

SECTION 40 95 13.13 – ^{A16}PROCESS CONTROL HARDWARE FOR LOCKS MACHINERY CONTROL SYSTEMS ^{A16}

1.01 SUMMARY:

A. ^{A16}**Scope:** This Section covers the performance requirements, design, and commissioning of complete process control systems (PCSs) based locks machinery control systems (LMCSs) for the ^{A17}Works. ^{A17} This Section of the Employer's Requirements shall be read in conjunction with the Sections listed in Table 40 95 13.13-1. ^{A16}

B. Related Sections:

Table 40 95 13.13-1: Related Sections			
1.	Section 01 81 13	-	Filling and Emptying (F-E) Systems
2.	Section 01 81 19	-	Lock Gates
3.	Section 01 81 23	-	Culvert and Conduit Valves
4.	Section 01 81 26	-	Communications, Control, Safety, and Security Systems
5.	Section 01 92 00	-	Facility Operation
6.	Section 09 69 00	-	Raised Access Floors
7.	Section 11 52 14	-	Video Walls
8.	Section 12 59 83	-	Custom Systems Furniture
9.	Section 27 10 00	-	Structured Cabling Systems for Communications Inside Plant
10.	Section 27 11 16	-	Cabinets, Racks, Frames, and Enclosures
11.	Section 27 21 00	-	Data Communications Equipment
12.	Section 27 53 13	-	Time Synchronization Systems
13.	Section 33 82 00	-	Cabling for Underground Communications Outside Plant
14.	Section 35 10 00	-	Waterway and Marine Signaling and Control Equipment
15.	Section 35 12 00	-	Vessel Detection Systems
16.	Section 40 00 00	-	Process Systems Integration
17.	Section 40 91 00	-	Primary Process Measurement Devices
18.	Section 40 95 13	-	Process Control Hardware
19.	Section 40 95 13.16	-	^{A10} Process Control Hardware for ^{A10} Fire Fighting Control Systems
20.	Section 40 95 13.19	-	^{A10} Process Control Hardware for ^{A10} Electrical Distribution Control Systems
^{A10} 21.	Section 40 96 45	-	Process Control Software ^{A10}
^{A10} 22. ^{A10}	Section 40 96 45.13	-	Process Control Software for LMCSs

