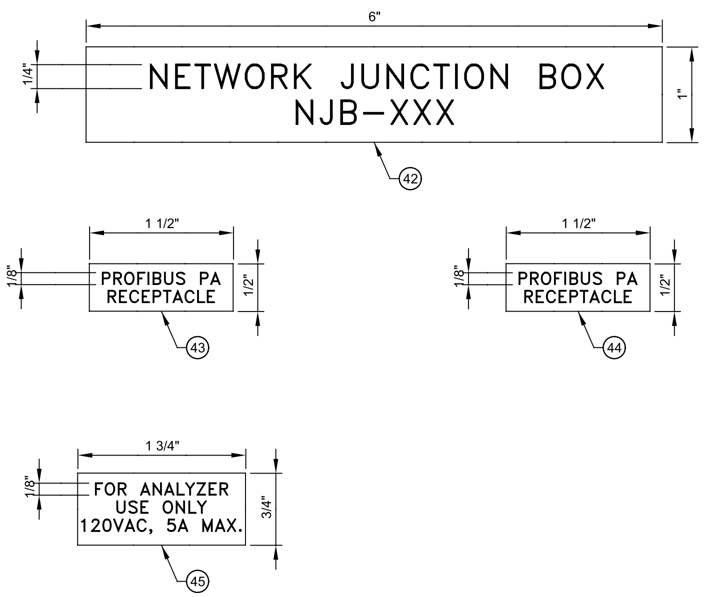
MAJOR EQUIPMENT SCHEDULE		
ITEM	QUANITY	DESCRIPTION
1	1	ENCLOSURE, NEMA 4Z, 316 STAINLESS STEEL W/INTEGRAL SUN SHIELD 60"H x 36"W x 12"D. SUB PANEL, STEEL 57"H x 33"W
2	1	FLOOR STAND KIT FOR ENCLOSURE
3	1 2	FIBER PATCH PANEL WALL MOUNT WITH 12-FIBER SC TYPE CONNECTORS
4	1	9 PORT FAST EHTERNET SWITCH DIN RAIL MOUNT
5	1	RS-485 (MODBUS RTU TO FIBER OPTIC CONVERTOR
6	1	POWER SUPPLY, RS-485 TO FIBER OPTIC CONVERTOR
7	1	MOTHERBOARD FOR DP/PA GATEWAY
8	1	PROFIBUS DP/PA GATEWAY
9	1	MOTHERBOARD FOR POWER AND DIAGNOSTIC MODULES
10	2 1	POWER MODULES WITH ADVANCED DIAGNOSTIC MODULE
11	1	GATEWAY, FIELD I/O TO PROFIBUS DP DIN RAIL MOUNT
12	2 2	DISCRETE INPUT MODULES BASE MODULE TERMINATIONS, DIN RAIL MOUNT
13	2 2	ANALOG INPUT MODULES BASE MODULE TERMINATIONS, DIN RAIL MOUNT
14	AS NEEDED	DIN RAIL
15	1	PROFIBUS PA SEGMENT PROTECTOR DIN RAIL MOUNT
16	2	RS-485 PROFIBUS TO FIBER OPTIC CONVERTOR
17	1	RECEPTACLE, 20A, GFCI, DIN RAIL MOUNT
18	4	RELAY SOCKET PULLOVER WIRE SPRING
19	3 3	END BRACKET TERMINAL STRIP MARKER AND INSERT
20	33	FUSE TERMINAL BLOCK
21	2	END SECTION
22	42	TERMINAL BLOCK
23	24	GROUND TERMINAL BLOCK
24	5	END SECTION
25	2	POWER SUPPLY, PRIMARY SWITCHED, REDUNDANT DIN RAIL MOUNT
26	1	QUINT DIODE REDUNDANCY MODULE
27	5	END BRACKET
28	8	KNIFE DISCONNECT TERMINAL BLOCKS WITH TEST SOCKET SCREW
29	1	SURGE PROTECTION DEVICE
30	AS NEEDED	SURFACE WIREWAY, 2 INCH WIDE x 4 INCH HIGH WITH COVER (FOR 24VDC)
31	AS NEEDED	SURFACE WIREWAY, 1 INCH WIDE x 4 INCH HIGH WITH COVER (FOR 120 VAC)
32	AS NEEDED	FAST-OPERATING CLAMP ASSEMBLY
33	2	RJ45 RECEPTACLE WITH SELF CLOSING CAP
34	6	PROFIBUS PA RECEPTACLE, FEMALE, PANEL MOUNT, MINIFAST
35	6	CONNECOTR COVER WITH 6" LANYARD FOR ITEM 34
36	4	SLB ELBOW, 1/2" HUBS, COPPER-FREE ALUMINUM
37	4	FS CAST BOX, 1/2" HUB, COPPER-FREE ALUMINUM
38	4	IN-USE WEATHERPROOF COVER, SINGLE GANG, VERTICAL MOUNT NON-METALIC HIGH IMPACT POLYCARBONATE
39	4	15A, 120VAC GFCI RECEPTACLE, BLACK WEATHER AND TAMPER RESISTANT
40	1	CIRCUIT BREAKER, SINGLE POLE, 30A, DIN RAIL MOUNT WEATHER AND TAMPER RESISTANT
41	1	HEAT EXCHANGE, 115V, 60HZ 316 STAINLESS STEEL, WHITE POWDER COATED PAINT
42	1	NAMEPLATE
43	2	NAMEPLATE
44	6	NAMEPLATE
45	4	NAMEPLATE
46	1	QUINT UPS
47	1	BATTERY UNIT

GENERAL NOTES:

1. ENCLOSURE DRAWING INDICATES DESIGN INTENT. CONTRACTOR WILL SUPPLY AS- BUILT DRAWINGS SHOWING ACTUAL ENCLOSURE LAYOUT WITH EQUIPMENT MANUFACTURER, PART NUMBER, AND PART COUNT.
2. REFER TO RELATED ELECTRICAL DRAWINGS FOR LOCATION OF THE JUNCTION BOX.
3. POWER SUPPLIES, ITEM 25, SIZED FOR LOADS SHOWN. PROVIDE ADEQUATELY SIZED POWER SUPPLIES IF LOADS INCREASE OR DECREASE.
4. FOR ITEM 11, REFER TO RELEVANT WIRING DIAGRAM FOR TYPE AND NUMBER OF REQUIRED I/O CARDS.
5. REFERENCE INDIVIDUAL NJB WIRING DIAGRAMS TO DETERMINE THE EXACT NUMBER OF EXTERNAL PA RECEPTACLES REQUIRED PER NJB.

KEY NOTES:

1. PLC FIELD NETWORK CONNECTIONS
2. FIELD DEVICE CONNECTIONS (PROFIBUS DP/PA)
3. POWER DISTRIBUTION (120VAC AND 24VDC)
4. EXTERNAL FIELD DEVICE CONNECTIONS
5. EXTERNAL DEVICE POWER



C NAMEPLATES

FILE: 9265A00N673.2dm

REV	DATE	BY	DESCRIPTION

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PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

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CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE NETWORK JUNCTION BOX TYPE 1

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

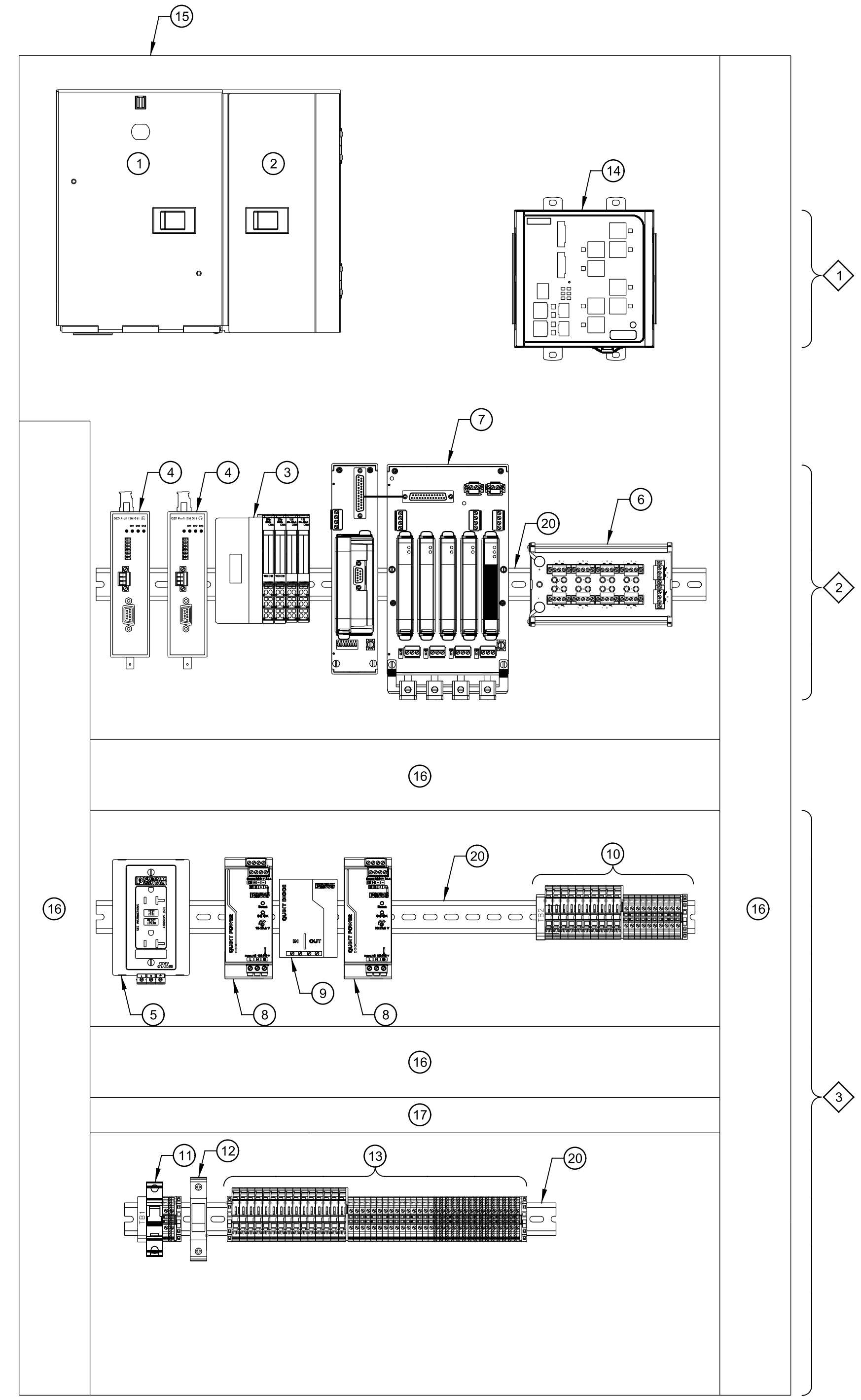
JOB NO. 9265A.00
DRAWING NO. IC13
SHEET NO. OF XX

