

## SECTION 40 96 45 – PROCESS CONTROL SOFTWARE

### 1.01 SUMMARY:

- A. <sup>A17</sup>**Scope:** <sup>A19</sup>This Section covers the performance requirements, design, installation, testing, and commissioning of complete software for process control systems (PCSs), including the locks machinery control systems (LMCSs), fire-fighting control systems (FFCSs), and the electrical distribution control systems (EDCSs) as parts of the Works.<sup>A19</sup> This includes requirements for clients and server software for human-machine interface (HMI) applications, programmable logic controller (PLC) applications, tag servers, open process control (OPC) servers, communications, security and auditing, single login software, and other software to be used in these systems.<sup>A17</sup> This Section of the Employer's Requirements shall be read in conjunction with the Sections listed in Table 40 96 45-1.
- B. **Related Sections:**

Table 40 96 45-1: Related Sections		
1.	Section 01 81 26	- Communications, Control, Safety, and Security Systems.
2.	Section 40 00 00	- Process Systems Integration.
3.	Section 40 95 13.13	- Process Control Hardware for Locks Machinery Control Systems.
4.	Section 40 96 45	- Process Control Software.
5.	Section 40 96 45.13	- Process Control Software for Locks Machinery Control Systems.

### 1.02 REFERENCES:

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

### 1.03 REQUIREMENTS:

- A. **General:**
- The Contractor shall meet all applicable requirements of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.03.
  - PCS software manufacturer shall have valid ISO 9001 certification. [ISO 20000 certification is preferred to ensure an ITIL style help desk.](#)
  - The Contractor shall provide software as required for PCSs and all software requirements of the hardware described in Section 40 95 13 (*Process Control Hardware*) and related Sections.
  - All software used in the control system shall use the English language.

5. All custom code used to develop HMI applications or PLC applications shall documented and become property of the Employer as per Section 01 78 23 (*Operation and Maintenance Data*), and detailed as specified in Subparagraph 1.03, A.3. (*Manuals*) of this Section.
6. The programming language for PLC software development shall be ladder logic, IEC 61131-3 compliant, supporting hyperlinks and extensible markup language (XML).
7. All software for process control systems shall meet the following:
  - a. Be designed and developed to have an integrity level of 2 or better, in accordance with CENELEC EN 50128.
  - b. <sup>A19</sup>Have Federal Information Processing Standards (FIPS) security certification for Level 2 and Common Criteria EAL 4+ or better either today or to be obtained sometime before final acceptance. <sup>A19</sup> Note that such certification requires identifying security functions since early design stages.
8. **Operating System:** Shall be suitable for real-time, and be field proven in similar applications.
9. **PCS Software:** <sup>A9</sup>Shall include, but not be limited to, the following:
  - a. <sup>A17</sup>Asset management, change and configuration management, and Disaster recovery (MACC). <sup>A17</sup>
  - b. Security server, for access control, authentication, and security auditing.
  - c. Tag server, to interchange data with Oracle or SAP, and OPC.
  - d. Business data server, to use factory floor data.
  - e. Authoring client for historical business data server, to generate monthly and special reporting.
  - f. PLC programming software, with ladder logic and PLC-to-PC communications software.
  - g. Device network configuration software.
  - h. Simulation software for PLC I/O.
  - i. Operator HMI software.
  - j. PLC logic simulation software.
  - k. PCS network topology software.

1. Trend software.<sup>A9</sup>
  10. **Time Synchronization:** All PCSs shall use a satellite downlink global positioning system (GPS), U.S. global navigation satellite system (GNSS) clock as the master reference, capable of generating a network time protocol (NTP) signal for all workstations, servers and PLCs.
  11. The Contractor shall provide for the local central console (LCC) console Employer's Personnel (operators) to use <sup>A9</sup>operator HMI<sup>A9</sup> application clients each connecting to machinery control station (MCS), water level display (WLD), machinery diagnostics station (MDS) and power distribution station (PDS) application servers respectively. <sup>A19</sup>The Contractor shall provide for remote central control (RCC) console Employer's Personnel operators to use application clients running on dedicated workstations per client. <sup>A19</sup> The Contractor shall provide for all other Employer's Personnel (users) to use application clients running on their respective single workstations.
- B. **Data Bases:** Shall include, but not be limited to, the following:
1. **MCS Operations Data Bases:**
    - a. All operator HMI commands shall be logged and stamped with date and time.
    - b. All MCS indication changes shall be stamped with date and time.
    - c. All MCS configuration changes shall be logged and stamped with date and time.
    - d. Login and logout.
  2. **MDS Maintenance Data Bases:**
    - a. MDS alarms.
    - b. Machinery process values.
- C. **Electronic Backup:** Shall include the following:
1. Image copy of hard disk of final "As-Built" software, of the computer it is installed in, with restore software.
  2. PLC programming files.
  3. Backup of all configuration files where applicable, for example <sup>A9</sup>PLC programming software <sup>A9</sup> setup, OPC server configuration files or MS-SQL database configuration.

