SECTION 25 05 11

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS
**08/24**

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/ and an SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this Section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the Contracting Officer to determine which requirement applies to the project.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135

| | |
|---|---|
| | (2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 802.1x | (2010) Local and Metropolitan Area Networks - Port Based Network Access Control |

INTERNET ENGINEERING TASK FORCE (IETF)

| | |
|---|---|
| IETF RFC 2819 | (2000) Remote Network Monitoring (RMON) Management Information Base (MIB) |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST FIPS 140-2 | (2001) Security Requirements for Cryptographic Modules |
| NIST FIPS 201-2 | (2013) Personal Identity Verification (PIV) of Federal Employees and Contractors |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| DODI 8551.01 | (2014) Ports, Protocols, and Services Management (PPSM) |
| DTM 08-060 | (2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement |

## 1.3 DEFINITIONS

### 1.3.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.

### 1.3.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.

1.3.3 Controller

A device other than a computer, IP Router, or Ethernet switch.

1.3.4 Mission Space

[A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a variable air volume (VAV) box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an air handling unit (AHU) in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.]

1.3.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network. Addresses may be other than IP addresses, and addressing may be at either Open Systems Interconnection (OSI) layer 2 or layer 3.

1.3.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.3.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.3.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.3.8 User Account Support Levels

The support for user accounts is categorized in this Section as one of

three levels:

1.3.8.1 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.3.8.2 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.3.9 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.3.10 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective

privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

#### 1.3.10.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device,

Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

#### 1.3.10.2 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

##### 1.3.10.2.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

##### 1.3.10.2.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

##### 1.3.10.2.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.3.10.2.4 View-Only User Interface

See Read-Only User Interface

1.3.10.3 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.3.10.3.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.3.11 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.4 ADMINISTRATIVE REQUIREMENTS

1.4.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with the [Contracting Officer (KO)][_____].

a. Government Computer Access Point of Contact: [Contracting Office (KO)][_____]

b. HTTPS Certificate Point of Contact: [Contracting Officer (KO)][_____]

c. Email Address Point of Contact: [Contracting Officer (KO)][_____]

d. Password Point of Contact: [Contracting Officer (KO)][_____]

e. Mobile Code Point of Contact: [Contracting Officer (KO)][_____][

f. PKI Infrastructure Point of Contact: [Contracting Officer (KO)][_____]

]

1.4.2 Coordination

Coordinate the execution of this Section with the execution of all other

Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.

b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

c. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.

e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install the software.

f. The Cybersecurity Interconnection Schedule must be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

g. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

h. Passwords must be coordinated with the indicated contact for the project site.

i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

## 1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Wireless and Wired Broadcast Communication Request; G, [_____]

] Device Account Lock Exception Request; G, [_____]

Multiple Ethernet Connection Device Request; G, [_____]

Contractor Computer Cybersecurity Compliance Statements; G

Contractor Temporary Network Cybersecurity Compliance Statements; G

Cybersecurity Interconnection Schedule (Encrypted); G, [_____]

Protection of Information At Rest Proposal; G, [_____]

Proposed STIG and SRG Applicability Report; G, [_____]

Pre-Construction Control System Inventory Report (Encrypted); G, [_____]

Contractor Personnel Certifications; G, [_____]

USACE OT/Control Systems Acceptable Use Policy (AUP); G, [_____]

Account Level Permissions List (Encrypted); G, [_____]

SD-02 Shop Drawings

Network Communication, Ports, Protocols and Services Report; G[, [_____]] Cybersecurity Network (Riser) Diagram (Encrypted);

G, [_____]

System Data Flow Diagram (Encrypted); G, [_____]

SD-03 Product Data

Control System Cybersecurity Documentation; G, [_____]

Certificate Protection Status (Encrypted); G, [_____]

SD-06 Test Reports

[ Wireless Communication Test Report; G, [_____]
]

Control System Cybersecurity Testing Procedures; G, [_____]

Control System Cybersecurity Testing Report; G, [_____]

Antivirus/Antimalware Scan Results; G, [_____]

SD-07 Certificates

Software Licenses; G, [_____]

SD-11 Closeout Submittals

[ Confidential Password Report; G, [_____]

][ Password Change Summary Report; G, [_____]

] Enclosure Keys; G, [_____]

Software and Configuration Backups (Encrypted); G, [_____]

Auditing Front End Software; G, [_____]

Device Audit Record Upload Software; G, [_____]

System Maintenance Tool Software; G, [_____]

Control System Scanning Tools; G, [_____]

STIG, SRG and Vendor Guide Compliance Result Report (Encrypted); G, [_____] Final Control System Inventory Report (Encrypted); G,

[_____]

Integrity Verification Software; G, [_____]

Vulnerability Resolution Report; G, [_____]

BIOS/UEFI Protection Password/Passphrase List (Encrypted); G,

[_____]

## 1.6 ENCRYPTED SUBMITTAL REQUIREMENTS

Submittals with sensitive data are marked with "(encrypted)" and must be encrypted with NIST FIPS 140-2 compliant encryption methods with a password that meets the requirements under paragraph PASSWORDS. Encrypted submittals must be sent via DoD SAFE (https://safe.apps.mil/) and only sent to those who need to know. If DoD SAFE is not available, the government will provide an alternative secure file transfer that must be used. Do not store encrypted submittals on shared storage systems. Store and send encrypted information separately than the password.

## 1.7 QUALITY CONTROL

### 1.7.1 Certifications

Personnel performing cybersecurity functions must have current [IAT level 1][IAT level II][_____] certification according to approved DoD IA baseline certifications. Provide Contractor Personnel Certifications no later than [30][_____] days following Notice To Proceed. A cybersecurity function includes security-relevant functions that ordinary users are not authorized to perform. Examples of these activities include, but are not limited to, creating/modifying user accounts, configuring auditing levels, configuring functionality of a device that is restricted from general users, network architecture design, and applying secure configuration to an Operating System or device. See https://public.cyber.mil/cwmp/dod-approved-8570- baseline-certifications/.

Personnel who will have access to make changes to the OT system must read, agree to, and sign the USACE OT/Control Systems Acceptable Use Policy (AUP), provided by the government prior to accessing the OT system. Provide signed AUPs no later than [30][_____] days after notice to proceed.

## 1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

### 1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model. Provide the Proposed STIG and SRG Applicability Report concurrently with the Pre-Construction Control System Inventory Report.

### [1.8.2 Cybersecurity Interconnection Schedule (Encrypted)

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Manufacturer, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication. [For communication with other authorized systems also provide the Foreign Destination and POC for Destination.] For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

### ]1.8.3 Network Communication, Ports, Protocols and Services Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}

Provide a Network Communication, Ports, Protocols and Services Report. For each networked device, document device identifier and the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP communication, document all TCP and UDP ports used. For each device using non-IP communication, document communication protocol and media used. If other control system Sections used on this project include

submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication, Ports, Protocols and Services Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Reports

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Pre-Construction Control System Inventory Report (Encrypted) report and a Final Control System Inventory Report (Encrypted), using the [ Inventory Spreadsheet][Hardware-Software List Template] listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 In the Control System Inventory Reports, document all [networked devices, including network infrastructure devices][devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators)], and all software. For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Reports as editable Microsoft Excel files. Provide the Pre-Construction Control System Inventory Report concurrently with the Proposed STIG and SRG Applicability Report

1.8.5 System Data Flow Diagram (Encrypted)

Submit a system data flow diagram (encrypted) a minimum of 60 days prior to installed operation of the equipment. Provide diagrams electronically in PDF as well as either Microsoft Visio (VSDX) or Microstation (DGN), formatted for 11" x 17" sheets. Include:

a. All devices that communicate via routable protocols.

b. The normal system communications among the devices on the network, including the ports and protocols utilized for communications

c. Arrows to indicate direction of data flow between components. Define the physical media and protocol for each link.

d. Logical boundary of the system marked with a red line clearly defining components inside the boundary as well as components outside the boundary. Label connections to external networks and indicate the boundary protection.

e. Indicate VLAN segmentation of the devices on the diagram.

1.8.6 Software and Configuration Backups (Encrypted)

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer on an encrypted external hard drive. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.

For all Ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

Test backups to verify as functional for restoring the system prior to submittal. Include verification of testing and functionality with submittal. If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

### 1.8.7 Cybersecurity Network (Riser) Diagram (Encrypted)

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity network (riser) diagram of the complete control system including all network and device hardware. For each device, include the device identifier, device type, and manufacturer. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in [one-line format][one-line format overlayed on a facility schematic][tabular format][_____].

Provide diagrams electronically in Portable Document Format (PDF) as well as either Microsoft Visio (VSDX) or Microstation (DGN), formatted for 11" x 17" sheets.

