



LAKE HAVASU CITY

Community Investment Department

SCADA System Design Standards

Prepared By

Lake Havasu City, Arizona

2019

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Glossary

AB Allen-Bradley Rockwell Automation

AES Advance Encryption Standard

APC American Power Conversion Corporation

BOM - Bill of Materials

DI - Device Integration

ENC - ESTeem Network Configuration

FBD - Function Block Programming Language

FCC - Federal Communication Commission

HMI Human Machine Interface

IEEE - Institute of Electrical and Electronics Engineers

I/O - Input/Output

LAN - Local Area Network

LD - Ladder Logic Programming Language

I-HC - Lake Havasu City

LM - Lean Managed

OIT - Operator Interface Terminal

OS - Operating System

PLC - Programmable Logic Controller

POE - Power over Ethernet

RIO - Remote Input/Output

RSTP - Rapid Spanning Tree Protocol

RTD - Resistance Temperature Detector

RTU - Remote Terminal Unit

SCADA Supervisory Control and Data Acquisition

SFC Sequential Function Chart Programming Language

ST - Structured Text Programming Language

ST (Fiber) - Straight Tip Fiber Connector

UPS Uninterruptable Power Supply VHF

Very High Frequency

VI-AN - Virtual Local Area Network

VM - Virtual Machine

WAN - Wide Area Network

WWTP - Waste Water Treatment Plant

1.0 Introduction

The water and wastewater facilities have been constructed over several years by different integrators and contractors, each with their own approach to control system design and philosophies. This approach has led to varied hardware and software platforms, programming styles, and graphics. This inconsistency has caused difficulty for operations and maintenance staff operating these facilities. The intent of this document is to define the control system standards for all new and upgrade projects.

This document is designed to be a living document that is updated over time to account for changes in hardware, equipment, and philosophies in the industry. Changes to this document must be approved by LHC, any deviations to this document must also be approved by LHC.

Updated

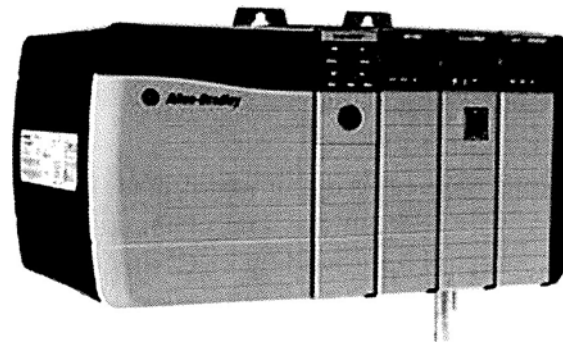
Date Modified	Modified By	Approved By	Comments
2015-03-30	Quantum	SB	Initial Document
2015-05-08	Quantum	SB	Update
2018-09-27	Lake Havasu City	JA/BR/NL	Update

2.0 Programmable Logic Controllers (PLC)

2.1 General

LHC has selected a specific Allen-Bradley (AB) family of Logix controllers as their standard PLCs. All PLCs supplied including skid systems, to LHC for new facilities or upgraded systems, will utilize the AB Logix controllers.

Figure 1, 1 Allen-Bradley ControlLogix PLC



2.2 Hardware

Each PLC processor should be sized to support the required I/O, communication connections, process functionality, data storage, and spare I/O as required for the project. There must be enough Ethernet ports to support the necessary networking requirements of the specific project plus two spare Ethernet/IP port for uploading and downloading PLC application programs. Additional networking requirements are covered elsewhere in this document or in the project specification. LHC has selected the AB Logix models listed below, which includes controllers that range from large to small. Table 1 .1 compares the three Logix platform controllers.

Large PLC processors should be used for complex control strategies or for large plant SCADA systems. The PLC shall include battery backed memory to retain the program during a power failure. Large PLC processors should be AB ControlLogix 1756-L7X.

Medium PLC processors may be used for remote automated equipment that requires a processor but not on a plant level. The PLC should include battery backed memory to retain their program during a power failure.