GENERAL NOTES:

1. PANEL CONSTRUCTION SHALL MEET THE FULL INTENT OF ARTICLE 409 IN THE NEC.
2. PROVIDE LABEL INDICATION INTEGRATOR'S LOGO MOUNTED ON THE FRONT EXTERIOR OF THE CABINET.
3. USE UL 508A SUPPLEMENT SB TO DETERMINE SHORT CIRCUIT RATINGS.

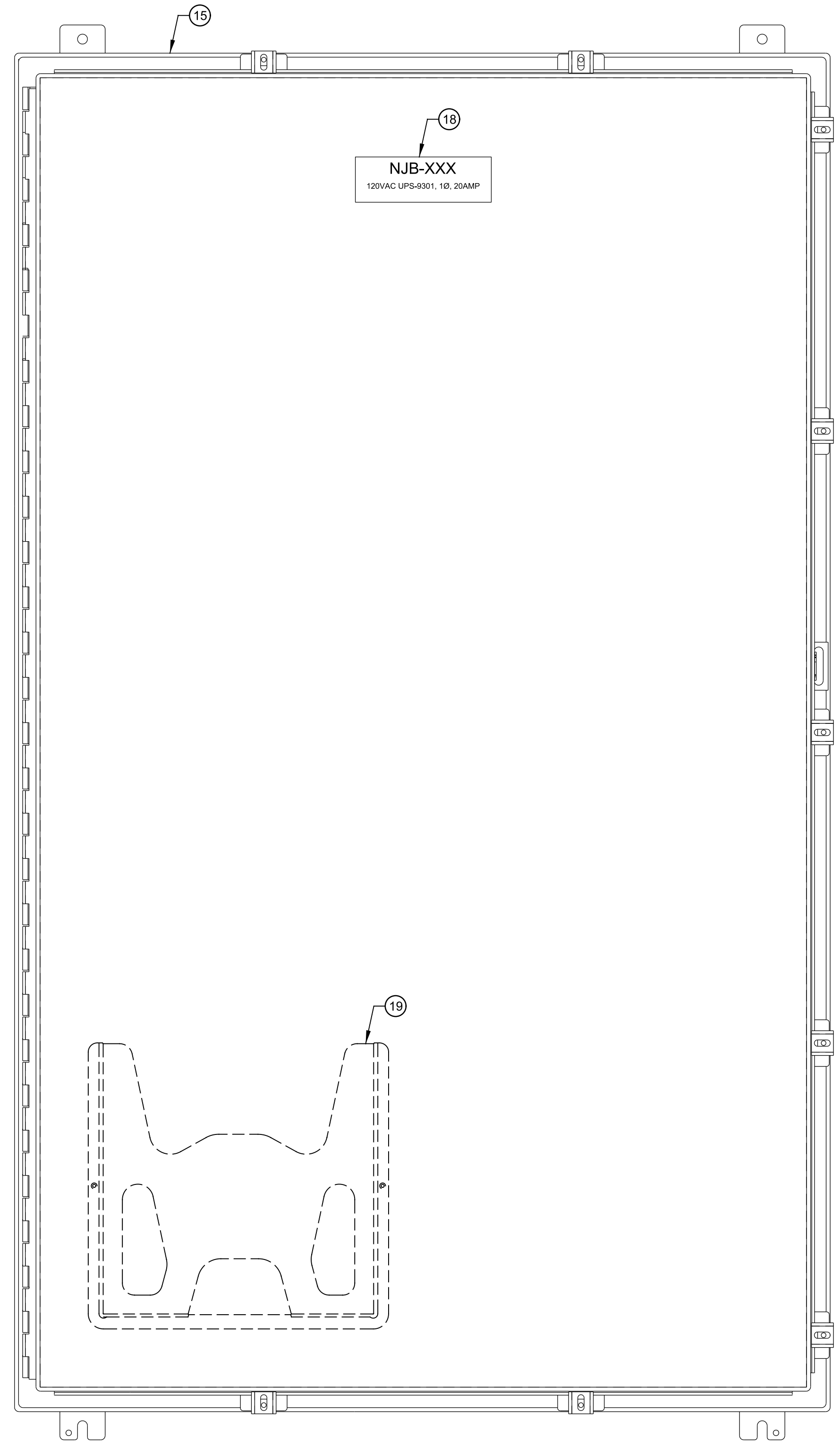
KEY NOTES:

1. PLC FIELD NETWORK CONNECTIONS
2. FIELD DEVICE CONNECTIONS (PROFIBUS DP/PA)
3. POWER DISTRIBUTION (120VAC AND 24VDC)



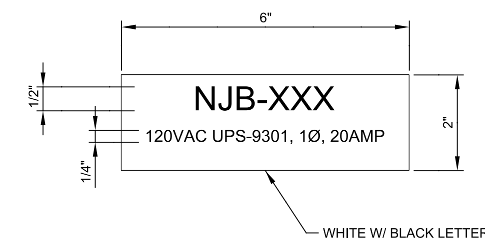
A INTERIOR ELEVATION

SCALE: 3" = 1'-0"
FILE: 9265A0000N674.2dm



B EXTERIOR ELEVATION

SCALE: 3" = 1'-0"
FILE: 9265A0000N674.2dm



C NAMEPLATE DETAIL

SCALE: NTS
FILE: 9265A0000N674.2dm

MAJOR EQUIPMENT SCHEDULE	
ITEM	DESCRIPTION
1	FIBER CLOSET HOUSING
2	FIBER OPTIC BULKHEAD (SM)
3	BL-20 PROFIBUS I/O MODULE
4	FIBER TO PROFIBUS DP TRANSCIEVER
5	120VAC RECEPTACLE (5A MAX.)
6	PROFIBUS PA BRICK, 8 CHANNEL
7	PROFIBUS GATEWAY, MOTHERBOARD, POWER SUPPLY, AND DIAGNOSTIC MODULE
8	24VDC POWER SUPPLY
9	24VDC REDUNDANNT DIODE
10	24VDC POWER DISTRIBUTION
11	120VAC POWER CONNECTION W/ 20 AMP CIRCUIT BREAKER
12	SPD - 120VAC IP
13	120VAC POWER DISTRIBUTION
14	ETHERNET SWITCH
15	WALL MOUNTED ENCLOSURE, NEMA 4X, 304 SS, 60"x36"x16" WITH SUB PANEL
16	WIREWAY - PANEL CHANNEL 3 INCH
17	WIREWAY - PANEL CHANNEL 1.5 INCH
18	NAMEPLATE
19	DATA POCKET
20	DIN RAIL

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE NETWORK JUNCTION BOX TYPE 2

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

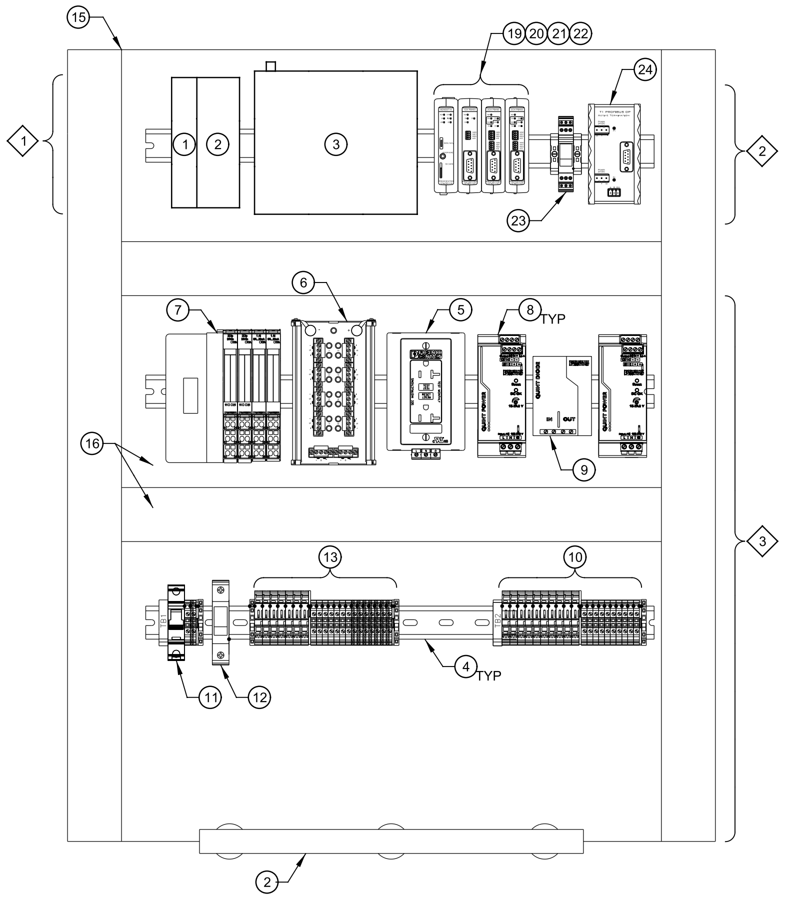
JOB NO. 9265A.00
DRAWING NO. IC14
SHEET NO. OF XX

GENERAL NOTES:

1. PANEL CONSTRUCTION SHALL MEET THE FULL INTENT OF ARTICAL 409 IN THE NEC.
2. USE UL 508A SUPPLEMENT SB TO DETERMAIN SHORT CIRCUIT RATINGS.