### 1.8.8 STIG, SRG and Vendor Guide Compliance Result Report (Encrypted)

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, document compliance with the STIG or SRG requirements.

a. For components which are scannable by [the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), include the SCAP][the Evaluate-STIG tool (available online at (CAC Required), include the Evaluate-STIG] report and raw scan results in addition to the final, manually reviewed and revised, documentation of compliance with STIG and SRG requirements. Checklist files should not contain any findings with a Not Reviewed (NR) status after manual reviews.

b. For components which do not support automated scanning, a manual review using the General Purpose STIG option should be done. A

completed Checklist file should not contain any findings with a Not Reviewed (NR) status after manual reviews

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

#### 1.8.8.1 STIG, SRG and Vendor Guide Compliance Result Report Deviations List

Within the STIG, SRG and Vendor Guide Compliance Result Report, include a Deviations List documenting all deviations required for system operation, and reasons why a STIG, patch, firmware update, or other requirement cannot be met. Include for each deviation:

a. STIG, SRG, Patch, Firmware Update, or other requirement being deviated

b. Vulnerability Identification

c. Rule Identification

d. Control

e. Control Correlation Identifier (CCI)

f. Finding

g. Justification

h. Current Risk-Mitigation Actions

### 1.8.9 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5(a),SA-5(b),SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

#### 1.8.9.1 Software Applications

For all software applications running on computers provide:

a. administrator documentation that describes secure configuration of the software {For Government Reference Only: relates to CCI-003124}

b. administrator documentation that describes secure installation of the software and software updates. {For Government Reference Only: relates to CCI-003125}

c. administrator documentation that describes secure operation of the software {For Government Reference Only: relates to CCI-003124}

d. administrator documentation that describes effective use and maintenance of security functions or mechanisms for the software {For Government Reference Only: relates to CCI-003127}

e. administrator documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software {For Government Reference Only: relates to CCI-003128}

f. user documentation that describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. user documentation that describes methods for user interaction which enables individuals to use the software in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. user documentation that describes user responsibilities in maintaining the security of the software {For Government Reference Only: relates to CCI-003131}

#### 1.8.9.2 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

i. Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}

## 1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the [Government][project site][_____] for a period [of no less than 5 years][___], and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

## 1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

### 1.10.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

#### 1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

#### 1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must perform a full antivirus scan at least once per day. Computers which have connected to any other network since the last full antivirus scan must perform a full antivirus scan prior to connection to the control system network or to the temporary contractor-installed IP network.

Perform an antivirus scan on all removable media (e.g., external hard drives, CDs, DVDs, USB flash drives) prior to connecting to the control system environment.

1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Firewall

Computers must have a firewall enabled and set to "public".

1.10.1.6 Encryption

Employ data-at-rest encryption to protect information stored on the device. The types of information that must be protected include site specific drawings, configuration files, project files, vulnerability data, and any other specific information that could potentially lead to a compromise. Immediately notify the Contracting Officer in the event that a Contractor-owned computer that stores this information is lost or stolen.

1.10.1.7 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.8 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

[ In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.]

Temporary wireless networks are NOT PERMITTED.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

All products used on this project must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

Switches must:

a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.[

c. For LOW Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.][

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819][

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.][

f. Support authentication via RADIUS server (for management and 802.1x)][

g. Support IEEE 802.1x network login.]

2.1.2 Configuration Requirements

Switches must:

a. Support configuration save and restore.

b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.[

d. Support the ability to lock configuration capability to a dedicated management port.]

## 2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

## 2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

{For Government Reference Only: This subpart (and its subparts) relate to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}

All computer-based databases must use [Microsoft SQL Server][ or ][Oracle][ or ][MySQL]. All computer-based web interfaces must use [Internet Information Services (IIS)][ or ][Apache] as the web server.

2.4 Lockable Enclosures with Padlock

Provide lockable enclosures with lockable handles, doors, or accessories allowing the cabinet to be secured using a padlock. Provide a stainless steel padlock with a minimum of a 3/8-inch diameter hardened shackle for each enclosure.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Configure hardware and software in accordance with the applicable STIGs and SRGs per the STIG and SRG applicability report. Install the most current versions of operating systems, software updates, firmware updates, security patches, service packs, and BIOS/UEFI, unless otherwise specified or approved. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication for Systems Other than Fire Protection Systems

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-001449}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication. [If requesting authorization for wireless or wired broadcast communication, wired broadcast media such as powerline carrier is preferred to wireless. ]

3.2.2.1 Wireless and Wired Broadcast IP Communications

[Unless specifically approved and installed in accordance with the project site requirements, ]Do not install wireless or wired broadcast IP networks, including: do not install a wireless access point; do not install or configure an ad-hoc wireless network; do not install or configure a WiFi Direct communication.

When explicitly authorized by the Government, wireless IP communication may be used to communicate with an existing wireless network.

3.2.2.2 Non-IP Wireless Communication

For LOW Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, use the maximum level of encryption supported by the specific protocol employed and select signal strength and radiated power to the minimum necessary for reliable communication.

For MODERATE Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, the radios must meet NIST FIPS 140-2 Level 2.

3.2.2.3 Wireless and Wired Broadcast Communication Request

Provide a report documenting the proposed use of wireless or wired broadcast communication prior to device selection using the Wireless and Wired Broadcast Communication Request Schedule at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 If there is no proposed use of wireless or wired broadcast communication, provide a document indicating this instead of the Request Schedule.

For each device proposed to use wireless or wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers of other devices communicating with the device, the protocol used for communication, encryption type and strength. For wireless communication, also show: RF Frequency, Radiated Power in dBm (decibel with a milliwatt reference), free-space range, and the expected as-installed range.

3.2.2.4 Wireless Communication Testing

As part of [Performance Verification Testing (PVT)][Functional Performance Testing {FPT}][_____], conduct testing of wireless communication for all devices indicated on the approved Wireless and Wired Broadcast Communication Request as requiring testing.

To test wireless communication, test for wireless network reception at multiple points along the wireless test boundary in the vicinity of the wireless device, and record whether a network connection can be established at each point. The wireless test boundary is [the building exterior walls][the facility fence line][_____]. If wireless testing is required, provide a Wireless Communication Test Report documenting the testing points and results at each point for each wireless device.

]3.2.3 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

### 3.2.4 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

#### 3.2.4.1 IP Network Routers

[ For IP-based communications across control systems, use Routers to control and restrict traffic flow between network and virtual local area network (VLAN) traffic. Configure routers using Access Control Lists (ACLs) using a deny-all, permit by exception approach. When network traffic is within the local perimeter use Traditional Network Routers. When network traffic leaves the local perimeter, use Integrated Service Routers (ISR) or Firewalls with VPN capability instead.]

[ Do not install any device that performs IP routing.]

#### 3.2.4.2 IP Devices With Multiple Ethernet Connections

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

### 3.2.5 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1),

SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.[

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that [all][IP][_____] network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.]

#### 3.2.5.1 Additional Cryptographic Protection Requirements for USACE Civil Works Systems

Protect the following communications using NIST FIPS 140-2 compliant encryption methods:

a. Public switched telephone network

b. Leased lines

c. Any wireless communication

Establish Virtual Private Network IPSec tunnels between different facilities and between wireless devices. Provide firewalls to control communications between tunnels. Firewalls must meet STIG requirements. Network and wireless devices must be on the DISA approved product list (APL). See https://aplits.disa.mil/processAPList.

### 3.2.6 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

All computers must support [and implement ]IEEE 802.1x for device authentication to the network.

#### 3.2.6.1 For HVAC Control System Devices

Devices using HTTP as a control protocol must use HTTPS instead. [Devices using Ethernet must support IEEE 802.1x. ][Devices using Fox Protocol must support IEEE 802.1x. ][Devices using BACnet must support network security as specified for BACnet Secure Connect in ASHRAE 135.]

#### 3.2.6.2 For Lighting Control System Devices

Devices using HTTP as a control protocol must use HTTPS instead. [Devices using Fox Protocol must support IEEE 802.1x. ][Devices using Ethernet must support IEEE 802.1x. ][Devices using BACnet must support network security as specified for BACnet Secure Connect in ASHRAE 135.]

#### 3.2.6.3 [_____] Control System Devices

[_____]

#### 3.2.6.4 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: [Devices using

Ethernet must support IEEE 802.1x. ]Devices using HTTP as a control protocol must use HTTPS instead.

### 3.2.7 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

### 3.2.8 Secure Network Design

Provide network segmentation for networks leaving a local physical boundary, containing multiple types of systems (such as control and electronic security systems), or controlling more than one process that does not require direct communication of the control system components amongst discrete processes. Dual-homed hosts are prohibited. Protect external connections to the outside with a router, firewall, VPN, and IDS.

Network Interface Cards (NICs) or network transceivers are considered to be network connected regardless of network protocol used. Unused NICs must be disabled. A device is considered to be wireless network connected unless the wireless network controller is physically disabled. It is not sufficient to disable the wireless NIC in settings.

### 3.2.9 OT Monitoring System (OTMS)

Provide [1 rack unit][2 rack units][[_____]rack units] of rack space for data taps to be furnished, installed, and configured by the Government.

## 3.3 ACCESS CONTROL REQUIREMENTS

### 3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405,
CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with

read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification. Disable any unnecessary or unused accounts. Disable any "guest-level" accounts that are created on the system by default.

#### 3.3.1.1 Computers

All computer operating systems must FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer must be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers must not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

##### 3.3.1.1.1 User Account Levels

Configure OT using three account access levels: operator level, service level, and administration level. Configure normal operations to occur using an operator level account. Configure the operator level with minimum privileges required to operate the system that does not allow for configuration changes. Disable removable media devices and USB ports (with the exception of keyboard and mouse) for all levels except the administrator level. Submit an Account Level Permissions List (Encrypted) documenting the names all levels and which permissions are allowed for each level.