Medium PLC processors should be AB CompactLogix 1769-L3X.

Table 1.1 Allen-Bradley Logix PLC Platform Comparison			
Parameter	Allen-Bradley ControlLogix 1756-L7X	Allen-Bradley CompactLogix 1769-L3XER	Allen-Bradley MicroLogix 1400
Size	Large	Medium	Small
Product Maturity	Active	Active	Active
CPU Processor Speed			
CPU Memory (Volatile Memo)	750 KB to 32 MB	512 KB to 3 MB	1 to 14 KB
Non-Volatile Memory	Compact Flash card (Similar to old digital camera cards): 64 MB, 128 MB	Compact Flash card (Similar to old digital camera cards): 64 MB, 128 MB	
Remote I/O	Yes	Yes	No
Maximum I/O	128,000	30 I/O modules	540
Specialty I/O	Thermocouple, RTD, HART	Thermocouple, RTD	Thermocouple, RTD
Hot Standby	No	No	No
CPU Communications		ControlNet, EtherNet/IP, Serial	DeviceNet, DH485, Modbus, EtherNet/IP
Backplane Communications Modules	EtherNet/IP, ControlNet, DeviceNet, Data Highway Plus Modbus, DH-485 Serial, Foundation Fieldbus	EtherNet/IP, ControlNet, DeviceNet, Modbus, DH-485	

Backplane Style	Rack Type (4, 7, 10, 13, 17 Slots)	Modular Type with built-in I/O. Expandable with Rail-mounted I/O modules	Modular Type with built-in I/O. Expandable with Rail-mounted I/O modules
Programming Software	RSLogix5000	RSLogix5000	RSLogix500
Programming Languages	LD, FBD, ST, SFC	CD, FBD, ST, SFC	Ladder Logic

Small PLC processors may be used for small standalone packages, lift stations, or small pumping stations. The PLC should include battery backed memory to retain their program during a power failure. Small PLC processors should be AB MicoLogix 1400-latest revision.

Remote I/O racks may be used in applications where several I/O points need to be brought back to the control system and a local processor is not required or cannot be justified. The remote I/O module for a CompactLogix 1756 is 1769-AENTR. The Control Logix uses the remote communication Module 1756-EN2T. Only LD, FBD programming will be allowed. If integrator uses FBD, no password protection will be allowed on and custom Function Blocks.

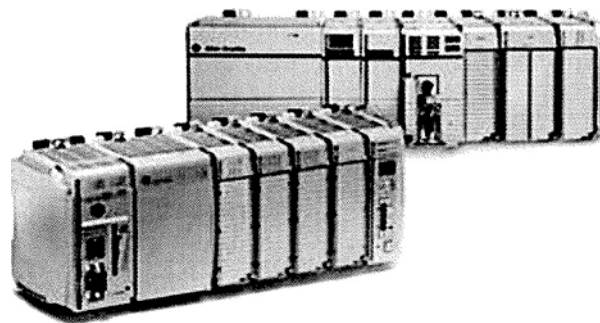
All new wastewater Treatment Plants shall use ControlLogix. Stand alone and OEM equipment at treatment plants shall be CompactLogix. North Regional Treatment Plant upgrades contact Wastewater Division to determine best strategy. Mulberry & Island Wastewater Treatment Plants currently have Micrologix SLC-500, 1400, and 1500 series equipment and will be moved to the CompactLogix platform. All new serial lift stations and upgrades to any serial lift station shall be CompactLogix. All other lift stations shall use Micrologix 1400.

All new water treatment plants shall use ControlLogix. Stand alone and OEM equipment shall be CompactLogix. The Water Treatment Plant currently has Micrologix SLC-500 equipment and will be upgraded to CompactLogix platform. All new PLC equipment at the Water Treatment Plant shall be CompactLogix. The water booster stations and collector wells have MicroLogix 1100 or 1400. All new booster stations and wells shall be MicroLogix 1400.