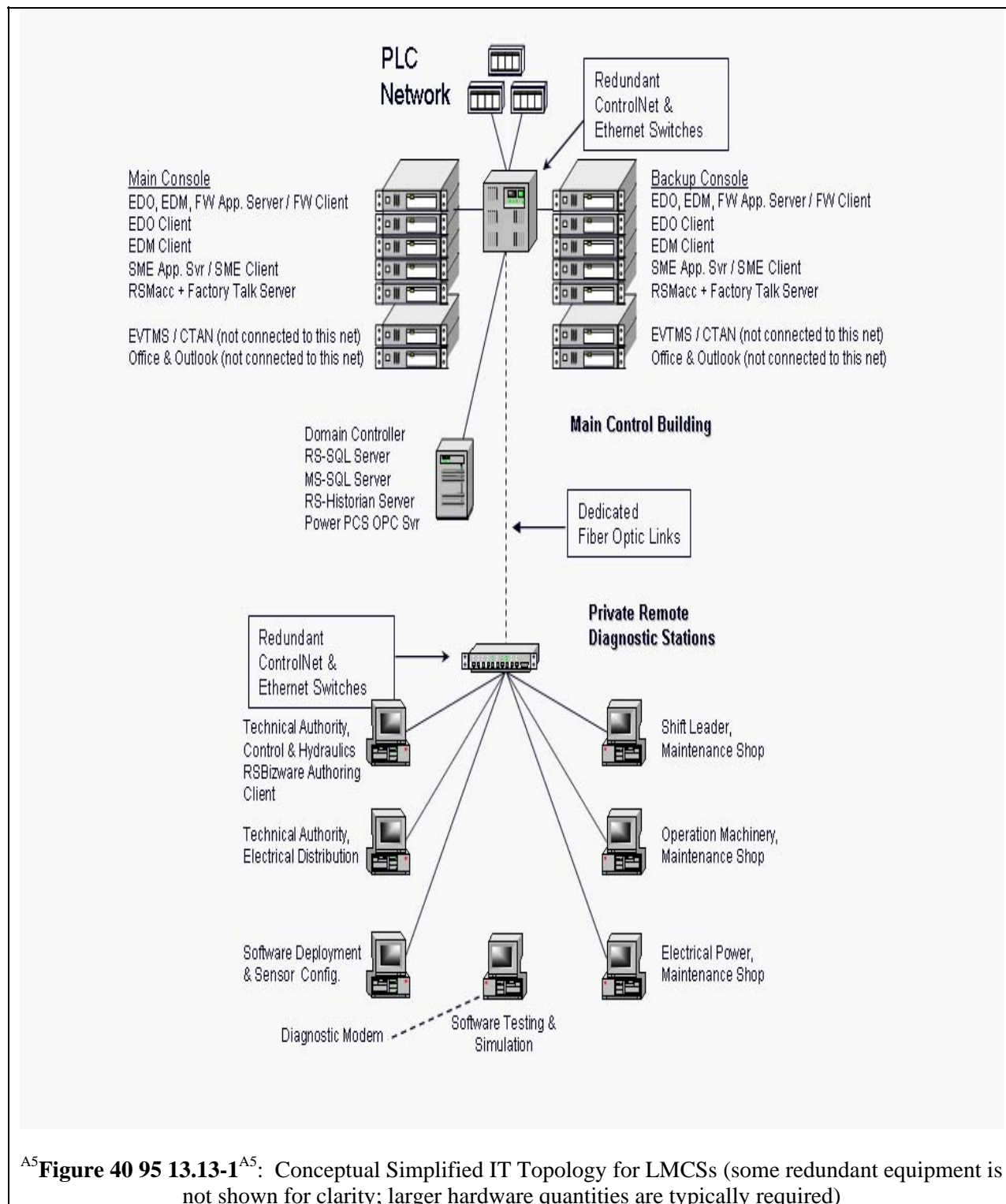
1.02 REFERENCES:

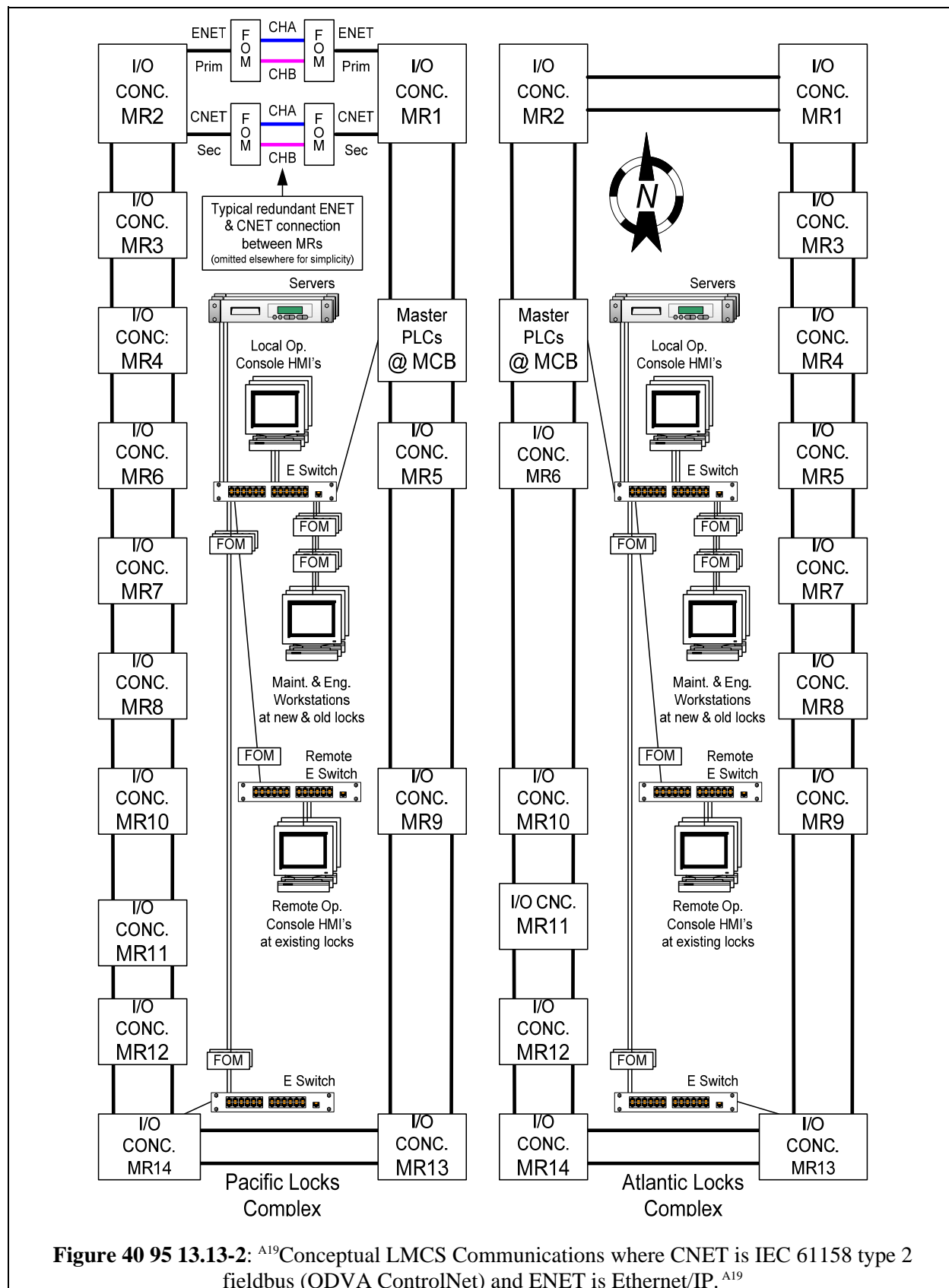
A. **Applicable Publications:** Refer to Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.02.