#### 3.3.1.2 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a lockable enclosure. Where this is required for a read only interface, the lockable enclosure must prevent viewing of data on the interface; for other interfaces, this lockable enclosure must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

#### 3.3.1.2.1 HVAC Control Systems

User Interface Requirements for LOW Impact HVAC Control Systems

| **User Interface Type** | **Access Control Requirement** |
|---|---|
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | [None Required][MINIMALLY] |
| Local Limited, Privileged | [MINIMALLY][Physical Security] |
| Local Full | MINIMALLY |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | MINIMALLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |

Notes:
1) Local Read Only User Interfaces are always Non-Privileged
2) Remote Full User Interfaces are always Privileged

User Interface Requirements for MODERATE Impact HVAC Control Systems

| **User Interface Type** | **Access Control Requirement** (See note 3) |
|---|---|
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | [None Required][MINIMALLY] |

| | |
|---|---|
| Local Limited, Privileged | [MINIMALLY and Physical Security][FULLY] |
| Local Full | MINIMALLY and Physical Security |

User Interface Requirements for MODERATE Impact HVAC Control Systems

| **User Interface Type** | **Access Control Requirement** (See note 3) |
|---|---|
| Remote Read Only | [None Required][MINIMALLY] |
| Remote Limited, Non-Privileged | FULLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |

Notes:
1) Local Read Only User Interfaces are always Non-Privileged
2) Remote Full User Interfaces are always Privileged
3) Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

3.3.1.2.2 Lighting Control Systems

User Interface Requirements for LOW Impact Lighting Control Systems

| **User Interface Type** | **Access Control Requirement** |
|---|---|
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | [None Required][MINIMALLY] |
| Local Limited, Privileged | [MINIMALLY][Physical Security] |
| Local Full | MINIMALLY |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | MINIMALLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |

Notes:
1) Local Read Only User Interfaces are always Non-Privileged
2) Remote Full User Interfaces are always Privileged

| User Interface Requirements for MODERATE Impact Lighting Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** (See note 3) |
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | [None Required][MINIMALLY] |

| User Interface Requirements for MODERATE Impact Lighting Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** (See note 3) |
| Local Limited, Privileged | [MINIMALLY and Physical Security][FULLY] |
| Local Full | MINIMALLY and Physical Security |
| Remote Read Only | [None Required][MINIMALLY] |
| Remote Limited, Non-Privileged | FULLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |

Notes:
1) Local Read Only User Interfaces are always Non-Privileged
2) Remote Full User Interfaces are always Privileged
3) Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

3.3.1.2.3 Electronic Security Systems (ESS)

| User Interface Requirements for LOW Impact Electronic Security Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** |
| Local Read Only (see note 1) | [KEY][MINIMALLY] |
| Local Limited, Non-privileged | NA |
| Local Limited, Privileged | [MINIMALLY and KEY][FULLY] |
| Local Full | FULLY and Physical Security |
| Remote Read Only | [None Required][MINIMALLY] |
| Remote Limited, Non-Privileged | NA |

| | |
|---|---|
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |

Notes:
1) Local Read Only User Interfaces are always Non-Privileged
2) Remote Full User Interfaces are always Privileged

User Interface Requirements for MODERATE Impact Electronic Security Systems

| **User Interface Type** | **Access Control Requirement** (See note 3) |
|---|---|
| Local Read Only (see note 1) | [KEY][MINIMALLY] |
| Local Limited, Non-privileged | NA |
| Local Limited, Privileged | FULLY |
| Local Full | FULLY and Physical Security |
| Remote Read Only | [None Required][MINIMALLY] |
| Remote Limited, Non-Privileged | NA |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |

Notes:
1) Local Read Only User Interfaces are always Non-Privileged
2) Remote Full User Interfaces are always Privileged
3) Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

3.3.1.2.4 Fire Protection Systems

User Interface Requirements for LOW Impact Fire Protection Systems

| **User Interface Type** | **Access Control Requirement** |
|---|---|
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | [None Required][KEY or MINIMALLY] |
| Local Limited, Privileged | KEY and Physical Security |
| Local Full | KEY |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | MINIMALLY |

| | |
|---|---|
| Remote Limited, Privileged<br>AND<br>Remote Full | FULLY |

Notes:
1) Local Read Only User Interfaces are always Non-Privileged

User Interface Requirements for MODERATE Impact Fire Protection Systems

| **User Interface Type** | **Access Control Requirement** |
|---|---|
| Local Read Only | (See note 2)<br>None Required |
| Local Limited, Non-privileged | [None Required][KEY or MINIMALLY] |
| Local Limited, Privileged | [KEY and Physical Security][FULLY] |
| Local Full | KEY |
| Remote Read Only | [None Required][MINIMALLY] |
| Remote Limited, Non-Privileged | FULLY |
| Remote Limited, Privileged<br>AND<br>Remote Full | FULLY |

Notes:
1) Local Read Only User Interfaces are always Non-Privileged
2) Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

### 3.3.1.2.5 USACE Civil Works Control Systems

User Interface Requirements for LOW Impact USACE Control Systems

| **User Interface Type** | **Access Control Requirement** |
|---|---|
| Local Read Only (see note 1) | KEY |
| Local Limited, Non-privileged | [(see note 3)][MINIMALLY] |
| Local Limited, Privileged | [(see note 3)][MINIMALLY][Physical Security] |
| Local Full | [(see note 3)][NA] |
| Remote Read Only | [(see note 3)][FULLY] |
| Remote Limited, Non-Privileged | NA |
| Remote Limited, Privileged | NA |

| | |
|---|---|
| Remote Full (see note 2) | FULLY |

User Interface Requirements for LOW Impact USACE Control Systems

| **User Interface Type** | **Access Control Requirement** |
|---|---|

Notes:
1)Local Read Only User Interfaces are always Non-Privileged
2)Remote Full User Interfaces are always Privileged
[3)Device or system should not be capable of providing the interface type, otherwise notify the COR]

User Interface Requirements for MODERATE Impact USACE Control Systems

| **User Interface Type** | **Access Control Requirement** (See note 3) |
|---|---|
| Local Read Only | KEY |
| Local Limited, Non-privileged | [(see note 4)][MINIMALLY] |
| Local Limited, Privileged | [(see note 4)][MINIMALLY and Physical Security] |
| Local Full | [(see note 4)][NA] |
| Remote Read Only | [(see note 4][FULLY] |
| Remote Limited, Non-Privileged | NA |
| Remote Limited, Privileged | NA |
| Remote Full | FULLY |

Notes:
1)Local Read Only User Interfaces are always Non-Privileged
2)Remote Full User Interfaces are always Privileged
3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS") [4) Device or system should not be capable of providing the interface type, otherwise notify the COR]

3.3.1.2.6 [_____] Control Systems

User Interface Requirements for LOW Impact [_____] Systems

| **User Interface Type** | **Access Control Requirement** |
|---|---|

| | |
|---|---|
| Local Read Only (see note 1) | [_____] |
| Local Limited, Non-privileged | [_____] |
| User Interface Requirements for LOW Impact [_____] Systems | |
| **User Interface Type** | **Access Control Requirement** |
| Local Limited, Privileged | [_____] |
| Local Full | [_____] |
| Remote Read Only | [_____] |
| Remote Limited, Non-Privileged | [_____] |
| Remote Limited, Privileged AND Remote Full (see note 2) | [_____] |
| Notes:<br>1) Local Read Only User Interfaces are always Non-Privileged<br>2) Remote Full User Interfaces are always Privileged | |
| User Interface Requirements for MODERATE Impact [_____] Systems | |
| **User Interface Type** | **Access Control Requirement** (See note 3) |
| Local Read Only | [_____] |
| Local Limited, Non-privileged | [_____] |
| Local Limited, Privileged | [_____] |
| Local Full | [_____] |
| Remote Read Only | [_____] |
| Remote Limited, Non-Privileged | [_____] |
| Remote Limited, Privileged AND Remote Full (see note 2) | [_____] |

| |
|---|
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated<br>(in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS") |

3.3.1.2.7 Default Requirements for Other Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

| Default User Interface Requirements for LOW Impact Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** |
| Local Read Only (see note 1) | [None Required][MINIMALLY] |
| Local Limited, Non-privileged | [None Required][MINIMALLY] |
| Local Limited, Privileged | [MINIMALLY][Physical Security] |
| Local Full | [MINIMALLY][FULLY] |
| Remote Read Only | [None Required][MINIMALLY] |
| Remote Limited, Non-Privileged | MINIMALLY |
| Remote Limited, Privileged<br>AND<br>Remote Full (see note 2) | FULLY |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged | |

| Default User Interface Requirements for MODERATE Impact Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement**<br>(See note 3) |
| Local Read Only (see note 1) | [None Required][MINIMALLY] |
| Local Limited, Non-privileged | [None Required][MINIMALLY] |
| Local Limited, Privileged | [MINIMALLY and Physical Security][FULLY] |

| | |
|---|---|
| Local Full | [MINIMALLY and Physical Security][FULLY] |
| Remote Read Only | [None Required][MINIMALLY] |
| Remote Limited, Non-Privileged | FULLY |
| Remote Limited, Privileged<br>AND<br>Remote Full (see note 2) | FULLY |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated<br>(in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS") | |

3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration

and auditing must be configured as indicated.

3.3.1.3.1 For Control System Applications Running on Computers

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.