**D. Coordination and Interoperability:**

1. PCSs shall be coordinated with the Employer's computerized maintenance management system (CMMS). The actual make and model is unknown at this time. [Interconnection with CMMS shall be via Employer intranet ports in Miraflores 7D and Gatun 24.](#)
2. <sup>A17</sup>The Employer currently uses Rockwell Automation RSMACC software for asset management, change and configuration management, Disaster recovery, and security (access control, authentication, and audit), and plans to replace it soon with Factory Talk Asset Center and Factory Talk Security software. <sup>A17</sup>

**E. Historical Data and Trending:**

1. PCSs shall be able to memorize chronologically all input / output (I/O) status changes that appear within the plant or at the interfaces. Moreover, printing out of analog trends and data logs shall also be possible.
2. The storage and retrieval of historical data function shall provide facilities to store without transfer to an external device.
3. One external long-term archiving media (e.g. optical disk) for memorization of historical data of the plant shall be provided.
4. Unless otherwise specified, all data from data acquisition and status input points shall be stored for no less than one year.
5. Wind direction and speed data from transducers at the ends of the Locks shall be sampled at least once a minute and shall be stored for no less than 1 year.

**F. Human-Machine Interface (HMI):**

**1. General:**

- a. The language used for all HMI applications shall be English.
- b. HMI applications shall run on redundant application servers, typically each central control console running as client with each sever respectively. Should one application server fail, both consoles shall run from the remaining application server.
- c. Each HMI application software shall have at least twice the needed license capacity to show the required displays with the required tags, and the excess capacity shall be reserved for future use.
- d. The Contractor shall provide for Employer's Personnel (operators) to access the HMI application via a software client running on the application server. The Contractor shall provide for Employer's Personnel (other users) on the network to access the HMI application remotely via software client, running on their workstations.

- e. All HMI applications shall run maximized and without minimize / maximize control buttons. Displays shall be designed to detect screen resolution settings and adjust the display accordingly for best fit of the display contents for the current screen resolution, without display scrolling. There shall be two types of application HMIs, interactive displays and monitoring displays.
- f. Display graphic detail and quality shall be as the overall examples shown in this Section, or better.
- g. **Interactive Displays:** Interactive displays shall have a “Look and Feel” similar to the latest versions of standard Windows applications in use by the Employer, that is, incorporating a title bar, a menu bar, and a toolbar on top, and a status bar on the bottom. All the interactive animation and control shall be carried out in the middle body of the display. All menu bars, tool bars, text input or selection of options shall be by employing standard Microsoft Active-X controls, with tool tip captions.
- h. **Monitoring Displays:** Monitoring displays shall be single screen, fixed displays and have no interaction with the Employer’s Personnel (operator) other than to display specific information.
- i. The default font for all HMI application objects shall be Tahoma, size 8, and color black.
- j. HMI shall be graphical and shall include support for data base templates, trend displays, other graphics, and web page creation.
- k. HMI shall consist mainly of Employer’s Personnel (operator) consoles connected on the site network via operator workstations. The operation on the operator consoles shall act on free configurable process displays on one side, and on standardized faceplates on the other side.
- l. HMI shall offer the following features on the Employer’s Personnel (operator) workstations:
  - 1) Mimic displays for operating and monitoring the Locks.
  - 2) Fixed-format displays such as overview displays, group displays, and equipment status displays.
  - 3) Data archiving which stores the data over a configurable period and offers the various logs as the alarms logs, event logs, trip logs, long term trending of analog variables automatically or on request.
  - 4) On-line event recording facilities.

- 5) <sup>A16</sup>**Programmable Process Value Trending Features:** Unless otherwise specified in Subparagraph 1.03 F.1.o. or elsewhere in the Employer's Requirements, analog values shall be memorized over at least 72 hours, with a sampling rate of 0.5 second minimum. <sup>A16</sup>
  - 6) Alarms annunciation and displays (with different priority levels).
  - 7) Statistic calculations.
  - 8) System diagnosis presentation.
- m. The systems shall be based on hierarchic visualization concept. This shall be reflected in the display hierarchy where the graphic elements can be displayed easily and quickly.
- n. Traveling through the displays (mimic displays, alarms displays, control displays, data logging, and functional groups displays) shall also be possible:
- 1) Either starting from an overview display, or
  - 2) By pointing at specific designated areas.
  - 3) The following display hierarchy shall be applied:
    - a) Site overview level.
    - b) Machinery room level.
    - c) Equipment level.
- o. **HMI Response Times:** Maximum data logging scan rates shall be 0.1 seconds and adjustable to lower rates as need for specific applications. Default screen animation scan rates shall be used as follows:
- 1) **Scan Class A:** 0.1 second for very fast process values, such as trending screens.
  - 2) **Scan Class B:** 0.5 second for status indication.
  - 3) **Scan Class C:** 1.0 second for machinery motion animations.
  - 4) **Scan Class D:** 2.0 second for water levels <sup>A9</sup> and <sup>A9</sup> vessel detection animation.