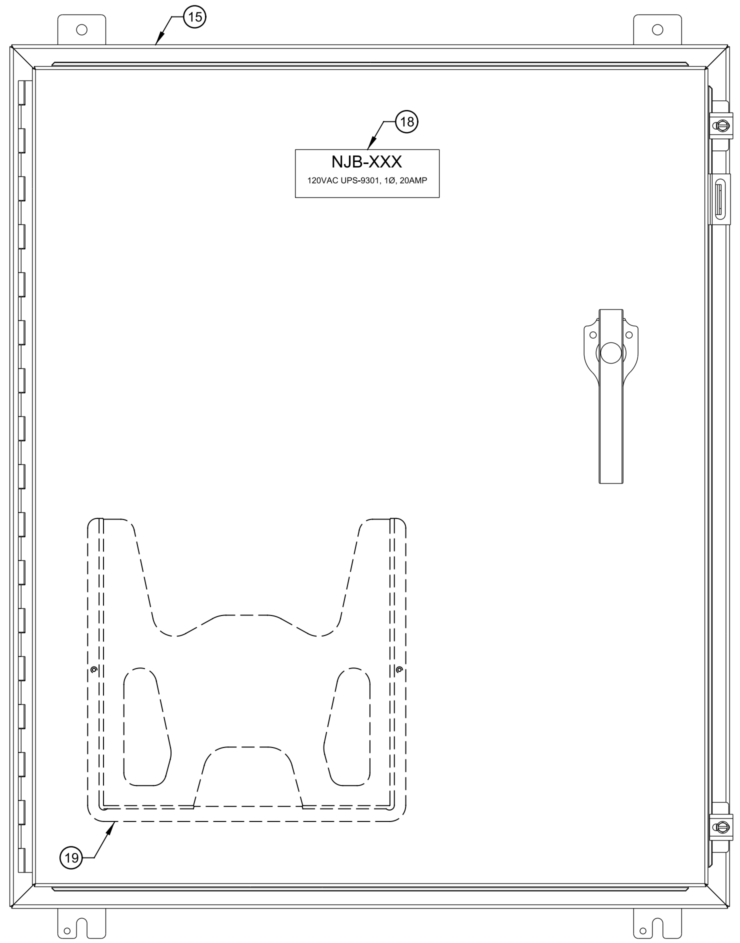
KEY NOTES:

1. PLC FIELD NETWORK CONNECTIONS
2. FIELD DEVICE CONNECTIONS (PROFIBUS DP/PA)
3. POWER DISTRIBUTION (120VAC AND 24VDC)



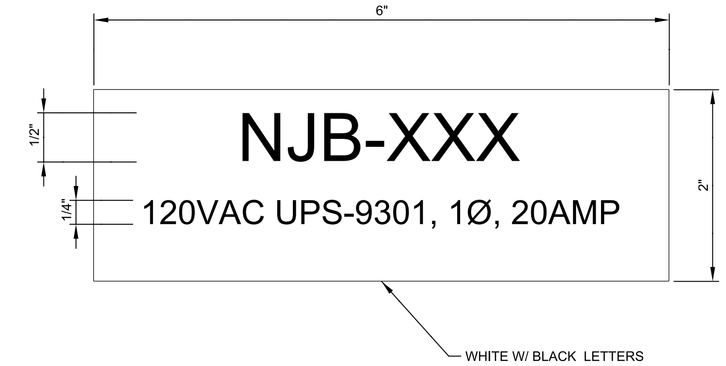
A INTERIOR ELEVATION

SCALE: 3" = 1'-0"
FILE: 9265A0000N675.2dm



B EXTERIOR ELEVATION

SCALE: 3" = 1'-0"
FILE: 9265A0000N675.2dm



C NAMEPLATE DETAIL

SCALE: NTS
FILE: 9265A0000N675.2dm

MAJOR EQUIPMENT SCHEDULE

ITEM	DESCRIPTION
1	FIBER PATCH PANEL
2	CAT6 PATCH PANEL
3	ETHERNET SWITCH
4	DIN RAIL
5	120VAC RECEPTACLE (5A MAX.)
6	PROFIBUS PA BRICK, 8 CHANNEL
7	POINT I/O RIO
8	24VDC POWER SUPPLY
9	24VDC REDUNDANNT DIODE
10	24VDC POWER DISTRIBUTION
11	120VAC POWER CONNECTION W/ 20 AMP CIRCUIT BREAKER
12	SPD - 120VAC IP
13	120VAC POWER DISTRIBUTION
14	GROUND BAR
15	WALL MOUNTED ENCLOSURE, NEMA 4X, WITH SUB PANEL
16	WIREWAY - PANEL CHANNEL 2 INCH WIDTH, 4 INCH DEPTH
17	DATA POCKET
18	NAMEPLATE
19	PROFIBUS DP/PA GATEWAY AND DIAGNOSTIC MODULE
20	PROFIBUS REPEATER MODULE
21	PROFIBUS FIBER REPEATER MODULE
22	PROFIBUS DP/PA COUPLER
23	PROFIBUS SURGE PROTECTOR
24	ACTIVE PROFIBUS SEGMENT TERMINATOR

REV	DATE	BY	DESCRIPTION

DESIGNED
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DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

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CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE NETWORK JUNCTION BOX TYPE 3

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC15
SHEET NO. OF XX

APPENDIX C – TAG NAMING STANDARDS

Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1 User: Dlmada Plot Date: 02-JUN-2014 10:37:58 AM

EQUIPMENT TAGGING SYSTEM

EQUIPMENT

EXAMPLE: PMP-15-410 INFLUENT PUMP NO. 1 REPRESENTS MAJOR PIECE OF EQUIPMENT

XXX-AA-BBB

XXX EQUIPMENT DESCRIPTOR

XXX			
AEB	Aeration Basin	FDR	FeeDeR
AER	AERator	FLT	FiLTer
AHU	Air Handling Unit	FLA	FLAre
ARC	AiR Compressor	FLO	FLOcculator
AND	ANerobic Digester	FU	FUse
ARF	AiR Filter	GAT	GATe
ARR	ARRestor	GRI	GRInder
AUG	AUGer	GRC	GRit Chamber
AVR	Air Vacuum Relief	HAM	Hydraulic Analog Modulating
BAR	BAR screen		valve actuator
BAS	BASin	HDM	Hydraulic Discrete Modulating
BC	Bypass Contactor		valve actuator
BFP	Belt Filter Press	HDR	Hydraulic Discrete Run open /
BIT	Bio Tower		run close valve actuator
BLO	BLOwer	HEA	HEAter
BOI	BOIler	IC	Isolation Contactor
BUR	BURner	INJ	INJector
CAL	CALibration Column	LAG	LAGoon
CB	Circuit Breaker	MAU	Make-up Air Unit
CEN	CENtrifuge	MIX	MIXer
CHI	CHIller	MMS	Magnetic Motor Starter
CHL	CHLorinator	MPR	Motor Protection Relay
CLR	CLaRifier	MTR	MoToR
CLA	CLAssifer	NAM	pNeumatic Analog Modulating
CLU	CLUtch		valve actuator
COA	COAlescer	NDM	pNeumatic Discrete Modulating
COL	COLlector		valve actuator
COS	COmposite Sampler	NDR	pNeumatic Discrete Run open /
CON	CONveyor		run close valve actuator
COO	COOler	PLO	PLOw
CPT	Control Power Transformer	PPR	Pump Protection Relay
CR	Control Relay	PRE	PREss
DAM	DAMper	PUD	PUlsation Dampner
DEC	DECarbonator	PMP	PuMP
DCD	DC Drive	REC	RECeiver
DIF	DIFfuser	RES	REServoir
DIS	DIStributor	SCB	SCruBber
DRY	DRYer	SCR	SCReen
DSC	DuSt Collector	SEL	SEaL
EAM	Electric Analog Modulating	SHA	SHAker
	valve actuator	SLA	SLAker
EDM	Electric Discrete Modulating	SLC	SLudge Collector
	valve actuator	STR	STRainer
EDR	Electric Discrete Run open /	SUF	SUpply Fan
	run close valve actuator	SV	Solenoid Valve
EDU	EDUctor	TNK	TaNK
ENG	ENgine Generator	THI	THIckener
EUH	Electrical Unit Heater	TRA	TRAp
EVP	EVaPorator	UVR	Ultra Violet Reactor
EXC	EXChanger	VAL	VALve
EXF	EXhaust Fan	VFD	Variable Frequency Drive
FAN	FAN	WEL	WELl