3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts [are not required to lock based on unsuccessful logon

attempts][must lock the user account [after [five][_____] consecutive failed login attempts][_____] and must unlock the user account after [15][_____] minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account].

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account[after [five][_____] consecutive failed login attempts][_____] and must unlock the user account after [60][_____] minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when [three][_____] unsuccessful logon attempts occur within a [15 minute][_____] interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for [1 hour][_____] and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

[There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.][The following high availability interfaces are exempt from unsuccessful logon attempts requirements:

| **High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements** | | |
|---|---|---|
| **User Interface** | **Location** | **Action to take in lieu of locking screen** |
| [_____] | [_____] | [_____] |
| [_____] | [_____] | [_____] |
| [_____] | [_____] | [_____] |

]

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Computers

[Except as shown in the Session Lock and Session Termination Exception Table, ]User Interface sessions provided by computer operating systems must support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination must be capable of being initiated by the user and must also be initiated by lack of activity. Session Lock must occur after [15][_____] minutes of inactivity, and Session Termination must occur after [30][_____] minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to [1][_____].

[Except as shown in the Session Lock and Session Termination Exception Table, ]Other User Interface sessions running on computers (for local user interfaces) or hosted on a computer (for remote user interfaces) and supporting accounts must support user initiation of Session Termination[ and session lock. Session lock may be initiated by user initiation or automatically after [15][_____] minutes of inactivity]. In addition, remote User Interface sessions must also initiate Session Termination after [30][_____] minutes of inactivity [unless otherwise indicated in the Session Lock and Termination Exceptions table].

3.3.4.4 Session Lock and Termination for Controllers

[Except as shown in the Session Lock and Session Termination Exception Table, ]Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after [30][_____] minutes of inactivity.

[Except as shown in the Session Lock and Session Termination Exception Table, ]Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination[, unless otherwise indicated in the Session Lock and Termination Exceptions table], with Session Termination initiated at [30][_____] minutes of inactivity.[ They must also support session lock, where session lock may be initiated by user initiation or automatically after [15][_____] minutes of inactivity.]

[3.3.4.5 Session Lock and Termination Exceptions

Table: Session Lock and Termination Exceptions

| **Device** | **Location** | **Session Lock and Termination Requirements for Device (or "none" to indicate session lock or session termination is not required)** |
|---|---|---|
| [_____] | [_____] | [_____] |
| [_____] | [_____] | [_____] |
| [_____] | [_____] | [_____] |

]3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions[ except read-only actions] by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

### 3.3.6 Physical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

#### 3.3.6.1 Physical Security for Media

##### 3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

##### 3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

##### 3.3.6.1.3 Physical Security for Non-Network Media in Fire Protection Systems

For Fire Suppression Systems which can be inhibited or forced to activate by manipulation of non-network wiring, install all non-network media outside of mission space, including analog and binary instrumentation wiring and power wiring, in rigid metallic conduit.

#### 3.3.6.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers, and other OT devices, connected to an IP network in lockable enclosures (both inside and outside of mission space).

##### 3.3.6.2.1 Physical Security for Devices in Fire Protection Systems

For Fire Suppression systems with a release panel, install all components of the suppression system either inside mission space, or within locked enclosures. Components of these systems include: release panel, any relay or interface panels, analog and binary inputs or outputs, control valves, manual valves.

#### 3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.

[3.3.6.4 Additional Physical Security for Confidentiality of User Interfaces and Printers

For each user interface or printer indicated in the "User Interfaces and Printers Requiring Additional Security Controls" table, implement the additional confidentiality controls indicated.

| User Interfaces and Printers Requiring Additional Security Controls | | |
|---|---|---|
| User Interface or Printer | Location | Additional Confidentially Control to be Implemented |
| [_____] | [_____] | [_____] |
| [_____] | [_____] | [_____] |
| [_____] | [_____] | [_____] |

]3.3.7 Enclosures

Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

## 3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)-IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

### 3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

[ For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.]

For MODERATE Impact Systems:[User interfaces provided by computer operating systems must implement multifactor authentication via PIV. ][User interfaces supporting accounts (FULLY or MINIMALLY) on computers must implement multifactor authentication via PIV. ][Devices with writable remote user interfaces must implement multifactor authentication via PIV. ][Devices with Privileged Remote User Interfaces must implement multifactor authentication via PIV.] Software running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

### 3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

#### 3.4.2.1 HVAC Control Systems Devices

[No additional system specific requirements apply.][User Interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.]

#### 3.4.2.2 Lighting Control Systems Devices

[No additional system specific requirements apply][User Interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.]

#### 3.4.2.3 Electronic Security System Devices

User interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.[ Other user interfaces which FULLY support accounts must use multifactor authentication via PIV.][ User interfaces which MINIMALLY support accounts must use either passwords or multifactor authentication via PIV.]

#### 3.4.2.4 [_____] Control System Devices

[_____]

### 3.4.3 User Identification and Authentication for Specific Devices

[ There are no additional device specific user interface requirements][ Additional user identification and authentication requirements are defined in the TABLE.

TABLE: Additional Device Specific User Identification and Authentication Requirements

| **User Interface Device or Description** | **Identification and Authorization Requirements** |
|---|---|
| [_____] | [_____] |
| [_____] | [_____] |

| | |
|---|---|
| [_____] | [_____] |
| [_____] | [_____] |

]

[3.4.3.1 [_____]

[_____]

]

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a minimum lifetime of 24 hours.

g. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of [four][_____] characters.

3.4.5.5 Password Configuration and Reporting

[ For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Summary Report in electronic format. Provide [two][_____] hardcopies of the Password Summary Report, each copy in its own sealed envelope.

][For all devices with a password, coordinate the changing of passwords with the project site following testing of the system but prior to turnover to the Government. Coordinate with Password Point of Contact to determine appropriate project site personnel to complete password changes. Accompany identified personnel to each device with a password and instruct personnel on the process of changing password. Record the time, date and personnel present when each device's password is changed and submit a Password Change Summary Report documenting this information.

Provide the Password Summary Report electronically in both PDF and Microsoft Excel.
]

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

[3.4.7 Implementation of PKI Infrastructure in Moderate Impact Systems (Except USACE Civil Works Systems)

Coordinate with the PKI Infrastructure Point of Contact to configure the system to implement PKI such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information; the system enforces authorized access to the corresponding private key; the system

maps the authenticated identity to the account of the individual or group; and the system implements a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network.

]3.4.8 Implementation of PKI Infrastructure in USACE Civil Works Systems

Coordinate with the PKI Infrastructure Point of Contact to configure the PKI system. Implement PKI digital certificates for communications where possible, such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information. Configure the system to enforce authorized access to the corresponding private key, to map the authenticated identity to the account of the individual or group, and to implement a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network. [Self-signed certificates are acceptable. ]Document communications devices that cannot be Certificate protected in a Certificate Protection Status (Encrypted) submittal for all communication devices prior to any equipment requiring certificates arriving at the site.

## 3.5 CYBERSECURITY AUDITING

[ Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the system, disable email notifications.]

USACE Civil Works systems do not permit email notification. Disable all email notification. Auditing requirements for email notification in this section do not apply to USACE Civil Works control systems

### 3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

#### 3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event. Send logs to a syslog server that is only accessible via accounts on the system with privileged level access.

3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Privileged activities or other system level access

e. Concurrent logons from different workstations

f. Successful and unsuccessful accesses to objects

g. Program initiations

h. Direct access to the information system

i. Account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

j. Kernel module load, unload, and restart

k. Operator actions related to operation of the system

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred

b. When the event occurred

c. Where the event occurred

d. The source of the event

e. The outcome of the event

f. The identity of any individuals or subjects associated with the event

g. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2 For HVAC Control System Controllers

3.5.1.2.1 HVAC Control System Controllers FULLY Supporting User Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.2.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful logon attempts to the controller

b. Successful logouts

c. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

d. All controller shutdown and startup

e. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.2.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. the identity of any individuals or subjects associated with the event

d. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2.2 Other HVAC Control System Controllers

There are no requirements to perform auditing at HVAC field controllers that do not FULLY support accounts.

3.5.1.3 For Lighting Control System Controller

3.5.1.3.1 Lighting Control System Controllers FULLY Supporting User Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.3.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful logon attempts to the controller

b. Successful logouts

c. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

d. All controller shutdown and startup

e. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.3.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. the identity of any individuals or subjects associated with the event

d. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.3.2 Other Lighting Control System Controllers

There are no requirements to perform auditing at Lighting field controllers that do not FULLY support accounts.

3.5.1.4 [_____] Control System Controllers

[_____]

3.5.1.5 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.5.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure

controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.5.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.5.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.5.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

### 3.5.3 Auditing Front End Software

The project site currently has the following software to support control system auditing: [none][_____]. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license [for subsequent Government installation][and install the software on [_____]][the control system front end computer in [_____]]. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

#### 3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

#### 3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

#### 3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems

The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.

#### 3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875,

CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to [2][_____] seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

### 3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For controllers capable of generating audit records, provide [60][_____] days worth of secure local storage, assuming [10][_____] auditable events per day.[

c. For computers, provide storage for at least [_____] audit records.]

#### 3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}

Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.

#### 3.5.4.2 Device Audit Record Upload Software

For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different

devices use different software, provide software of each type required to upload audit logs from all devices.