2. **Areas of Responsibility (AORs):**

- a. PCS shall be capable of having no less than 5 user types. Areas of responsibility shall include, but not be limited to, the following for each locks:
  - 1) **System Administrator:** Shall have access to install or remove personal computer (PC) based or server based software, gateways, firewalls, domain controllers, HMI software, configure AORs, configure access rights, user password management, configure general network connectivity and protection, install, remove and maintain databases, backup and restore software configuration and hard disk images. Full access to database reporting software. Installs, maintains and manages the security and change management software for PLCs.
    - a) **HMI Software:** Shall have the capability to view and configure all features but not have control capabilities.
    - b) **PLC Programming Software:** Shall have the capability to view and configure all features but not have programming capabilities.
  - 2) **Engineering Authorities:** Shall have access to install, remove and modify PLC based software, view and modify all HMI software, remotely configure highway addressable remote transducer (HART) protocol sensors, view and modify databases, and has full access to database reporting software. Shall have the capability to apply remote resets where available.
    - a) **HMI Software:** Shall have the capability to view and configure all software features. Shall only view user level operation HMI application parameters and options for Lockage operation.
    - b) **PLC Programming Software:** Shall have the capability to view and configure all features and shall have all programming capabilities.
  - 3) **Operators:** Shall have full control of operation applications. Shall have the capability to view all maintenance applications and apply remote resets where available. Shall have the capability to view all reports and database information.
    - a) **HMI Software:** Shall have the capability to view, configure and control all user level operation HMI application parameters and options for Lockage operation.

- b) **PLC Programming Software:** Shall have the capability to upload and view programming software, but shall not have programming or download capabilities.
  - 4) **Employer Locks Maintenance Personnel:** Shall only have the capability to view operation applications and shall have full view and control over maintenance applications. Shall have the capability to apply remote resets where available. Shall have the capability to view all reports and database information.
    - a) **HMI Software:** Shall have the capability to view all user level operation HMI application parameters and options for Lockage operation.
    - b) **PLC Programming Software:** Shall have the capability to upload, download and view programming software, but shall not have programming capabilities.
  - 5) **Employer other Maintenance Personnel:** Shall only be capable of viewing maintenance reports and database information.
    - a) **HMI Software:** Shall have the capability to view all user level operation HMI application parameters and options for Lockage operation.
    - b) **PLC Programming Software:** Shall only have the capability to upload and view programming software, and shall not have programming capabilities.
- 3. **PCS Operations Console (Left Side):** 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. The left side of the central console shall provide Lockage operation control functions by means of the following workstations:
  - a. Machinery control station (MCS), 3 displays, one display per Locks level
  - b. Water level display (WLD)
  - c. Automatic Identification System (AIS) (existing Employer system)
  - d. Vessel schedule terminal (existing Employer system)
  - e. Operations log database server client application, email and office workstation



4. **PCS Operations Console (Right Side):** All maintenance-related monitoring 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 Lock maintenance monitoring functions by means of the following workstations:
    - a. Machinery diagnostics station (MDS)
    - b. Power distribution station (PDS)
  5. **PCS Operations Console Software Architecture:** The console operators shall use <sup>A9</sup>operator HMI software <sup>A9</sup> application clients each running on MCS, WLD, MDS and PDS application servers respectively. PCS remote workstations shall use multiple application clients running on their respective single workstations. <sup>A9</sup>Operator HMI software <sup>A9</sup> applications shall communicate with PLCs using Factory Talk Services provided by <sup>A9</sup>PLC programming software. <sup>A9</sup> Other sources of data not compatible with <sup>A9</sup>PLC programming software <sup>A9</sup> shall communicate with the <sup>A9</sup>operator HMI software <sup>A9</sup> applications through an OPC server. All application server and OPC server software shall be configured for redundancy and failover in case of a fault.
- G. **Manuals:** For all software of this Section, a customized manual as specified in Section 01 78 23 (*Operation and Maintenance Data*) shall be provided, with sections detailing the specific Employer configuration used for the final “as built” software versions, as follows.
1. **Software Installation:** This section shall detail all installation steps required to carryout this procedure from clean start. This shall include details of which software needs to be installed first, and specific installation choices applicable to the Employer.
  2. **Software Configuration:** This section shall detail all software commissioning steps and configuration choices and parameters applicable to the Employer.
  3. **Program Description:** This section shall provide a descriptive narrative of all programs developed specifically for the Employer, including block diagrams, subroutine functions, standard parameters, faults, error list, and their combinations, and other information as needed.
  4. **Software Code:** All custom developed code for the Employer shall be appended to the manual, with a narrative introduction describing the object that calls the code, what it does, what source inputs it requires, and what output data it provides. All software code shall be well documented with detailed comments.
- H. **Security:**
1. <sup>A17</sup>PCSs shall be compatible and ready for asset management, change and configuration management, and Disaster recovery software for authentication, audit, and security. <sup>A17</sup>