PROCESS TAGGING

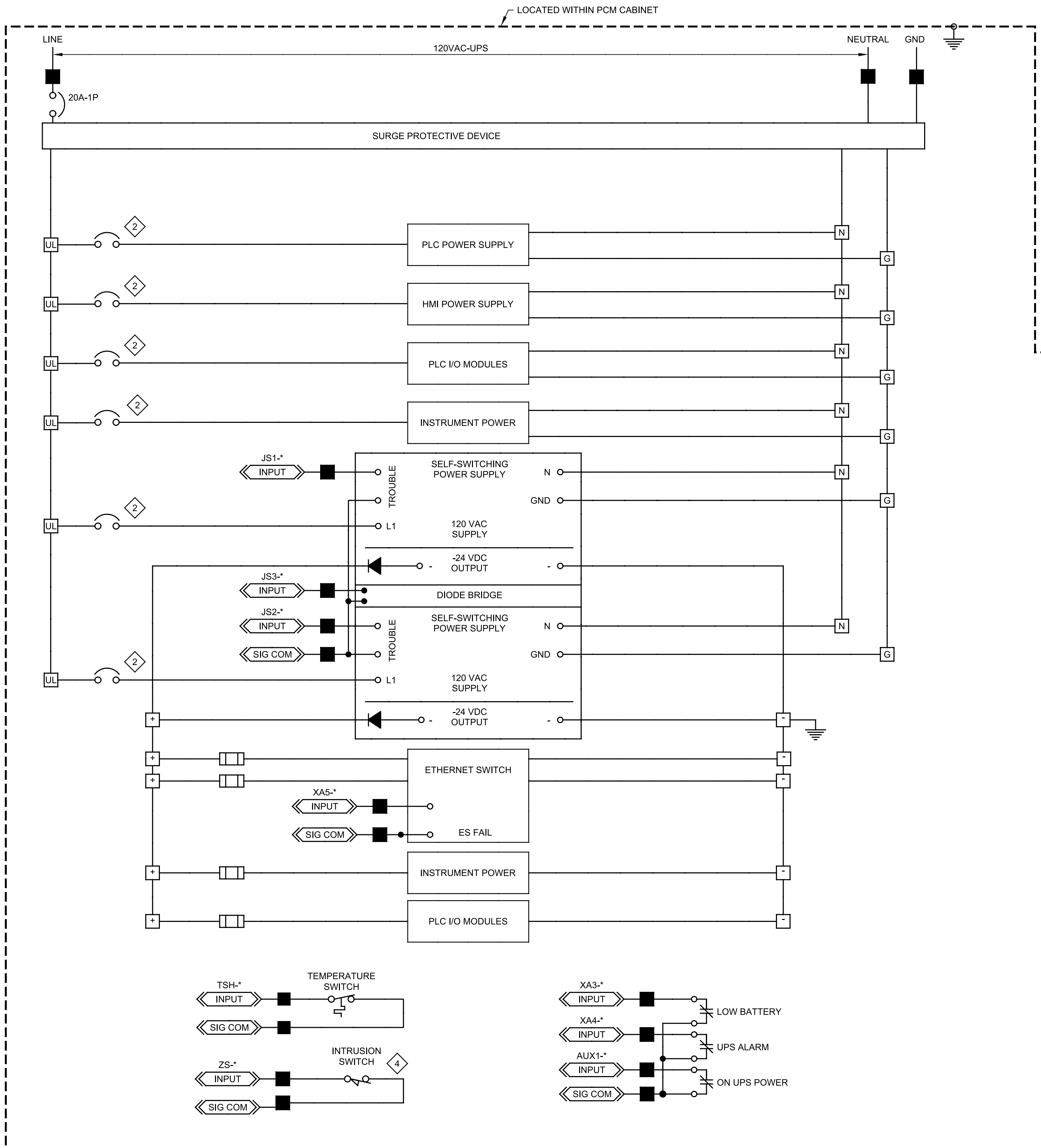
AA	BBB	
00		**INSTRUMENTATION**
	000	
	100	ELECTRICAL EQUIPMENT
	200	PCMs
	300	STANDBY POWER
	400	
	500	
	600	
	700	
	800	
	900	
05		**SUPPORT FACILITIES - MISCELLANEOUS**
	000	FIRE SYSTEM
	100	SECURITY SYSTEM
	200	POWER MANAGEMENT
	300	
	400	
	500	
	600	
	700	
	800	
	900	
09		**SITE WASTE PUMP STATION**
	000	SYSTEM WIDE
	100	
	200	
	400	
	500	
	600	
	700	
	800	SAMPLING AND ANALYZERS
	900	
10		**SCREENINGS FACILITIES**
	000	SYSTEM WIDE
	100	SCREENINGS
	200	SCREENINGS CONVEYANCE
	300	SCREENINGS COMPACTION
	400	
	500	
	600	
	700	
	800	
	900	
15		**INFLUENT PUMP STATION**
	000	SYSTEM WIDE
	100	WET WELL
	200	INFLUENT PUMPING
	300	TIPPING TROUGH
	400	
	500	
	600	
	700	
	800	SAMPLING AND ANALYZERS
	900	HVAC
20		**GRIT FACILITIES**
	000	SYSTEM WIDE
	100	GRIT BASIN INLET
	200	GRIT BASIN OUTLET
	300	GRIT BASIN
	400	GRIT PUMPING
	500	GRIT WASHING
	600	
	700	
	800	SAMPLING AND ANALYZERS
	900	HVAC