[When Device Audit Record Upload Software is capable of uploading audit logs over the network, install Device Audit Record Upload Software on the same computer as the Auditing Front End Software.] Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In the case of a failure in the auditing system, computers associated with auditing must provide email notification[ and must [_____]]. For MODERATE Impact systems, the computer must also notify the associated auditing front end software. In case of an audit failure, if possible, continue to collect audit records by [overwriting existing audit records][_____].

For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device must notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by [overwriting existing audit records][_____] if able. The auditing front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the Network Communication, Ports, Protocols and Services Report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

For HVAC Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For Lighting Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required.

For Other Control Systems: For LOW Impact Systems: [Do not provide devices with remote user interfaces or with full user interfaces where one was not required.] [Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.]

For Other Control Systems: For MODERATE Impact Systems: Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For all MODERATE Impact Systems: Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

Do not install software that is not specifically required to meet a contract requirement. Remove any previously installed that is not specifically required to meet a contract requirement. Do not implement functionality within software that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Network Reliance in MODERATE Impact HVAC Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller

executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.2.2 Network Reliance in MODERATE Impact Lighting Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

[3.7.2.3 Network Reliance in MODERATE Impact [_____] Control Systems

[_____]

]3.7.2.4 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

[Mobile code may only be downloaded from a specifically authorized mobile code repository. Coordinate with the Mobile Code Point of Contact for the location of a repository.]

3.7.4 Protection of Information at Rest In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199, CCI-002472, CCI-002475, CCI-002476}

Computers must protect information at rest in accordance with applicable STIGs.

Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.

### 3.7.5 Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems

{For Government Reference Only: This subpart relates to SC-7(a), SC-7(c), SC-7(4)(a), SC-7(4)(c), SC-7(5), SC-7(7), SC-7(9)(a), SC-7(11), SC-7(13), SC-7(13), SC-7(18); CCI-001097, CCI-001098, CCI-001102, CCI-002396, CCI-001109, CCI-002397, CCI-002398, CCI-002399, CCI-002403, CCI-001120, CCI-001119, CCI-001126}

#### 3.7.5.1 Radio Interfaces for Fire Protection Systems

When radios interfacing a local fire protection system to a supervisory system are not NIST FIPS 140-2 validated, use a relay panel interface between the local fire protection system and the radio. Install and configure the relay panel to prohibit initiating any action within the local fire protection system other than causing the system to play a pre-recorded message[ or causing the system to play a live audio message]. [Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal][Install relays using the normally closed contact such that they pass a signal when they open, and so that a relay that loses power or has a failed coil passes the signal]

#### 3.7.5.2 Fire Suppression System Network Isolation

For fire suppression systems including a release panel, any network used in these systems must be dedicated to these systems and must be isolated from any other network, including other components of the Fire Alarm and Fire Suppression systems. Use only dry contacts and relays to transfer signals from these systems to any other systems. [Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal][Install relays using the normally closed contact such that they pass a signal when they open, and so that a relay that loses power or has a failed coil passes the signal]

### 3.7.6 Application Separation

Configure operating systems, applications, and network accessible devices using application separation. Utilize the operating system on the primary partition of the hard drive. Install application databases on a different partition than the operating system. Install web servers on a different partition than the operating system. Do not install web servers and database servers on the same computer. Do not host web servers and database servers on the same Virtual Machine.

## 3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

## 3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system, including programming of devices, without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal. Provide any hardware keys or dongles, software keys, license numbers, and other information required to enable the Government to access or change the system.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit [one hard copy][[_____] hard copies] of the software user manual for each piece of software.

## 3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

[ For LOW Impact Systems: [Provide emergency power in accordance with the control system and equipment specification Sections, [_____]]

] For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not

install local uninterruptible power supplies (UPSes) as a source of device power.

### 3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

## 3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

### 3.11.1 Computers and Software Running on Computers

Computers and applications running on computers must meet relevant vulnerability scanning STIGs/SRGs and respond to approved DoD vulnerability scanning tools.

### 3.11.2 Controllers

Provide controllers that are scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

## 3.12 VULNERABILITY ALERTS

Prior to installation, adhere to all vendor-specific and CISA Information Assurance Vulnerability Alert (IAVA, see https://www.cisa.gov/uscert/ncas/alerts) requirements for reporting, patching, and/or mitigating. For alerts which occur after installation but before government acceptance:

a. Notify the Contracting Officer within 48 hours of receipt of the alert and within 48 hours of resolution of vulnerabilities.

b. Resolve the vulnerabilities within 30 days of the alert.

c. Submit a Vulnerability Resolution Report within 14 days of resolving the vulnerabilities in the alert. The report must identify the vulnerability alert ID and the date of resolution for each component.

## 3.13 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/approved-products-list/): [NONE][electronic security systems(ESS)][_____].

## 3.14 BIOS/UEFI PROTECTION

Provide a protection mechanism to prevent unwanted changes to the system BIOS/UEFI for all devices on the system, where technically feasible. BIOS/UEFI Protection Mechanisms must utilize passwords or passphrases that conform to DoD STIG requirements. BIOS/UEFI Protection passwords must be used to allow access by system engineering and administrative personnel after initial commissioning of the system. Enable UEFI Secure Boot if hardware and Operating System support the option. Provide a BIOS/UEFI Protection Password/Passphrase List (Encrypted) documenting all passwords and passphrases.

## 3.15 SYSTEM AND INTEGRATION INTEGRITY

### 3.15.1 Malicious Code Protection

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Provide the most up-to-date DoD approved software with up-to-date signatures. Verify that the software does not negatively affect the operation of the OT system. Computers being installed must be configured with up-to-date signatures, not older than 10 days, prior to deployment. Submit Antivirus/Antimalware Scan Results to show evidence of a clean scan. Coordinate with the Government Computer Access Point of Contact as required.

a. [Provide malware protection software licenses.][Malware protection software licenses will be Government furnished.]

b. [Provide malware protection software media.][Malware protection software media will be Government furnished.]

c. [Install and configure malware protection software in accordance with the relevant STIGs.][Malware protection software will be Government installed.]

3.15.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}

If there exists Integrity Verification Software that can check boot process, software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists, provide a statement to this affect in lieu of the software.

[The system prevents the installation of software and firmware without verification of the digital signature using an approved certificate.]

[3.15.3 Information System Monitoring

{For Government Reference Only: This subpart relates to SI-4 (a),(b); CCI-001253, CCI-002645}

[_____]

]3.16 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.16.1 Control System Cybersecurity Testing Procedures

Prepare and submit Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.16.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.16.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package

3.17 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other Sections, provide a minimum of [_____] hours of technical support for cybersecurity

testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

## 3.18 CYBERSECURITY TRAINING

Provide [eight][_____] hours of classroom[ and hands-on] training for [six][_____] Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

SECTION 26 05 19.00 10

INSULATED WIRE AND CABLE
**11/22**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

| | |
|---|---|
| ICEA S-58-679 | (2014) Control, Instrumentation and Thermocouple Extension Conductor Identification |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI/NEMA WC 71/ICEA S-96-659 | (2014; R 2022) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy |
| NEMA WC 26 | (2008) Binational Wire and Cable Packaging Standard |
| NEMA WC 57 | (2014) Standard for Control, Thermocouple Extension, and Instrumentation Cables |
| NEMA WC 70 | (2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy |
| NEMA WC 74/ICEA S-93-639 | (2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2023) National Electrical Code |

UL SOLUTIONS (UL)

| | |
|---|---|
| UL 44 | (2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the

submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[ SD-01 Preconstruction Submittals

Cable Installation Plan; G

] SD-03 Product Data

Wire and Cable; G

Conductors; G

Cable Manufacturing Data

SD-06 Test Reports Test Report(s), Inspection Report(s), and

Verification Report(s); G

[Cable Installation Report; G

]1.3 DELIVERY, STORAGE, AND HANDLING

Furnish cables on reels or coils. Each cable and the outside of each reel or coil, must be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable must contain only one continuous cable without splices. Cables for exclusively dc applications, as specified in paragraph "High-Voltage Test Source," must be identified as such. Shielded cables rated 2,001 volts and above must be reeled and marked in accordance with NEMA WC 26, as applicable. Reels must remain the property of the [Contractor] [Government].

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Wire Table

Furnish wire and cable in accordance with the requirements of the Cable Schedule ( to be included in the 90% submital documentation), conforming to the detailed requirements specified herein.

2.1.2 Rated Circuit Voltages

All power wire and cable must have minimum rated circuit voltages in accordance with NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Power wire and cable for circuit voltages rated 0-600 volts must be rated not less than 600 volts. Control wire and cable must have minimum rated circuit voltages in accordance with NEMA WC 57, but must be rated 600 volts if routed in raceway with other conductors that are rated 600 volts.

2.1.3 Conductors

2.1.3.1 Material for Conductors

Conductors must conform to all the applicable requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Copper conductors must be annealed copper material and they may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

2.1.3.2 Size

Minimum wire size must be as listed below.

a. No. 12 AWG for power and lighting circuits

b. No. 10 AWG for current transformer secondary circuits

c. No. 14 AWG for potential transformer, relaying, and control circuits

d. No. 16 AWG for annunciator circuits

e. No. 19 AWG for alarm circuits

Minimum wire sizes for rated circuit voltages of 2,001 volts and above must not be less than those listed for the applicable voltage in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable.