- B. **Drawings:** Refer to Section 40 00 00 (*Process Systems Integration*), Paragraph 1.02.
- C. ^{A9}**Background Information on LMCSs in Existing Locks:** The Employer’s existing LMCSs currently have the following:
1. 937 PLCs from Rockwell Automation, including MicroLogix 1500, PLC5, SLC5/04, and SLC5/05.
 2. Approximately 22,816 hours of training of electricians, electronics technicians, operators, inspectors, and engineers for the above PLCs.
 3. Over 50 different existing stock items standardized.
 4. Software licenses, including RSViewSE HMI, RSBizware business data server for factory floor data, RSSQL database, RSHistorian reporting tools, RSMacc change management and configuration management, RSNetworkx configuration software, RSTeststand, and Arena simulation software. All these require annual renewals.^{A9}

1.03 REQUIREMENTS:

- A. **General:**
1. The Contractor shall meet all applicable requirements of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*).
 2. The LMCS shall meet the general requirements of Section 40 95 13 (*Process Control Hardware*), Paragraph 1.03.
 3. A control console shall be installed in central control room with control of all locks machinery.
- B. **Architecture:**
1. ^{A17}Atlantic and Pacific LMCSs shall be PCSs ^{A17} with several PLCs running the facilities’ production with easy transport of both real-time and historical production data to operations, maintenance, engineering, and administrative computer workstations.
 2. Data shall be provided in high degree of analysis and classification, capable of trends and statistics, with very high data integrity, in customizable and printable format reports.
 3. Architecture shall ^{A9}include^{A9} a fault-tolerant, ^{A9}resilient, and^{A9} self-healing redundant optical fiber network connecting all the devices.