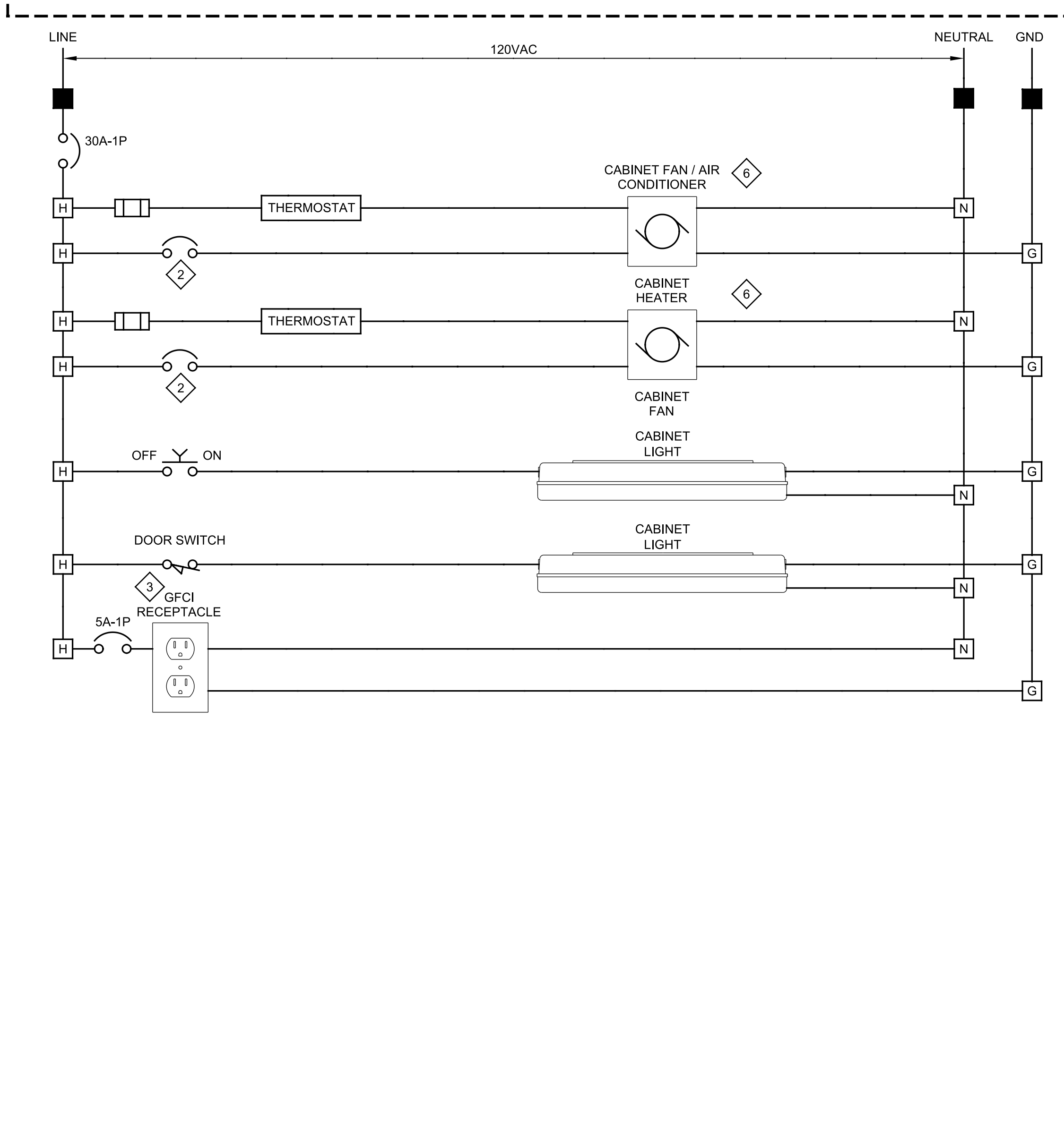
PROCESS TAGGING

AA	BBB	
22		**CHEMICAL ENHANCED PRIMARY TREATMENT**
	000	SYSTEM WIDE
	100	FERRIC LOADING/UNLOADING
	200	FERRIC STORAGE
	300	FERRIC FEED
	400	POLYMER LOADING/UNLOADING
	500	POLYMER STORAGE
	600	POLYMER FEED
	700	
	800	SAMPLING AND ANALYZERS
	900	
25		**PRIMARY SEDIMENTATION**
	000	SYSTEM WIDE
	100	CHAIN AND FLIGHT SLUDGE COLLECTORS
	200	SCUM PIPES
	300	PRIMARY SLUDGE PUMPS
	400	BLOWERS
	500	PRIMARY INFLUENT DISTRIBUTION CHANNELS
	600	PRIMARY SEDIMENTATION TANKS EFFLUENT CHANNELS
	700	PRIMARY EFFLUENT CHANNEL
	800	SAMPLING AND ANALYZERS
	900	HVAC
30		**ODOR CONTROL**
	000	SYSTEM WIDE
	100	
	200	
	300	
	400	
	500	
	600	
	800	SAMPLING AND ANALYZERS
	900	
32		**SUPPORT FACILITIES**
	000	SYSTEM WIDE
	100	UTILITY WATER SYSTEMS
	200	UTILITY WATER SYSTEMS
	300	IRRIGATION WATER
	400	HOT WATER SYSTEM
	500	STEAM SYSTEM
	600	NON-POTABLE WATER SYSTEM
	700	POTABLE WATER SYSTEM
	800	SAMPLING AND ANALYZER
	900	HVAC

REV | DATE | BY | DESCRIPTION
DESIGNED
DRAWN
CHECKED
DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL
CITY OF SUNNYVALE CALIFORNIA
CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
EQUIPMENT TAGGING SYSTEM
WASTEWATER TREATMENT
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY
JOB NO. 9265A.00
DRAWING NO. IC16
SHEET NO. OF XX
LAST SAVED BY: dimada
PROJECT NO. 9265A00 FILE NAME: 9265A00IC16.dgn

APPENDIX D – CONTROL PANEL STANDARDS





NOTES:

1. SCHEMATIC ILLUSTRATES DESIGN INTENT ONLY. PROVIDE ALL NECESSARY COMPONENTS TO MEET PROJECT REQUIREMENTS.

KEY NOTES:

1. SIZE UPS AND BATTERY BASED ON UPS SPECIFICATION REQUIREMENTS.
2. SIZE BASED ON PROTECTION NEEDS.
3. RECEPTACLE FOR LAPTOP.
4. PROVIDE QUANTITY REQUIRED. FOR A TWO-DOOR ENCLOSURE, A SINGLE LIMIT SWITCH IS ACCEPTABLE, PROVIDED IT IS INSTALLED TO SWITCH ON THE LAST DOOR TO CLOSE.
5. PROVIDE HARDWIRED CONNECTIONS OR RECEPTACLE/PLUG AS REQUIRED BY MAINTENANCE BYPASS SWITCH.
6. VERIFY LOADS BASED ON TEMPERATURE CALCULATIONS. PROVIDE ADDITIONAL CIRCUIT IF REQUIRED.

TERMINAL BLOCK LEGEND

Symbol	Description
■	PCM
H	120VAC
N	NEUTRAL
G	GROUND
UL	UPS 120VAC
+	24VDC (+)
-	24VDC (-)

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE

PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

CITY OF SUNNYVALE CALIFORNIA

CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE PLC POWER DISTRIBUTION PANEL

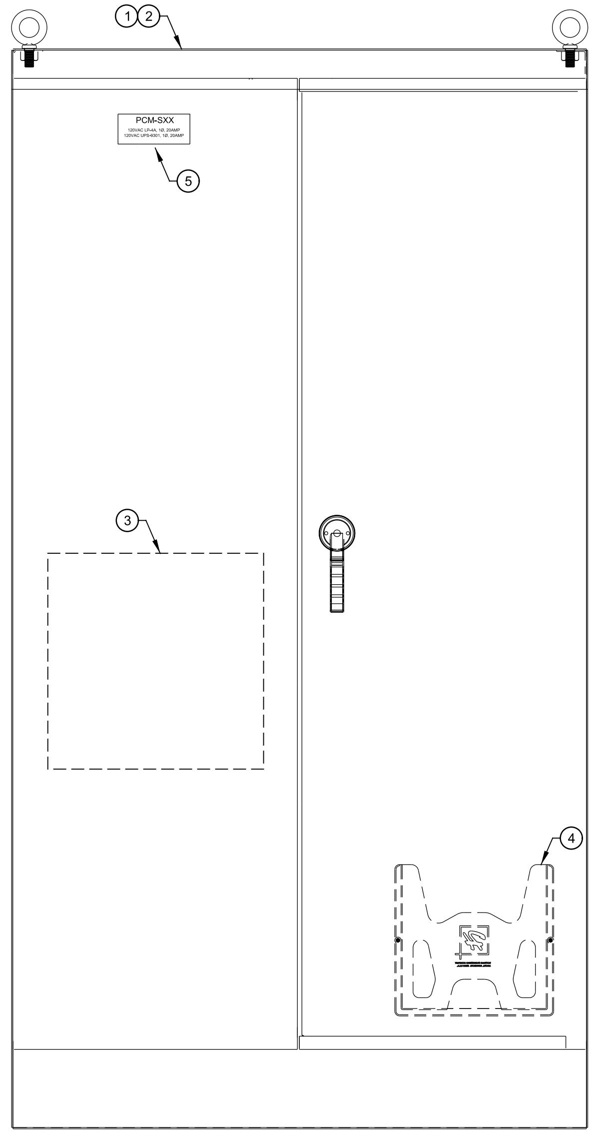
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC17
SHEET NO. OF XX

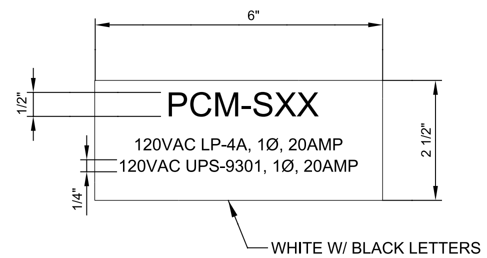
Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1 User: DImada Plot Date: 29-MAY-2014 3:42:12 PM
LAST SAVED BY: dimada
PROJECT NO. 9265A00 FILE NAME: 9265A00IC17.dgn

GENERAL NOTES:

1. PANEL CONSTRUCTION SHALL MEET THE FULL INTENT OF ARTICLE 409 IN THE NEC.
2. USE UL 508A SUPPLEMENT SB TO DETERMINE SHORT CIRCUIT RATINGS.
3. REFERENCE NETWORK DIAGRAMS XX TO XX AND XX TO XX FOR 120VAC PCM CIRCUIT DESIGNATIONS.



A PANEL TYPE 1
SCALE: NO SCALE
FILE: 8562F1000671.2dm



NAMEPLATE DETAIL

EQUIPMENT SCHEDULE	
ITEM	DESCRIPTION
1	ENCLOSURE, NEMA 12, FREE STANDING, 90"X48"X20"
2	ENCLOSURE, BACKPANEL, 78"X44"
3	FOLDING SHELF 18"X18"
4	DATA POCKET
5	NAMEPLATE (SEE SCHEDULE)

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

CITY OF SUNNYVALE CALIFORNIA

CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE PCM PANEL LAYOUT 48"
TYPE 1 EXTERNAL

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC18
SHEET NO. OF XX

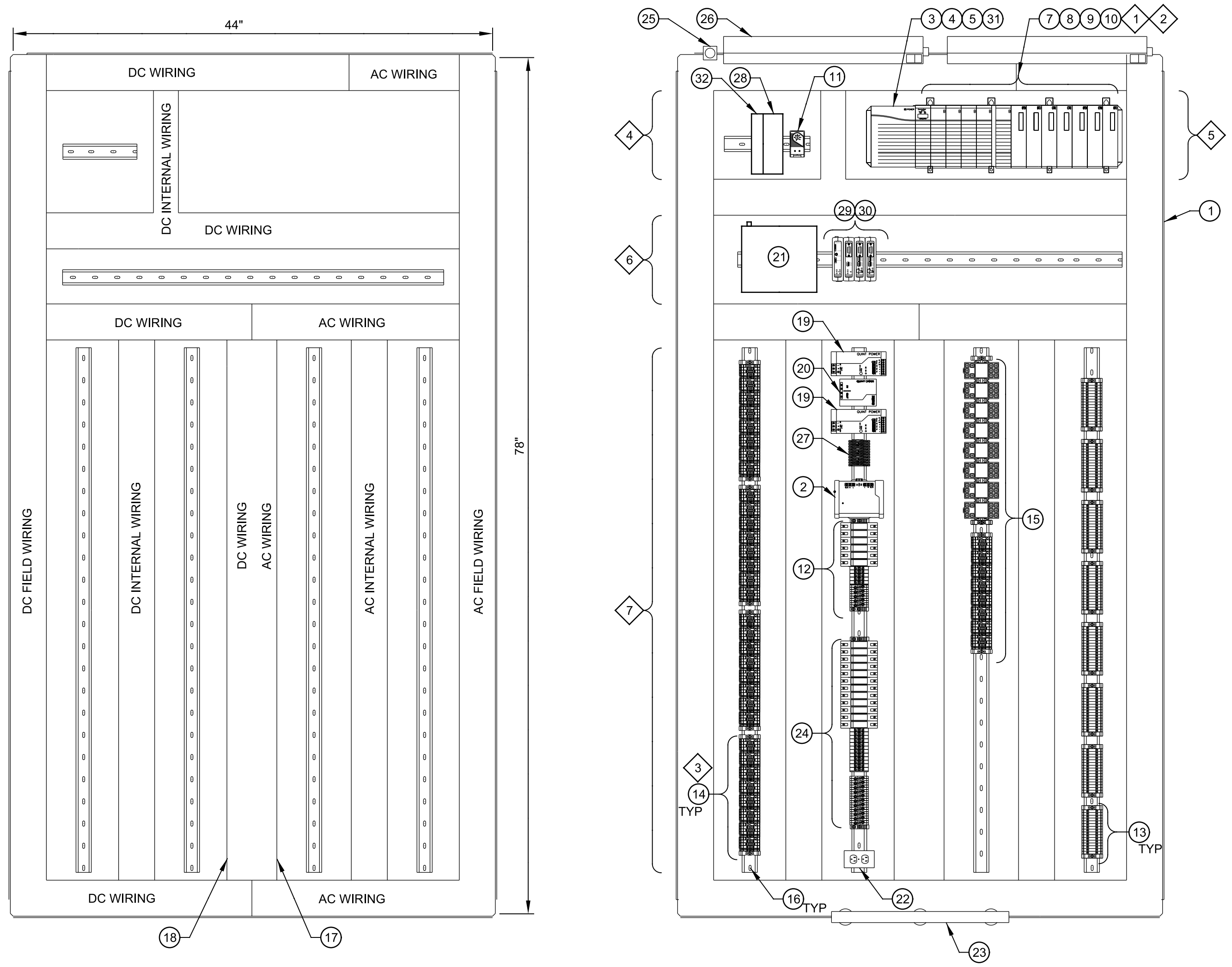
LAST SAVED BY: dimada Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1 User: DImada Plot Date: 29-MAY-2014 3:43:23 PM