2.1.3.3 Stranding

Conductor stranding classes cited herein must be as defined for control conductors in NEMA WC 57 or as defined for 0-2,000 volts power conductors in NEMA WC 70, as applicable. Lighting conductors No. 10 AWG and smaller must be solid or have Class B stranding. Any conductors used between stationary and moving devices, such as hinged doors or panels, must have Class H or K stranding. All other conductors must have Class B or C stranding, except that conductors as shown, or in the schedule, as No. 12 AWG may be 19 strands of No. 25 AWG, and conductors shown as No. 10 AWG may be 19 strands of No. 22 AWG. Conductor stranding classes for circuit voltages 2,001 volts and above must be as defined in ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639, as applicable.

2.1.3.4 Conductor Shielding

Use conductor shielding conforming to NEMA WC 57 for control wire and cable as applicable. Use conductor shielding conforming to ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable, on power cables having a rated circuit voltage above 2,000 volts.

2.1.3.5 Separator Tape

Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

2.1.4 Insulation

2.1.4.1 Insulation Material

Unless specified otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, Type XHHW conforming to UL 44. Insulation for control wire and cable must meet the requirements of NEMA WC 57. Insulation requirements for wire and cable rated less than 2,000 volts must meet the requirements of NEMA WC 70. Insulation requirements for wire and cable rated 2,001-5,000 volts must meet the requirements of ANSI/NEMA WC 71/ICEA S-96-659. Insulation requirements for wire and cable rated 5,001 volts and greater must meet the requirements of NEMA WC 74/ICEA S-93-639.

2.1.4.2 Insulation Thickness

The insulation thickness for each conductor must be based on its rated circuit voltage.

2.1.4.2.1 Power Cables, 2,000 Volts and Below

The insulation thickness for single-conductor and multiple-conductor power cables rated 2,000 volts and below must be as required by NEMA WC 70, as applicable. Some thicknesses of NEMA WC 70 will be permitted only for single-conductor cross-linked thermosetting polyethylene insulated cables without a jacket. NEMA WC 70 ethylene-propylene rubber-insulated conductors must have a jacket.

2.1.4.2.2 Single-Conductor and Multiple-Conductor Control Cables

The insulation thickness of control conductor sizes 22 AWG to 10 AWG used for control and related purposes must be as required by NEMA WC 57, as applicable. Control conductors larger than 10 AWG must be as required by NEMA WC 70.

2.1.5 Jackets

All cables must have jackets meeting the requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, and NEMA WC 74/ICEA S-93-639, as applicable, and as specified herein. Individual conductors of multiple-conductor cables must be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables, except for shielded cables, must be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables and shielded single-conductor cables must be provided with a common overall jacket, which must be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.

2.1.5.1 Jacket Material

The jacket must be one of the materials listed below. Variations from the materials required below will be permitted only if approved for each specific use, upon submittal of sufficient data to prove that they exceed all specified requirements for the particular application.

2.1.5.1.1 General Use

| | |
|---|---|
| Heavy-duty black neoprene | NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |
| Heavy-duty chlorosulfonated polyethylene | NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |
| Heavy-duty cross-linked (thermoset) chlorinated polyethylene | NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |

2.1.5.1.2 Accessible Use Only, 2,000 Volts or Less

Cables installed where they are entirely accessible, such as cable trays and raceways with removable covers, or where they pass through less than 10 feet of exposed conduit only, must have jackets of one of the materials in item "a. General Use" or one of the following:

| | |
|---|---|
| General-purpose neoprene | NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |
| Black polyethylene (MDPE) | NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |
| Thermoplastic chlorinated polyethylene | NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |

2.1.5.2 Jacket Thickness

The minimum thickness of the jackets must be not less than 80 percent of the respective nominal thicknesses specified below.

2.1.5.2.1 Multiple-Conductor Cables

Thickness of the jackets of the individual conductors of multiple-conductor cables must be as required by NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable and must be in addition to the conductor insulation thickness required by the applicable respective NEMA publication for the insulation used. Thickness of the outer jackets and associated coverings of the assembled multiple-conductor cables must be as required by NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable.

2.1.5.2.2 Single-Conductor Cables

Single-conductor cables must have a jacket thickness as specified in

NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable.

### 2.1.6 Multiple-Conductor Cables

Grounding conductor(s) conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable must be furnished for each multiple-conductor cable. Assembly and cabling must be as specified in paragraph CABLING.

## 2.2 CABLE IDENTIFICATION

### 2.2.1 Color-Coding

Insulation of individual conductors of multiple-conductor cables must be color-coded in accordance with ICEA S-58-679, except that colored braids will not be permitted. Only one color-code method must be used for each cable construction type. Control cable color-coding must be [in accordance with ICEA S-58-679.. Power cable color-coding must be as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

(4) Grounded neutral - white

(5) Insulated grounding conductor - green

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 240/120 volt, single phase: Black and red

### 2.2.2 Cabling

Individual conductors of multiple-conductor cables must be assembled with flame-and moisture-resistant fillers, binders, and a lay conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639. Flat twin cables are prohibited. Fillers must be used in the interstices of multiple-conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers must be non-hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber-filled or other approved type of binding tape must consist of a material that is compatible with the other components of the cable and must be lapped at least 10 percent of its width.

### 2.2.3 Dimensional Tolerance

The outside diameters of single-conductor cables and of multiple-conductor cables must not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

## PART 3 EXECUTION

### 3.1 INSTALLATION INSTRUCTIONS

Submit cable manufacturing data [as requested]. The following information must be provided by the cable manufacturer for each size, conductor quantity, and type of cable furnished:

a. Minimum bending radius, in inches - For multiple-conductor cables, this information must be provided for both the individual conductors and the multiple-conductor cable.

b. Pulling tension and sidewall pressure limits, in pounds.

c. Instructions for stripping semiconducting insulation shields, if furnished, with minimum effort without damaging the insulation.

d. Upon request, compatibility of cable materials and construction with specific materials and hardware manufactured by others must be stated. Also, if requested, recommendations must be provided for various cable operations, including installing, splicing, terminating, etc.

### 3.2 CABLE INSTALLATION PLAN

Provide a cable installation plan which includes the following for each raceway. Exclude raceways with less than 45 degrees of total bending or shorter than 20 feet.

a. Raceway name

b. Circuit names with wire sizes and quantities

c. Maximum tolerable pulling tension

d. Maximum tolerable sidewall pressure

e. Estimated maximum pulling tension

f. Estimated maximum sidewall pressure

g. Jam ratio

h. Lubricant and coefficient of friction

i. Pulling device(s)

j. Direction of pull

### 3.3 TEST REPORT(S), INSPECTION REPORT(S), AND VERIFICATION REPORT(S)

#### 3.3.1 Cable Data

Do not begin any wire and cable fabrication until materials are submitted and approved by the Contracting Officer. Submit cable data for approval including, but not limited to, dimensioned sketches showing cable construction and sufficient additional data to show that wire and cable meet the requirements of this Section.

3.3.2 Inspection and Tests

Inspection and tests of wire and cable furnished under these specifications must be made by and at the plant of the manufacturer, and must be witnessed by the Contracting Officer, unless waived in writing. The Government may require or perform further tests before or after installation. Testing in general must comply with NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Specific tests required for particular materials, components, and completed cables must be as specified in the sections of the above standards applicable to those materials, components, and cable types. Tests must also be performed in accordance with the additional requirements specified below. Submit two certified copies of test reports.

3.3.2.1 High-Voltage Test Source

Where the applicable standards allow a choice, high-voltage tests for cables to be used exclusively on dc circuits must be made with dc test voltages. Cables to be used exclusively on ac circuits must be tested with ac test voltages. If both ac and dc will be present, on either the same or separate conductors of the cable, ac test voltages must be used.

[3.3.2.2 Cable Installation Report

After installation, provide a report of each cable identified in the cable installation plan. Include the maximum applied pulling tension of each cable. Identify all cables with pulling tensions which exceeded 90% of the limit in the approved cable installation plan.

]3.3.2.3 Independent Tests

The Government may make visual inspections, continuity or resistance checks, insulation resistance readings, power factor tests, or dc high potential tests at field test values. A cable's failure to pass these tests and inspections, or failure to produce readings consistent with acceptable values for the application, will be grounds for rejection of the cable.