4. ^{A17}As a minimum, architecture shall be in accordance with the guidelines of Figure 40 95 13.13-1 (*Conceptual Simplified IT Topology for LMCSs*). For information only, reference is made to Conceptual Design Drawing Nos. VF-1700-118-159 and VF-1700-118-160, and CPP Conceptual Design (with a greater number of PLCs) included in Volume VI, Part 5, all subject to the final paragraph of Sub-Clause 5.1 of the Conditions of Contract. ^{A17}
 5. The system architecture shall be extremely flexible and shall be able to fit with radical changes in control philosophy through simple programming changes.
- C. **Arrow Indication:** Shall be in accordance with Section 35 10 00 (*Waterway and Marine Signaling and Control Equipment*).
- D. **Backup Site:** A remote control terminal shall be installed in an adjacent existing locks “control house” for backup operation capability: one at Miraflores Locks for Pacific locks complex, and one at Gatun Locks for Atlantic locks complex.
- E. **Communications:**
1. **Master Station-to-PLC Communications:** Backbone shall have four paths in accordance with the guidelines of ^{A5}Figure 40 95 13.13-2^{A5}, all using different fiber optic cables on different routes. This figure assumes 14 machinery rooms per Post-Panamax locks set for equipment clusters, two new control rooms (each with one PLC), and remote I/O from WSBs through 3 of 8 PLCs per locks set.
- F. **Culvert and Conduit Valves:** The LMCS shall monitor and control all culvert and conduit valves. Refer to Section 01 81 23 (*Culvert and Conduit Valves*). PCS controls shall be centralized in the nearest machinery room.
- G. **Hardware:** Shall be in accordance with Section 40 95 13 (*Process Control Hardware*).
- H. **Human Machine Interface (HMI):** Shall be in accordance with Section 40 96 45 (*Process Control Software*).
- I. **Independence:** LMCSs for the Works shall be stand-alone and independent from the LMCS of the existing Gatun, Miraflores, and Pedro Miguel locks.
- J. **Installation:** Unless otherwise specified, installation shall be in accordance with Section 40 95 13 (*Process Control Hardware*).
- K. **Interlocks:**
1. Interlocks shall be based on the machinery indication information.
 2. If the machinery indication information is not available, the interlock shall always assume an “Open” condition for gates and valves, see Section 40 96 45.13 (*Process Control Software*).

L. Items to be Provided:

1. Local central control (LCC) consoles.
2. Remote central control (RCC) consoles, including one in Miraflores Locks control house for the Pacific locks complex, and one in Gatun locks control house for the Atlantic locks complex.
3. PLCs and I/O racks at main control building and machinery rooms.
4. Machinery room controls for normal/emergency control.
5. Instrumentation and indication hardware, and their respective enclosures, for all functions and requirements ^{A10}described herein^{A10} and in Section 40 96 45.13 (*Process Control Software*).
6. ^{A19}All User workstations, including for Employer systems described herein.^{A19}
7. Information management servers
8. Communication systems of each lock complex.
9. All other equipment or functions described herein and in Section 40 96 45.13, (*Process Control Software*).

M. Redundancies: In addition to the redundancy requirements of Section 40 95 13 (*Process Control Hardware*), all operation machinery shall have two parallel control systems, standard PLC logic for general local and remote use, and basic electrical logic for emergency use when PLC system fails. See Section 40 91 00 (*Primary Process Measurement Devices*) for details.

N. Rolling Gates: The LMCS shall monitor and control the following, in accordance with Section 01 81 19 (*Lock Gates*). All controls shall be centralized in the nearest machinery room.

1. **Gate Flotation and Buoyancy:** LMCS shall monitor water level inside the rolling gates as required for floating. The Employer envisions a static ballasting system and small bilge pumps for this.
2. Equalization valves between any pair of gates (if used)
3. Lock rolling gate track cleaning system
4. Visual aids to navigation
5. Pedestrian crossing audio-visual alarms
6. Vehicular crossings

7. Gate recess pumping / dewatering system, including recess dewatering pumps whose thermal capacity shall be well above the expected value.
- O. **Software:** Shall be in accordance with Section 40 96 45.13 (*Process Control Software for LMCS*).