GENERAL NOTES:

1. PANEL CONSTRUCTION SHALL MEET THE FULL INTENT OF ARTICAL 409 IN THE NEC.
2. PROVIDE LABLE INDICATION INTEGRATOR'S LOGO MOUNTED ON THE FRONT EXTERIOR OF THE CABINET.
3. USE UL 508A SUPPLEMENT SB TO DETERMAIN SHORT CIRCUIT RATINGS.
4. ENCLOSURE DRAWING INDICATES TYPICAL DESIGN INTENT. SUBMIT AND PROVIDE DRAWINGS SHOWING ACTUAL ENCLOSURE LAYOUT WITH EQUIPMENT MANUFACTURER, PART NUMBER, AND PART COUNT.
5. ALL TIE WRAPS SHALL BE LOCATED OUTSIDE OF THE WIRE DUCTS.
6. ELEVATE ALL DIN RAIL A MINIMUM OF 2 INCHES OFF OF BACK PANEL.
7. FILE FLAT ALL TIE WRAP ENDS. TIE WRAP CUTTING TOOL, NOT SIDE CUTTERS SHALL BE USED.
8. NO 480VAC CIRCUITS SHALL TERMINATE IN OR PASS THROUGH, CONTROL CABINETS.
9. NO CAMERA OR TELEPHONE CABLES SHALL TERMINATE IN OR PASS THROUGH CONTROL CABINETS.
10. ALL CONDUIT PENETRATIONS SHALL BE LOCATED IN THE TOP OR BOTTOM OF THE ENCLOSURE. NO SIDE, FRONT, OR REAR PENETRATIONS ALLOWED.
11. QUANITY OF COMPONETS VARIES AS REQUIRED FOR EACH CABINET.

KEY NOTES:

1. SPACE FOR COMMUNICATION MODULES AS REQUIRED.
2. SPACE FOR ANALOG, DISCRETE, AND SPACE I/O MODULES AS REQUIRED.
3. REFERENCE XX.
4. PATCH PANELS
5. PLC HARDWARE
6. FIELD NETWORK COMMUNICATIONS
7. INTERNAL POWER, EXTERNAL POWER AND TERMINAL STRIPS



A TYPE 1 PANEL

SCALE: NO SCALE
FILE: 8562F1000671.2dm

PCM LAYOUTS	
ITEM	DESCRIPTION
1	BACK PANEL
2	120VAC SURGE PROTECTOR
3	PLC POWER SUPPLY
4	CONTROLLOGIX PLC
5	COMMUNICATION MODULES - ETHERNET/IP
6	COPPER TO FIBER CONVERTERS
7	ANALOG INPUT MODULES
8	ANALOG OUTPUT MODULES
9	DIGITAL INPUT MODULES
10	DIGITAL OUTPUT MODULES
11	CABINET TEMPERATURE TRANSMITTER
12	PCM POWER DISTRIBUTION
13	DISCRETE TERMINAL BLOCKS
14	ANALOG TERMINAL BLOCKS
15	RELAY AND BASE - 4PDT
16	DIN RAIL
17	WIRE DUCT - NARROW SLOT, GRAY
18	WIRE DUCT - NARROW SLOT, WHITE
19	POWER SUPPLY, 24 VDC
20	REDUNDANCY MODULE
21	ETHERNET SWITCH
22	RECEPTACLE
23	GROUND BAR
24	POWER CIRCUITS FOR FIELD DEVICES
25	INTRUSION DOOR SWITCH
26	CABINET LIGHT WITH DOOR SWITCH
27	24 VDC POWER DISTRIBUTION TERMINALS
28	FIBER PATCH PANEL
29	COMMUNICATION MODULES
30	COMMUNICATIONS SURGE PROTECTORS
31	CONTROLLOGIX CHASSIS
32	COPPER PATCH PANEL

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

CITY OF SUNNYVALE CALIFORNIA

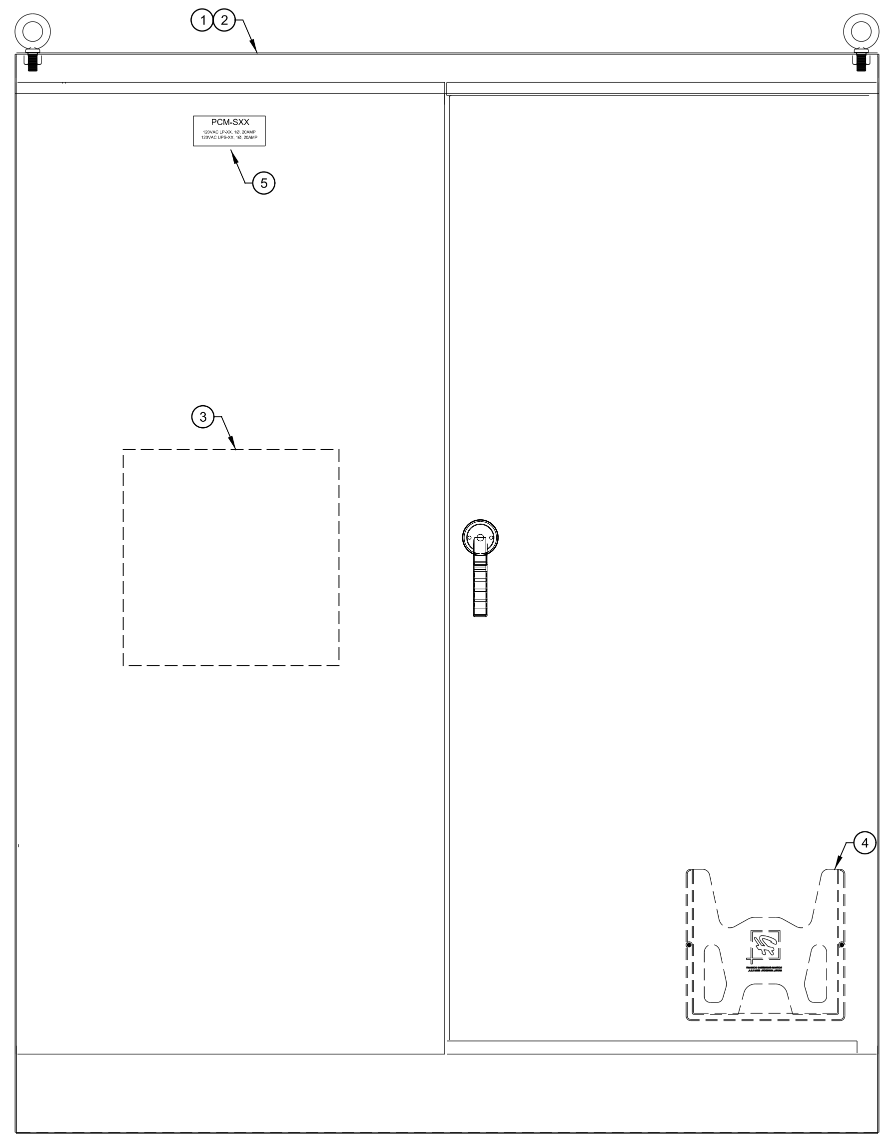
CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE PCM PANEL LAYOUT 48"
TYPE 1 INTERNAL

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

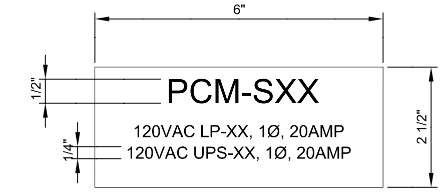
JOB NO. 9265A.00
DRAWING NO. IC19
SHEET NO. OF XX

GENERAL NOTES:

1. PANEL CONSTRUCTION SHALL MEET THE FULL INTENT OF ARTICLE 409 IN THE NEC.
2. USE UL 508A SUPPLEMENT SB TO DETERMINE SHORT CIRCUIT RATINGS.
3. REFERENCE NETWORK DIAGRAMS XX TO XX AND XX TO XX FOR 120VAC PCM CIRCUIT DESIGNATIONS.