3.3.2.4 Reports

Furnish results of tests. No wire or cable must be shipped until authorized. Lot number and reel or coil number of wire and cable tested must be indicated on the test reports.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM
**08/23**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B1 | (2013) Standard Specification for Hard-Drawn Copper Wire |
| ASTM B8 | (2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM D709 | (2017) Standard Specification for Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

| | |
|---|---|
| NECA NEIS 1 | (2015) Standard for Good Workmanship in Electrical Construction |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C80.1 | (2020) American National Standard for Electrical Rigid Steel Conduit (ERSC) |
| ANSI C80.3 | (2020) American National Standard for Electrical Metallic Tubing (EMT) |
| ANSI C80.5 | (2020) American National Standard for Electrical Rigid Aluminum Conduit |
| NEMA FU 1 | (2012) Low Voltage Cartridge Fuses |
| NEMA ICS 1 | (2022) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2020) Industrial Control and |

| | |
|---|---|
| | Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 3 | (2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA KS 1 | (2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum) |
| NEMA RN 1 | (2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| NEMA TC 2 | (2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit |
| NEMA TC 3 | (2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing |
| NEMA WD 1 | (1999; R 2020) Standard for General Color Requirements for Wiring Devices |
| NEMA Z535.4 | (2023) Product Safety Signs and Labels |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2023) National Electrical Code |
| NFPA 70E | (2024) Standard for Electrical Safety in the Workplace |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA-607 | (2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910.147 | The Control of Hazardous Energy (Lock Out/Tag Out) |
| 29 CFR 1910.303 | Electrical, General |

UL SOLUTIONS (UL)

| | |
|---|---|
| UL 1 | (2005; Reprint Jan 2022) UL Standard for Safety Flexible Metal Conduit |
| UL 6 | (2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel |
| UL 6A | (2008; Reprint Mar 2021) UL Standard for Safety Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel |

| | |
|---|---|
| UL 20 | (2018; Reprint May 2023) UL Standard for Safety General-Use Snap Switches |
| UL 44 | (2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables |
| UL 50 | (2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations |
| UL 83 | (2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables |
| UL 248-4 | (2010; Reprint Apr 2019) Low-Voltage Fuses - Part 4: Class CC Fuses |
| UL 248-8 | (2011; Reprint Aug 2020) Low-Voltage Fuses - Part 8: Class J Fuses |
| UL 248-10 | (2011; Reprint Aug 2020) Low-Voltage Fuses - Part 10: Class L Fuses |
| UL 248-12 | (2011; Reprint Aug 2020) Low Voltage Fuses - Part 12: Class R Fuses |
| UL 248-15 | (2018) Low-Voltage Fuses - Part 15: Class T Fuses |
| UL 360 | (2013; Reprint Jan 2024) UL Standard for Safety Liquid-Tight Flexible Metal Conduit |
| UL 486A-486B | (2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors |
| UL 486C | (2018; Reprint May 2021) UL Standard for Safety Splicing Wire Connectors |
| UL 489 | (2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 510 | (2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 514B | (2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings |
| UL 651 | (2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings |
| UL 797 | (2007; Reprint Apr 2023) UL Standard for Safety Electrical Metallic Tubing -- Steel |
| UL 845 | (2021) UL Standard for Safety Motor Control Centers |

| | |
|---|---|
| UL 984 | (1996; Reprint Sep 2005) Hermetic Refrigerant Motor-Compressors |
| UL 1242 | (2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel |
| UL 4248-1 | (2022) UL Standard for Safety Fuseholders - Part 1: General Requirements |
| UL 4248-12 | (2018; Reprint Feb 2022) UL Standard for Safety Fuseholders - Part 12: Class R |

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.3 RELATED REQUIREMENTS

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS applies to this section, with the additions and modifications specified herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Motor Control Centers; G

Control Panel; G

SD-03 Product Data

Circuit Breakers; G

Switches; G

Motor Controllers; G

SD-06 Test Reports

600-volt Wiring Test; G

SD-07 Certificates

Fuses; G

SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5; G

1.5 QUALITY ASSURANCE

1.5.1 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated. NECA NEIS 1 shall be considered the minimum standard for workmanship.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Electrical Systems

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein. Submit operation and maintenance manuals for electrical systems that provide basic data

relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.7 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

2.2 CONDUIT AND FITTINGS

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.1.2 Rigid Aluminum Conduit

ANSI C80.5, UL 6A.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40, and EPC-8] in accordance with NEMA TC 2,UL 651.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only. 2.2.4 Electrical,

Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3. 2.2.5 Plastic-Coated Rigid

Steel and IMC Conduit

NEMA RN 1, Type 40( 40 mils thick).

2.2.6 Flexible Metal Conduit

UL 1, limited to 6 feet.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360, limited to 6 feet.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

Steel compression type. 2.2.8 Fittings for

Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.3 CABINETS, JUNCTION BOXES, AND PULL BOXES

UL 50; volume greater than 100 cubic inches, NEMA Type 1 enclosure; sheet steel, hot-dip, zinc-coated. Where exposed to wet, damp, or corrosive environments, NEMA Type 3Ras indicated.

2.4 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 24 months prior to date of delivery to site.

2.4.1 Conductors

Provide the following:

a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.

b. Conductors No. 8 AWG and larger diameter: stranded.

c. Conductors No. 10 AWG and smaller diameter: solid.

d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.

2.4.1.1 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

a. Branch circuits: No. 12 AWG.

b. Class 1 remote-control and signal circuits: No. 14 AWG.

c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.

d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

2.4.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors.

2.4.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

a. Grounding conductors: Green.

b. Neutral conductors: White.

c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a different colored (not green) stripe for each.

2.4.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

2.4.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts, Type XHHW conforming to UL 44, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where equipment or devices require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.4.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

## 2.5 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

## 2.6 DEVICE PLATES

Provide the following:

a. UL listed, one-piece device plates for outlets to suit the devices installed.

b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.

c. For nonmetallic boxes and fittings, other suitable plates may be provided.

d. Sectional type device plates are not be permitted.

e. Plates installed in wet locations: gasketed and UL listed for "wet locations."

## 2.7 SWITCHES

### 2.7.1 Toggle Switches

NEMA WD 1, UL 20, single pole, double pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: white thermoplastic.

b. Wiring terminals: screw-type, side-wired.

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

### 2.7.2 Switch with Red Pilot Handle

NEMA WD 1. Provide the following:

a. Pilot lights that are integrally constructed as a part of the switch's handle.

b. Pilot light color: red and illuminate whenever the switch is closed or "on".

c. Pilot lighted switch: rated 20 amps and 120 volts or 277 volts as indicated.

d. The circuit's neutral conductor to each switch with a pilot light.

2.7.3 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA 1 Type 304 stainless steel, enclosure per NEMA ICS 6.

2.8 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible[ switch][ panel][ and control center]. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers[ or other circuit protective devices] for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.8.1 Fuseholders

Provide in accordance with UL 4248-1.

2.8.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 248-12, Class RK-1. Provide only Class R associated fuseholders in accordance with UL 4248-12.

2.8.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 248-8, UL 248-10, UL 248-4, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.8.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 248-15, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.9 CONTROL PANEL

Provide a brush system control panelpanelboards in accordance with the following:

a. Power source input: 480 volts ac, 3 phase, 60 hz.

b. Control panel complete with hand held pendant controller.

c. Relay and programmable logic control (PLC) system with remote input and monitoring contacts available.

d. Automatic, continuous, and manual modes of operation.

## 2.10 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated.

## 2.11 MOTORS

Provide motors in accordance with the following:

a. Hermetic-type sealed motor compressors: Also comply with UL 984.

b. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified.

c. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters.

d. Rate motors for operation on 208-volt, 3-phase circuits with a terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits with a terminal voltage rating of 460 volts.

e. Use motors designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating.

f. Unless otherwise indicated, use continuous duty type motors if rated 1 HP and above.

g. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

### 2.11.1 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

### 2.11.2 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment as specified herein. Power wiring and conduit: conform to the requirements specified herein. Control wiring: provided

under, and conform to, the requirements of the section specifying the associated equipment.

2.12 MOTOR CONTROL CENTERS Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Provide motor control centers in accordance with the following:

a. UL 845, NEMA ICS 2, NEMA ICS 3.

b. Interconnecting wires: copper.

c. Terminal blocks: plug-in-type so that controllers may be removed without disconnecting individual control wiring.

2.13 LOCKOUT REQUIREMENTS

Provide circuit breakers, disconnecting means, and other devices that are electrical energy-isolating capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147, NFPA 70E and 29 CFR 1910.303. Comply with requirements of Division 23, "Heating, Ventilating, and Air Conditioning (HVAC)" for mechanical isolation of machines and other equipment.

2.14 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.15 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 0.125 inch thick, white with black center core.

e. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

f. Minimum size of nameplates: one by 2.5 inches.

g. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.16 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.1.3 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s)

installed in conduit and raceways. Minimum conduit size: 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 6 inches.

3.1.3.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.4 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

3.1.4.1 Restrictions Applicable to Aluminum Conduit

a. Do not install underground or encase in concrete or masonry.

b. Do not use brass or bronze fittings.

c. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.2 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors.

f. Do not use in fire pump rooms.

g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.3 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40.

(1) Do not use where subject to physical damage, including but not limited to, mechanical equipment rooms, electrical equipment

rooms, fire pump rooms, and where restrictions are applying to both PVC Schedule 40 and PVC Schedule 80.

(2) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

b. PVC Schedule 80.

(1) Do not use where subject to physical damage, including but not limited to, hospitals, power plant, missile magazines, and other such areas.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

-

3.1.4.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.5 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Plastic cable ties are not acceptable. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Identify independent conduit support in both fire and non-fire rated assemblies per NFPA 70. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.4.6 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.4.7 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.4.8 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 1/2 inch diameter. Provide liquid tight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors.

Provide separate ground conductor across flexible connections. Plastic cable ties are not acceptable as a support method.

3.1.5 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, and when specifically indicated. Boxes in other locations: sheet steel, except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit system. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to

raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.5.1 Boxes

Boxes for use with raceway systems: minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet.