1.04 DESIGN CRITERIA / SYSTEM PERFORMANCE:

A. General:

1. **Problem to be Solved:** LMCSs shall solve the following business needs:
 - a. ^{A16}Monitor and control all machinery, pumps, and valves, to operate locks complexes at safe and adequate water levels without Dry-Docking vessels, overflowing, or any other abnormal conditions while minimizing possible slopovers. ^{A16} This shall consider extreme combinations of tide and lake levels, and include control and indication of all applicable handrails and walkways over RGs.
 - b. Meet filling and emptying requirements of Section 01 81 13 (*Filling and Emptying (F-E) Systems*), including throughput requirements without objectionable water waves, turbulence, and hawser forces.
 - c. Standardize product types used at existing locks ^{A10} (refer to Table Nos. 01 81 26-7, 8, and 11) ^{A10} while avoiding obsolescence, if feasible at the time of installation. This is desirable to leverage existing inventory and training related with these products.
 - d. ^{A10}Reduce component selection in the new design as much as possible by using multifunctional components to consolidate many components into one. ^{A10} The Contractor shall use as many features from each device as applicable to the process, to leverage component capabilities.
 - e. Use as many features from each device as applicable to the process, to leverage component capability.
 - f. When developing fault tolerance logic, to reuse as many existing sensor types and device features as possible before deciding to add more hardware.
2. **Restrictions to be Considered:**
 - a. The LMCS shall meet all system requirements specified in Section 40 95 13 (*Process Control Hardware*).
 - b. The LMCS shall meet all operations requirements described in Sections 01 81 13 (*Filling and Emptying (F-E) Systems*) and 01 92 00 (*Facility Operation*).

- c. All centralized operations-related control and information shall be displayed for operator use by means of a central control console, as described in Section 12 59 83 (*Custom Systems Furniture*). These stations shall be physically restricted from unauthorized use, by means of access control to control room. The left side of the central console shall provide the following functions, as described in Section 40 96 45 (*Process Control Software*):
 - 1) Machinery control station (MCS), one display per locks level.
 - 2) Water level display (WLD).
 - 3) Enhanced vessel tracking system terminal (existing Employer's system)
 - 4) Vessel schedule terminal (existing Employer's system)
 - 5) Operations log database server client, email and office workstations.
- d. All centralized maintenance-related control and information shall be displayed for operator use by means of a central control console, as described in Section 12 59 83 (*Custom Systems Furniture*). The right side of the central console shall provide the following functions, as described in Section 40 96 45 (*Process Control Software*):
 - 1) Machinery diagnostics station (MDS)
 - 2) Power distribution station (PDS)
- e. The center position of the central console shall have no less than four CCVS video flat screen monitors larger than 508 mm (20 inch) screen diagonal, and a CCVS video control keyboard with joystick.
- f. ^{A19}The LCC console operators use viewing software clients each connecting to MCS, MDS, PDS, and WLD application servers respectively. ^{A19}RCC console operators use application clients running on dedicated workstations per client. All other users use application clients running on their respective single workstations.
- g. Centralized control consoles shall be capable of operating in the following modes: manual, semi-automatic and full automatic.
- h. LMCS servers shall not run any virtual operating system(s).
- ^{A9}i. LMCSs shall avoid wasting water, except as required for salinity control. ^{A9}

B. Design Criteria:

1. The Contractor shall ^{A17}include in the design of the Works ^{A17}safety interlocks that impede any unwanted or catastrophic event caused by faulty machinery operations. ^{A19}Unwanted or catastrophic events caused by faulty operations of machinery are those that will result in flooding a chamber, drying a chamber, raising or lowering the water level in a chamber beyond acceptable limits, closing a gate on a ship, tug or small vessel, and/or creating water hammer in a culvert or conduit. ^{A19}
2. The design shall provide for:
 - a. **Automatic Mode:** Automatic trouble free operation with provisions for alerting the operator as to what the automatic process will be compensating for, if any.
 - b. **Semi-automatic Mode:** Semi-automatic trouble free operation with provisions for alerting the operator as to what the semi-automatic process and what does the manual action is needed in order to compensate for, if any.
 - c. **Manual Operation Mode:** ^{A10}The system shall provide the operators with a detailed step-by-step explanation of the manual process. ^{A10}
 - d. Except ^{A10}in ^{A10}emergencies, the safety interlocks shall not be by-passed under all possible variants of the processes.
 - e. When certain gates or valves are out of commission for repair or maintenance, the system shall perform in a similar way, alerting and providing safety interlocks.