A TYPE 2 PANEL
SCALE: 1 1/2" = 1'-0"
FILE: 8562F1000N672.2dm



NAMEPLATE DETAIL

EQUIPMENT SCHEDULE	
ITEM	DESCRIPTION
1	ENCLOSURE, NEMA 12, 78" FREE STANDING, 90"X72"X20"
2	ENCLOSURE, BACKPANEL, 78"X68"
3	FOLDING SHELF 18"X18"
4	DATA POCKET
5	NAMEPLATE (SEE SCHEDULE)

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

CITY OF SUNNYVALE CALIFORNIA

CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE PCM PANEL LAYOUT 90"
TYPE 2 EXTERNAL

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC20
SHEET NO. OF XX

Plot Date: 02-JUN-2014 10:55:36 AM User: BRoepken
Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1
LAST SAVED BY: broepken

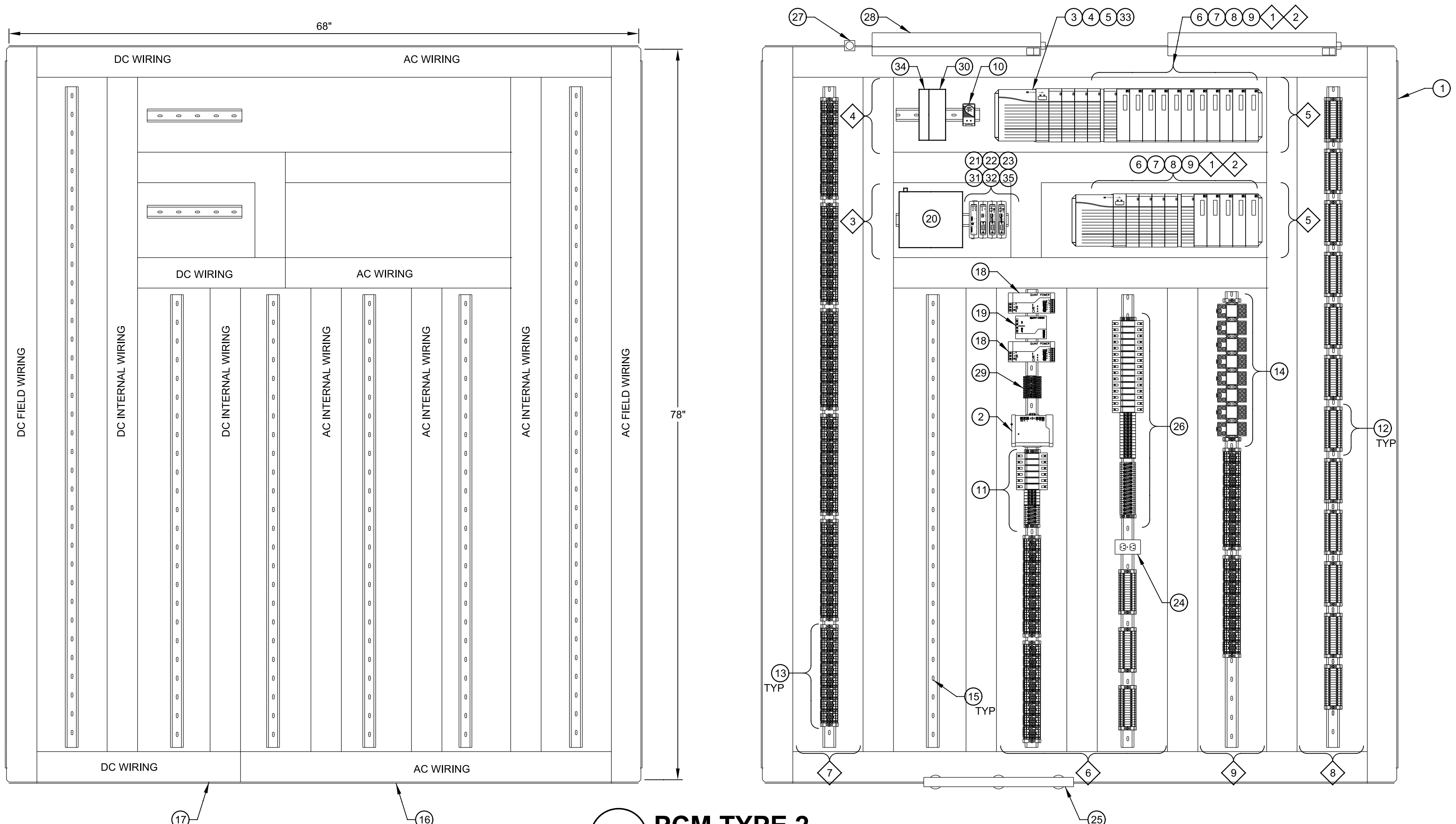
PROJECT NO. 9265A00 FILE NAME: 9265A00IC20.dgn

GENERAL NOTES:

1. PANEL CONSTRUCTION SHALL MEET THE FULL INTENT OF ARTICAL 409 IN THE NEC.
2. PROVIDE LABLE INDICATION INTEGRATOR'S LOGO MOUNTED ON THE FRONT EXTERIOR OF THE CABINET.
3. USE UL 508A SUPPLEMENT SB TO DETERMAIN SHORT CIRCUIT RATINGS.
4. ENCLOSURE DRAWING INDICATES TYPICAL DESIGN INTENT. SUBMIT AND PROVIDE DRAWINGS SHOWING ACTUAL ENCLOSURE LAYOUT WITH EQUIPMENT MANUFACTURER, PART NUMBER, AND PART COUNT.
5. ALL TIE WRAPS SHALL BE LOCATED OUTSIDE OF THE WIRE DUCTS.
6. ELEVATE ALL DIN RAIL A MINIMUM OF 2 INCHES OFF OF BACK PANEL.
7. FILE FLAT ALL TIE WRAP ENDS. TIE WRAP CUTTING TOOL, NOT SIDE CUTTERS SHALL BE USED.
8. NO 480VAC CIRCUITS SHALL TERMINATE IN OR PASS THROUGH, CONTROL CABINETS.
9. NO CAMERA OR TELEPHONE CABLES SHALL TERMINATE IN OR PASS THROUGH CONTROL CABINETS.
10. ALL CONDUIT PENETRATIONS SHALL BE LOCATED IN THE TOP OR BOTTOM OF THE ENCLOSURE. NO SIDE, FRONT, OR REAR PENETRATIONS ALLOWED.
11. QUANITY OF COMPONETS VARIES AS REQUIRED FOR EACH CABINET.

KEY NOTES:

1. SPACE FOR COMMUNICATION MODULES AS REQUIRED.
2. SPACE FOR ANALOG, DISCRETE, AND SPACE I/O MODULES AS REQUIRED.
3. SPACE FOR FIELDBUS HARDWARE AS REQUIRED.
4. PATCH PANELS
5. PLC HARDWARE
6. INTERNAL POWER, EXTERNAL POWER AND TERMINAL STRIPS
7. ANALOG TERMINAL BLOCKS
8. DISCRETE TERMINAL BLOCKS
9. CONTROL/INTERPOSING RELAYS



A PCM TYPE 2
SCALE: NO SCALE
FILE: 8562F1000672.2dm

PCM LAYOUTS

ITEM	DESCRIPTION
1	BACK PANEL
2	120VAC SURGE PROTECTOR
3	PLC POWER SUPPLY
4	CONTROLLOGIX PLC
5	COMMUNICATION MODULES - ETHERNET/IP, PROFIBUS DP,
6	ANALOG INPUT MODULES
7	ANALOG OUTPUT MODULES
8	DIGITAL INPUT MODULES
9	DIGITAL OUTPUT MODULES
10	CABINET TEMPERATURE TRANSMITTER
11	PCM POWER DISTRIBUTION
12	DISCRETE TERMINAL BLOCKS
13	ANALOG TERMINAL BLOCKS
14	RELAY AND BASE - 4PDT
15	DIN RAIL
16	WIRE DUCT - NARROW SLOT, GRAY
17	WIRE DUCT - NARROW SLOT, WHITE
18	POWER SUPPLY, 24 VDC
19	REDUNDANCY MODULE
20	ETHERNET SWITCH
21	(FUTURE COMM MODULES)
22	(FUTURE COMM MODULES)
23	(FUTURE COMM MODULES)
24	RECEPTACLE
25	GROUND BAR
26	POWER CIRCUITS FOR FIELD DEVICES
27	INTRUSION DOOR SWITCH
28	CABINET LIGHT WITH DOOR SWITCH
29	24 VDC POWER DISTRIBUTION TERMINALS
30	FIBER PATCH PANEL
31	(FUTURE COMM MODULES)
32	(FUTURE COMM MODULES)
33	CONTROLLOGIX CHASSIS
34	COPPER PATCH PANEL
35	(FUTURE COMM MODULES)
36	(FUTURE COMM MODULES)

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE PCM PANEL LAYOUT 90"
TYPE 2 INTERNAL