Input/Output hardware should be specified as follows.

- Digital input and output modules should be 24-volt dc for wastewater lift stations and 120 vac for (Water & Wastewater) Treatment Plants if the I/O wire run is greater than 100 feet.
- Analog input and output modules should be 4-20 mA.

Figure 12 Allen-Bradley CompactLogix PLC



2.3 Software

Software required for the AB Logix's family consists of Studio 5000 for ControlLogix and CompactLogix PLCs as well as RSLogix500 for the MicroLogix PLC.

Studio 5000 supports Ladder Diagram, Function Block Diagram, Structured Text, and Sequential Function Chart programming languages. RSLogix 500 only supports ladder logic.

In order to allow future additions and modifications to the program, the Contractor will include annotation throughout the program explaining the functionality of the PLC program. All annotated code will be supplied to LHC, no exception.

No PLC code will be password protect, including skids, unless otherwise stated by LHC. In such circumstance LHC will be given a full outline of passwords for all PLCs and skids.

All contracted programming will be done and completed using the contractors programming license. LHC will not provide programming software nor licensing.

The Contractor should inquire with LHC on every project to determine if a copy of the licensed Studio 5000 or RSLogix 500 programming software is required to be turned over at the end of the project.

All PLC programs shall be submitted to Lake Havasu City for review and approval prior to construction of the control panel. The Water & Wastewater Divisions will assign I.P. addresses respectively.

3.0 Operator Interface Terminal (OIT)

3.1 General

For this document OIT is defined as a PLC-based operator interface device consisting of a graphic display with operator input functionality. The OIT is typically a flat panel type of display mounted on the front of a PLC enclosure.

LHC has evaluated various OITs in service and available platforms and selected AB PanelView Plus touch screen. OITs will be provided in applications when operations or maintenance staff requires access to control, monitoring, functions, set points, equipment status, and alarms within the PLC. In general, an OIT will be located on the face of all PLC enclosures located at major facilities and remote sites.

3.2 Hardware

All OITs supplied including skid systems, to LHC for new facilities or upgraded systems, will utilize AB's PanelView Plus touch screen. The PanelView Plus will be sized and have a resolution necessary to meet the projects needs and space. Operator input shall be via touch screen. The OIT shall utilize Ethernet IP communications port for connection to the PLC control network.

3.3 Software

All OITs should be configured with Rockwell Software FactoryTalk View Studio ME programming software. The Contractor should inquire with LHC on every project to determine if a copy of the OIT software is required at the end of the project.

Final OIT projects will be provided in two formats, one format will be the native backup file with the file extension .apa. The second format will be the runtime format that is downloaded into PanelView Plus, and has the file extension .mer.

All contracted programming will be done and completed using the contractor's programming license. LHC will not provide programming software or licensing.

All OIT programs shall be submitted to Lake Havasu City for review and approval prior to construction of the control panel.

4.0 Radio and Telemetry Equipment

4.1 General

Given the large amount of data transmitted through SCADA systems an Ethernet radio is necessary for wireless communication. LHC evaluated various radio platforms and has selected two radios from two different manufactures. One radio is Esteem's 4.9GHz licensed 195Ep Ethernet radio. A licensed frequency will be purchased and used for all 4.9GHz radio as provided by the state. The second radio is General Electric's MDS-LN1 @173Mz. Contact I-HC for approval to use the General Electric MDA-LN1 radio.

4.2 Hardware

All SCADA system radios should use the 195Ep Esteem radio. This radio provides high speed Ethernet connection with AES security encryption. Major lift stations will use an AA204Ep Planar Array Antenna. These antennas must be mounted and pointed in the appropriate direction. Collection sites will implement an AA20DMEp Omni antenna to receive signals within 360 degrees.