C. Engineering Authority Workstations:

1. Engineering stations shall be provided for the control and hydraulic engineering technical authority, at least one per new lock site. These stations shall be physically restricted from unauthorized use, and shall be used to carry out the following:
 - a. Downloading or uploading PLC software to all PLCs in the plant.
 - b. On-line development or modifications of PLC user program software.
 - c. Centralized configuration and monitoring of all HART protocol enabled sensors.
 - d. Modifying all possible ^{A9}software^{A9} configurations.
 - e. Configuring OPC link servers
 - f. Authoring reports on reporting software

- g. Using the MDS application.
- 2. An engineering station shall be provided for the electrical engineering technical authority in each new lock site. These stations shall be physically restricted from unauthorized use and shall be used to carry out the following:
 - a. Downloading or uploading software to all power monitoring controllers in the plant.
 - b. On-line development or modifications of to user all power monitoring controllers' program software.
 - c. Centralized configuration and monitoring of all power monitoring devices.
 - d. Modifying all possible power monitoring software configurations.
 - e. Configuring OPC link servers
 - f. Authoring reports on reporting software
 - g. Using the MDS application.

D. Maintenance Workstations:

- 1. The MDS application ^{A10} shall provide ^{A10} graphic and animated display of real-time data, historical data and analysis results for quick diagnosis of defects and malfunctions, for maintenance response, for automatic reports of activities, and for determining the origin of a failure. For detailed description of MDS, refer to Section 40 96 45 (*Process Control Software*).
- 2. Maintenance Stations shall be provided in each new lock site for the shift leader, the operating machinery shop supervisor, and the electrical power shop supervisor. These stations shall be physically restricted from unauthorized use.
- 3. These stations shall be used to carry out the following:
 - a. Downloading or uploading PLC software to all PLCs in the plant
 - b. On-line / off-line viewing of PLC user program software
 - c. Centralized configuration and monitoring of all HART protocol enabled sensors.
 - d. Printing reports on reporting software
 - e. Using the MDS application

E. Machinery Position Indication:

1. Machinery position indication used by the locks operator shall primarily be ^{A10}real-time ^{A10} sensed gate position or valve body position by means of an analog absolute type position transducer. Analog discrete sensors shall be used as backup.
2. Measuring machine actuator position or other indirect machine position indications shall be a secondary source of information.
3. Using the last operator command issued to infer position is unacceptable.

F. Security:

1. LMCS CANs shall be isolated standalone networks as described by the system architecture.
2. In consideration for security, single direction data replication (historical) or streaming (real-time) may be output from the LMCS to other networks, without any type of ^{A10}acknowledgement ^{A10} or feedback ^{A10} input into ^{A10} the LMCS. [Note that FIPS common criteria software certification is required in accordance with Section 40 96 45 \(Process Control Software\).](#)
3. Other parallel, non-connected networks may coexist by placing workstations within the LMCS control console, such as the internal employer office WAN, AIS, and Marine Traffic Control System (MTCS).

G. Software Deployment Workstations:

1. A software deployment station shall be provided for the network administrator of each LMCS.
2. These stations shall be physically restricted from unauthorized use, and shall be used to carry out the following:
 - a. General LAN management
 - b. General database management
 - c. General report management and authoring
 - d. ^{A19}Deploying new versions of HMI applications for viewing software servers or operator interface touch sensitive displays ^{A19}
 - e. Backup / restore all software configurations
 - f. Backup / restore all hard drive images.

H. System Simulation and Software Testing Workstations:

1. Workstations shall meet the requirements of Section 40 96 45 (*Process Control Software*).
2. A workstation for system simulation and software testing shall be provided for the Engineering personnel at each new lock site.
3. These stations shall be physically restricted from unauthorized use, and shall be used to carry out the following:
 - a. Testing HMI application animations and interaction with PLCs
 - b. Testing operator interface displays interaction with PLCs.
 - c. System I/O simulation and manipulation to test PLC software logic, operator interfaces and HMI application software
 - d. Test database transaction triggers and transaction performance.

I. Water Level Equalization:

1. LMCSs shall provide a trouble free Equalization process that takes into consideration all possible variables, and combination of variables to be encountered.
2. Some of the variables that will be encountered are: low and high lake levels, low and high sea tides, random use of any combination and sequence of short chamber, semi-long chamber and long chamber.

1.05 SUBMITTALS: Shall be in accordance with Section 40 00 00 (*Process Systems Integration*), Paragraph 1.05.

1.06 QUALITY ASSURANCE: Shall be in accordance with Section 40 00 00 (*Process Systems Integration*), Paragraph 1.06.

END OF SECTION