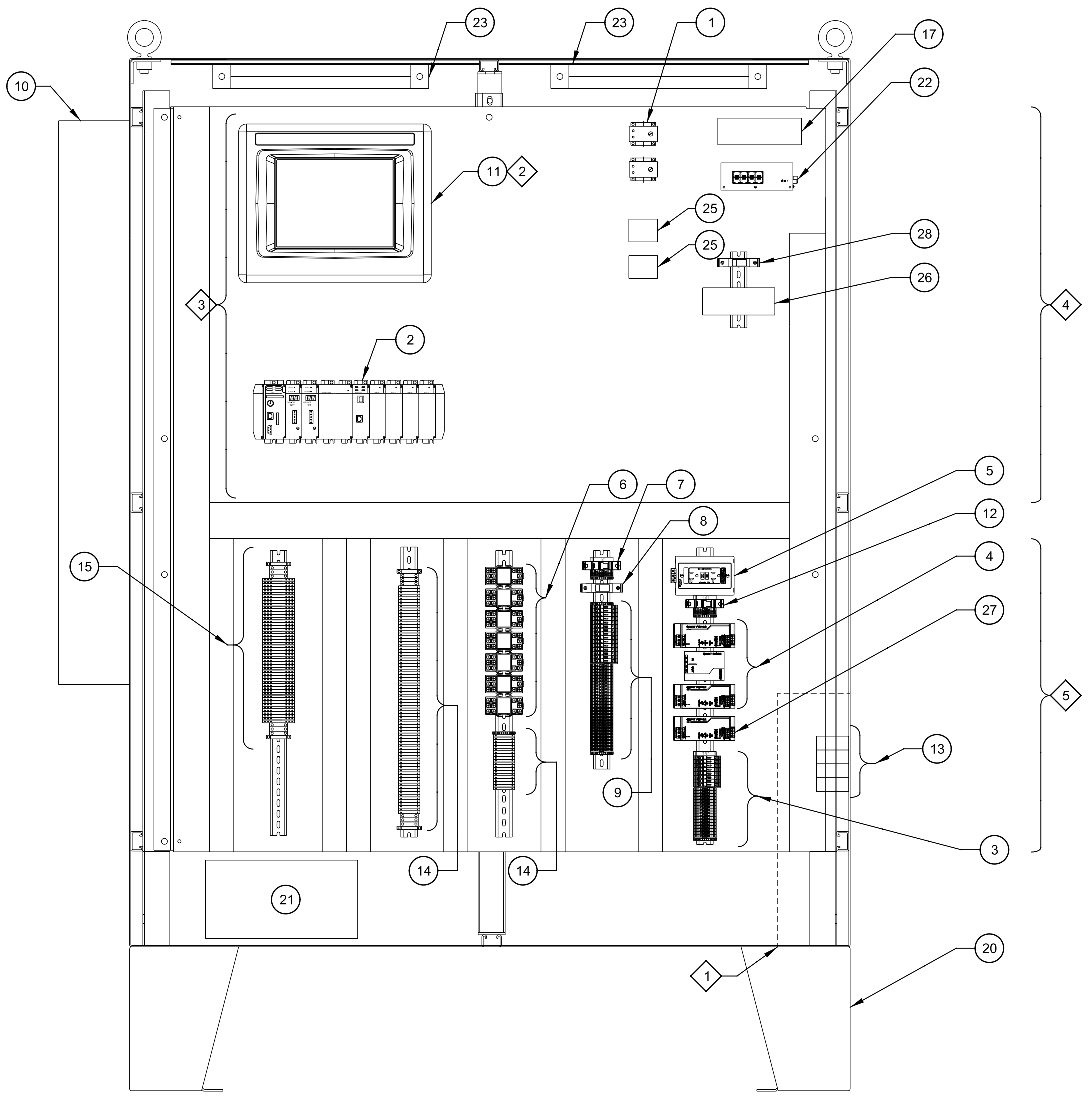
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC21
SHEET NO. OF XX

PROJECT NO. 9265A00 FILE NAME: 9265A00IC21.dgn
Plot Date: 29-MAY-2014 3:44:05 PM User: Dlmada PlotScale: 2:1 DesignScript: Carollo_Std_Pen_v0905.pen ColorTable: gshade.ctb Model: Layout1
LAST SAVED BY: dlmada

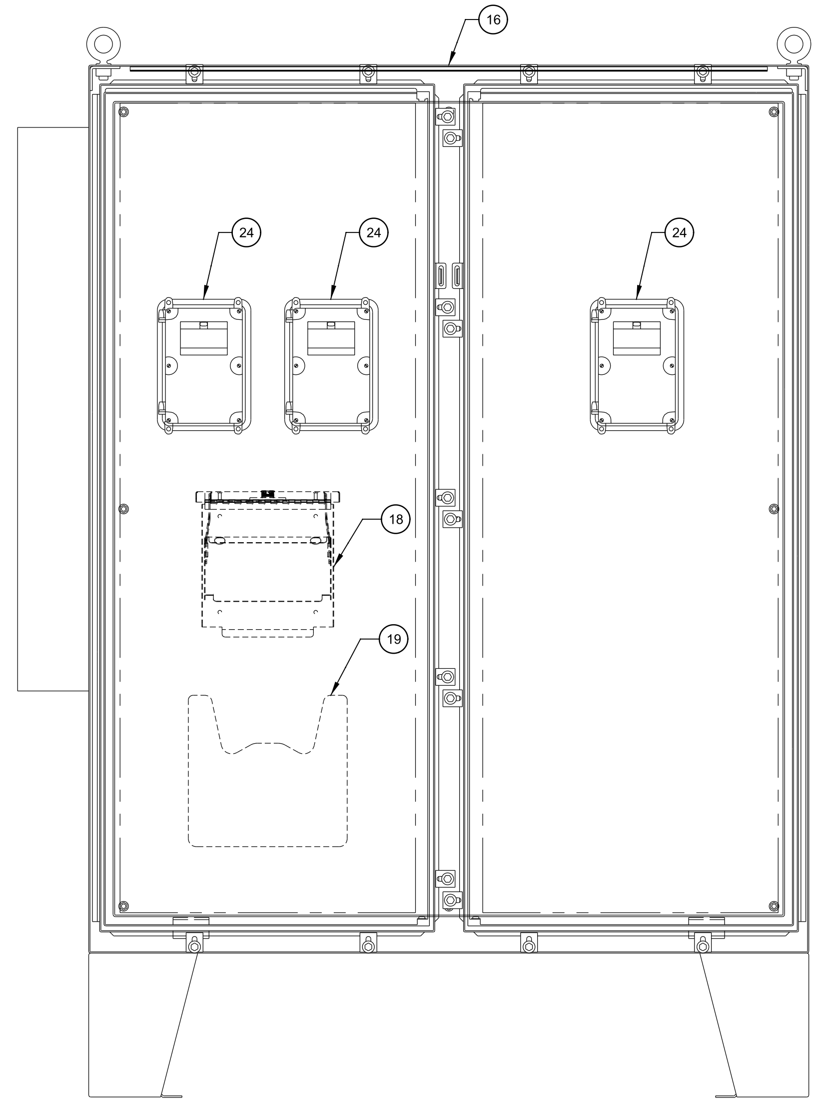
KEY NOTES:

1. AREA FOR INSTRINSICALLY SAFE CIRCUITS.
2. PROVIDE BRACKET FOR MOUNTING HMI.
3. PLC HARDWARE AND OIT.
4. PATCH PANELS AND FIELD NETWORK COMMUNICATIONS.
5. INTERNAL POWER, EXTERNAL POWER, AND TERMINAL STRIPS.



A RTU INTERNAL LAYOUT

SCALE: 1 1/2" = 1'-0"
FILE: FILE



B RTU ELEVATION

SCALE: 1 1/2" = 1'-0"
FILE: FILE

PCM LAYOUTS	
ITEM	DESCRIPTION
1	THERMOSTAT
2	ALLEN BRADLEY CONTROLLOGIX
3	24VDC POWER DISTRIBUTION
4	24VDC POWER SUPPLY AND DIODE
5	120VAC RECEPTACLE
6	CONTROL RELAYS
7	120VAC POWER (UPS)
8	120VAC SPD
9	120VAC POWER DISTRIBUTION
10	HEAT EXCHANGER
11	12 INCH HMI
12	120VAC POWER
13	INTRISICALLY SAFE RELAY
14	DISCRETE FIELD TERMINALS (AC)
15	ANALOG FIELD TERMINALS
16	2 DOOR NEMA 4X STEEL ENCLOSURE 60"x86"x24"
17	FIBER PATCH PANEL
18	FOLDING SHELF
19	DOCUMENT HOLDER
20	LEG KIT
21	UPS
22	ETHERNET SWITCH
23	LIGHTING KIT
24	HYDRORANGER 200
25	MINICAS II
26	RADIO
27	12VDC POWER SUPPLY
28	SURGE PROTECTOR

Plot Date: 29-MAY-2014 3:44:20 PM User: DImada
Model: Layout1 ColorTable: gshade.ctb DesignScript: Carollo_Std_Pen_v0905.pen PlotScale: 2:1
LAST SAVED BY: dimada

REV | DATE | BY | DESCRIPTION

DESIGNED / DRAWN / CHECKED / DATE | PROJECT ENGINEER | PROJECT MANAGER | PRINCIPAL

CITY OF SUNNYVALE CALIFORNIA

CITY OF SUNNYVALE
MASTER PLAN
INSTRUMENTATION
SAMPLE RTU ELEVATION

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9265A.00
DRAWING NO. IC22
SHEET NO. OF XX

PROJECT NO. 9265A00 FILE NAME: 9265A00IC22.dgn

APPENDIX E – PROGRAMMING STANDARDS

PLC PROGRAMMING STANDARDS – EXAMPLE TABLE OF CONTENTS

OPERATOR INTERFACE PROGRAMMING STANDARDS – EXAMPLE TABLE OF CONTENTS