All small remote lift stations should utilize existing MDS 1710 VHF serial radios operating at 173.2375 MHz for connecting back to Island treatment plan. During any hardware failures all future serial radios should be replaced with a MDS-LN1 . The lower frequency allows the signal to bounce off objects, rather than being absorbed, making for ease of communication without line of sight between antennas. This also creates the added benefit of implementing radio masts and antennas with significantly smaller physical foot prints.

Contractor is required to do a physical radio path study prior to purchasing either radio. I-HC will determine which radio to use prior to bid.

4.3 Software

Esteem provides free utility software for radio configuration and IP discovery. This includes Esteem Network Configuration Utility and Discovery Utility.

The ESTeem Network Configuration (ENC) Utility is a software program designed to simplify the configuration of Esteem radios. The ENC program will allow graphical, point and-click configuration of network routing and then configure each ESTeem wireless modem for the network as designed. The ENC program will eliminate the need to program or update each ESTeem wireless modem individually.

195E Discovery Utility will display all ESTeem 195E series radio modems connected to the computer's Ethernet connection regardless of their current IP address. This utility will allow modification of the modem's IP address to the network of the computer for further configuration through a Web browser.

5.0 Control system networking

5.1 General

The main communication backbone for the SCADA system utilizes fiber communication and has a parallel Ethernet radio system in place to create redundancy. Managed Ethernet switches shall be located in each PLC or network panel for both the SCADA and PLC network.

As previously defined, the PLCs and OITs should be capable of Ethernet/IP communication and adequate Ethernet/IP ports are required for all equipment necessary for the specific project plus two spare for downloading PLC application program.

Managed switches shall utilize the IEEE Rapid Spanning Tree Protocol (RSTP) for network routing and optimization. In the event of a network switch failure, RSTP will automatically determine the most efficient way to re-route network traffic in order to reestablish communication throughout the network. A possible scenario for this function includes losing fiber connection. In this even the RSTP Protocol with reroute connection through the existing Ethernet radio connection.

They need to spec out the type of manage switches that are going to be allowed. This might take a discussion with the IT personnel to Identify acceptable switches

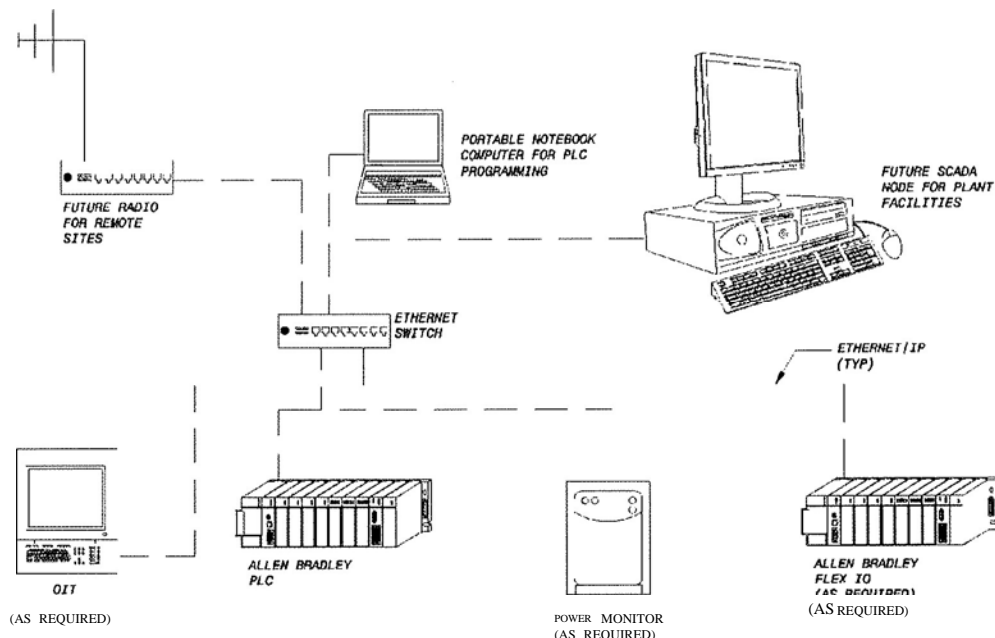


Figure 1.3 Example Control System Network Diagram for Typical Installation

5.2 Hardware

Ethernet Switches used for connection to the SCADA system through radio or Ethernet should be from the Phoenix Contact FL Switch LM series or appropriate equal. This store-and-forward switch complies with IEEE 802.3, 2 priority classes according to IEEE 802.1 p.