2. PCSs domains shall be one per Locks Site, and different than Employer intranet domain.
3. PCSs shall only allow login to Employer’s Personnel (users) that have the privilege after they enter the correct user name and password (authentication). The control console operation shall be comprised of multiple workstations and servers. The Employer’s Personnel (operators) ending and staring their work shifts shall be able to quickly logout and login respectively while the backup (or main) console is in control, and with a single operator login/logout that, in turn, shall be capable of automatically login/logout into all applicable servers and workstations.

**1.04 DESIGN CRITERIA / SYSTEM PERFORMANCE:** Contractor shall provide, configure, develop, install and commission all PCS indicated software below.

**A. General:**

1. **Problem to be Solved:** The systems shall solve the following business needs:
  - a. To provide a combination of commercial software suites capable of integrating seamlessly all features described herein.
  - b. To operate relevant machinery or equipment with minimal system response time and downtime, such that it does not have a negative impact on operations.
  - c. To capture data of machinery or equipment conditions, process the data, evaluate the data, report alarms, suggest course of action, correlate events and present various statistical and trending charts for decision making as applicable for both operation and maintenance tasks at the designated authority workstations.
  - d. To facilitate operation and maintenance tasks by simplifying, making easy, and expediting the operation, the testing, and the maintenance tasks.
  - e. To control, ensure, and report safety issues, both physically as well as electronically.
  - f. To provide operational security, including interlocks running normally in the background to prevent invalid operations.
  - g. <sup>A19</sup>To provide means to measure and display key performance indicators (KPIs) for each PCS, including dashboards. <sup>A19</sup>
2. **Restrictions to be Considered:** Refer to Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Subparagraph 1.03 D.

**B. Central Control Console HMI Software:**

**1. Network Software:**

- a. Domain controller software
- b. **Workstation Software:** Includes Employer approved operating system and antivirus software.
- c. **Single Login Software:** The system shall only allow login to users that have the privilege after they enter the correct user name and password (authentication). The control console operation shall be comprised of multiple workstations and servers. The operators ending and staring their work shifts shall be able to quickly logout and login respectively while the backup (or main) console is in control, and with a single operator logout/login that, in turn, shall be capable of automatically logout/login into all applicable servers and workstations.

**2. PLC Software:**

- a. <sup>A9</sup>PLC programming software communications <sup>A9</sup>
- b. OPC Server Link Master
- c. <sup>A17</sup>Asset management, change and configuration management, and Disaster recovery server <sup>A17</sup>
- d. Tag sever

**3. Security:**

- a. Security server
- b. <sup>A17</sup>**Maintenance Automation Control Center (MACC):** Change Management, and Audit with Asset Management, change and configuration management, and Disaster recovery software. <sup>A17</sup>

**4. <sup>A17</sup>Network and Device Health Monitoring:** MACC with Asset Management, change and configuration management, and Disaster recovery software. <sup>A17</sup>

**5. Database and Analysis:**

- a. <sup>A9</sup>Historian software with plant metrics <sup>A9</sup>
  - 1) Database reporting software

**6. PLC Programming and Testing Software:**

- a. <sup>A9</sup>Enterprise series software

- b. <sup>A11</sup>PLC emulation software<sup>A11</sup>
- c. Simulation software for PLC I/O
- d. Enterprise Manufacturing Intelligence (EMI) simulation software<sup>A9</sup>

**C. Power Distribution System Software:**

- 1. Consumed power cost calculation by equipment hierarchy
- 2. Energy and demand trending
- 3. Power Quality and Total Harmonic Distortion analysis
- 4. Event logging, analysis and event waveform viewing
- 5. OPC Server, if needed.

**1.05 SUBMITTALS:** Shall be in accordance with Section 40 00 00 (*Process Systems Integration*), Paragraph 1.05. [In addition, FIPS security certification for Level 2 and Common Criteria EAL 4+ are required for the applicable PCS software's security functions.](#)

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

**END OF SECTION**