Features:

- TCP/IP protocol
- BootP-compatible
- Port mirroring
- Integrated web server function
- Multicast filtering
- IGMP snooping
- VLAN
- Rapid Spanning Tree (RSTP)

All new fiber equipment provided for new facilities and upgrades to existing facilities should utilize straight tip (ST) single mode fiber optic connectors and cable. These are designed for long distance communication necessary for the existing system.

6.0 Computer Hardware

6.1 Server

Server Requirements will vary dramatically on a project to project basis and are constantly being updated with new hardware. To find spec appropriate equipment contact a Schneider representative for more details in relation to future project needs.

6.2 Workstation

Operator and Development workstation computers should meet the follow minimum requirements listed below with up to date hardware.

- 15 Dual Core 2.5 GHz Processing Speed
- 4GB Ram
- 500GB Hard Drive with RAID 1
- Windows 7 Professional Operating System

6.3 Monitor

All monitors should meet the minimum listed requirement for workstations.

- 120 V Power
- 16:9 Widescreen Aspect Ratio
- LED backlight
- Resolution of 1280x1024
- 60Hz Refresh Rate
- DVI Input
- VGA Input
- HDMI input
- Temperature Range Operating: 0 °c to 40 °c (32 °F to 104 °F)

Temperature Range Non-operating: Storage: -20 °c to 60 °c (-4 °F to 140 °F)

7.0 UPS

7.1 Indoor Workstation

An appropriately sized UPS should be provided for each server, workstation, and network communication Equipment. All equipment must be approved and authorized by LHC with documentation to ensure the necessary hardware requirements are met. All indoor UPS's should meet the minimum requirements listed below for workstations and communication equipment.

- 120 vac Input
- 500-2,000 VA Depending on equipment load
- Device runtime of 30 minutes based on application load
- Temperature Range Operating: 0 °c to 40 °c (32 °F to 104 °F)
- Temperature Range Non-operating: Storage: -20 °c to 60 °C (-4 °F to 140 °F)

7.2 Outdoor Remote stations

Operation critical remote lift stations should be equipped with a custom UPS panel sized and designed appropriately for the electrical load and environment. All equipment must be approved and authorized by I-HC with documentation to ensure the necessary hardware requirements are met. All outdoor UPS's should meet the minimum requirements listed below for remote lift stations

120V Input

24V Output

250-1500 VA Depending on equipment load

Device runtime of 30 minutes based on application load

Temperature Range Operating: 0 °c to 40 °c (32 °F to 120 °F)

Temperature Range Non-operating: Storage: -20 °c to 60 °c (-4 °F to 140 °F)

Placed in a nonmetallic enclosure

Appropriate Cooling Device Minimum 400 BTU

Relays indicating battery use

Relays indicating a dead battery

The current visualization software for the wastewater system is Wonderware- System Platform 2014R2.

The current visualization software for the water system is Wonderware InTouch version 10.5 and will be upgraded to System Platform.

The City has two acceptable outside integrators of new equipment and programming into the Wonderware Platform galaxy. To ensure that new systems are being added and not let stand alone and also to allow reporting and backup procedures to run on any additions to the system. Screen development and Updates to the system structures need to be reviewed and approved by the SCADA supervisor prior to implementation. Current acceptable integrators include;

- Alliance Service and Control Specialist
- Quantum Engineering

Any additional repeating radios or fiber optic connections need to be included as part of the initial design and construction of related projects. If locations are to be controlled remotely then they need to have acceptable fiber connections and or Hi speed Ethernet radio.