3.1.5.2 Pull Boxes

Construct of at least minimum size required by NFPA 70. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.6 Mounting Heights

Mount panelboards, circuit breakers, motor controller and disconnecting switches so height of center of grip of the operating handle of the switch or circuit breaker at its highest position is maximum 79 inches above floor or working platform or as allowed in Section 404.8 per NFPA 70. Mount lighting switches 48 inches above finished floor. Mount receptacles 18 inches above finished floor, unless otherwise indicated. Mount other devices as indicated.

3.1.7 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with manufacturer's recommendations.

3.1.7.1 Marking Strips

Provide marking strips for identification of power distribution, control, data, and communications cables in accordance with the following:

a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.

b. Use permanent ink for the wire numbers

c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.

d. Size marking strips to accommodate the two sets of wire numbers.

e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.

g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.8 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.9 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.10 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.11 Grounding and Bonding

Provide in accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Make interconnection to the gas line on the customer's side of the meter. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607. Where ground

fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.12 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

3.1.13 Repair of Existing Work

3.1.13.1 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

3.1.13.2 Continuation of Service

Maintain continuity of existing circuits of equipment to remain. Maintain existing circuits of equipment energized. Restore circuits wiring and power which are to remain but were disturbed during demolition back to original condition.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets. Provide nameplate on all equipment in access controlled spaces and areas.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to each

test. Where applicable, test electrical equipment in accordance with NETA ATS.

3.5.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring per NETA ATS to provide direct reading of resistance. All existing wiring to be reused must also be tested.

-- End of Section --

SECTION 26 28 00.00 10

MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS
**08/22**

PART 1 GENERAL

1.1 SUMMARY

These specifications include the design, fabrication, assembly, wiring, testing, and delivery of the items of equipment and accessories and spare parts listed in the Schedule and shown on the drawings.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1 (2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)

ASME B1.20.1 (2013; R 2018) Pipe Threads, General Purpose (Inch)

ASTM INTERNATIONAL (ASTM)

ASTM A780/A780M (2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81 (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

IEEE C2 (2023) National Electrical Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (2022) Standard for Industrial Control and Systems: General Requirements

NEMA ICS 2 (2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V

NEMA ICS 4 (2015) Application Guideline for Terminal

| | |
|---|---|
| | Blocks |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2023) National Electrical Code |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| DOD 8510.01 | (2022) Risk Management Framework (RMF) for DoD Systems |
| DODI 8500.01 | (2014) Cybersecurity |

UL SOLUTIONS (UL)

| | |
|---|---|
| UL 44 | (2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables |
| UL 489 | (2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 845 | (2021) UL Standard for Safety Motor Control Centers |
| UL 1063 | (2017; Reprint Jun 2022) UL Standard for Safety Machine-Tool Wires and Cables |

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G

Shop Drawings; G

Motor Control Centers; G

SD-03 Product Data

Equipment; G

Factory Tests

Request For Settings

SD-06 Test Reports

Factory Tests

Acceptance Checks And Tests; G

SD-07 Certificates

Motor Control Centers

1.4 DELIVERY, STORAGE, AND HANDLING

Submit copies of such descriptive cuts and information as are required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications, within 30 calendar days after date of receipt of notice to proceed for approval. Include descriptive data showing typical construction of the types of equipment proposed, including the manufacturer's name, type of molded case circuit breakers or motor circuit protectors, performance capacities and other information pertaining to the equipment. Ship the equipment as completely assembled and wired as feasible so as to require a minimum of installation work. Carefully pack and ship separately any relay or other device which cannot withstand the hazards of shipment when mounted in place on the equipment. Mark these devices with the number of the panel which they are to be mounted on and fully identified. Wrap all finished painted surfaces and metal work or otherwise protect from damage during shipment. Prepare all parts for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck. Carefully package and clearly mark all spare parts and accessories.

1.5 MAINTENANCE

1.5.1 Accessories and Tools

Furnish a complete set of accessories and special tools unique to equipment provided and required for erecting, handling, dismantling, testing and maintaining the apparatus.

1.5.2 Extra Materials

Furnish spare parts as specified below. All spare parts must be of the same material and workmanship, must meet the same requirements, and must be interchangeable with the corresponding original parts furnished.

| SPARE PARTS | |
|---|---|
| Amount | Description |
| 2 of each type and size | Fuses |
| 1 | Circuit breaker auxiliary switch |
| 2 for each type | Indicating lamp assemblies |
| 4 | Keys for motor control center door loc |

| | |
|---|---|
| 1 for each type and rating | Circuit Breaker |

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are standard products of a manufacturer regularly engaged in their manufacture and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening and that conform to the requirements of these specifications. Provide high quality materials, free from defects and imperfections, of recent manufacture, and of the classification and grades designated. All materials, supplies, and articles not manufactured by the Contractor must be the products of other recognized reputable manufacturers.

2.1.1 Rules

Provide equipment conforming to the requirements of NFPA 70 unless more stringent requirements are indicated herein or shown. NEMA rated and UL listed equipment has been specified when available. Provide equipment meeting NEMA and UL construction and rating requirements as specified. No equivalent will be acceptable. Immediately notify the Contracting Officer of any requirements of the specifications or Contractor proposed materials or assemblies that do not comply with UL or NEMA. International Electrotechnical Commission (IEC) rated equipment will not be considered an acceptable alternative to specified NEMA ratings.

2.1.2 Coordination

The general arrangement of the motor control centers, switchboards and panelboards is shown on the contract drawings. Any modifications of the equipment arrangement or device requirements as indicated will be subject to the approval of the Contracting Officer. If any conflicts occur necessitating departures from the drawings, submit details of and reasons for departures for approval prior to implementing any change.

2.2 NAMEPLATES

Provide nameplates made of laminated sheet plastic or of anodized aluminum approximately 1/8 inch thick, engraved to provide white letters on a black background. Fasten the nameplates to the panels in proper positions with anodized round-head screws. Lettering must be minimum 1/2 inch high. Provide nameplate designations in accordance with lists on the drawings, and as a minimum provide nameplates for the following equipment:

a. Motor Control Centers

b. Individual items of equipment mounted in the Motor Control Centers

c. Switchboards

Provide equipment of the withdrawal type with nameplates mounted on the removable equipment in locations visible when the equipment is in place.

## 2.3 CONNECTIONS

Furnish all bolts, studs, machine screws, nuts, and tapped holes in accordance with ASME B1.1. Provide sizes and threads of all conduit and fittings, tubing and fittings, and connecting equipment in accordance with ASME B1.20.1. Provide ferrous fasteners that have rust-resistant finish and equip all bolts and screws with approved locking devices. Manufacturer's standard threads and construction may be used on small items which, in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items must meet the above requirements.

## 2.4 MOLDED CASE CIRCUIT BREAKERS

Provide molded case circuit breakers conforming to the applicable requirements of UL 489. Provide circuit breakers that are manually-operated, that are the quick-make, quick-break, common trip type, and that are of the automatic-trip type unless otherwise specified or indicated on the drawings. Operate all poles of each breaker simultaneously by means of a common handle. Provide operating handles that clearly indicate whether the breakers are in "On," "Off," or "Tripped" position and have provisions for padlocking in the "Off" position. Provide personnel safety line terminal shields for each breaker. Furnish circuit breakers that are products of only one manufacturer, and are interchangeable when of the same frame size.

### 2.4.1 Trip Units

Except as otherwise noted, provide combination thermal and instantaneous magnetic or solid state trip units for the circuit breakers, of frame sizes and the trip unit ratings as shown on the drawings. The Government reserves the right to change the indicated trip ratings, within frame limits, of the trip devices at the time the shop drawings are submitted for approval. Submit copies of outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions, within 30 calendar days after date of receipt of notice to proceed, for the approval of the Contracting Officer. Set nonadjustable instantaneous magnetic trip units at approximately 10 times the continuous current ratings of the circuit breakers.

### 2.4.2 480-Volt AC Circuits

Furnish circuit breakers for 480-volt or 277/480-volt ac circuits that are rated 600 volts ac, andthat have an UL listed minimum interrupting capacity of 14,000 symmetrical amperes at 600 volts ac.

### 2.4.3 120/240-Volt AC Circuits

Circuit breakers for 120-volt ac circuits rated less than 120/240 or 240 volts ac are not permitted, and must have a UL listed minimum interrupting capacity of 10,000 symmetrical amperes.

## 2.5 WIRING

Provide control wire consisting of stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44 or Type MTW meeting UL 1063, and passing the VW-1 flame tests included in those standards. Provide hinge wire consisting of Class K stranding. The minimum size of control wire is be No. 14 AWG. Furnish power wiring for 480-volt circuits and below that is the same type as control wiring and a minimum size of No. 12 AWG. Give special attention to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

## 2.6 CONTROL SWITCHES

### 2.6.1 General

All control switches must be of the rotary switchboard type with handles on the front and the operating contact mechanisms on the rear of the panels. Provide each switch with ample contact stages to perform the functions of the control system and provide with at least two spare contacts. Provide self-aligning contacts that operate with a wiping action. Provide a positive means of maintaining high pressure on closed contacts. Compression springs or pivotal joints must not carry current. All control switches must be suitable for operation on 600-volt AC or 250-volt DC circuits. All such switches must be capable of satisfactorily withstanding a life test of at least 10,000 operations with rated current flowing in the switch contacts. Provide switches capable of continuously carrying 20 amperes without exceeding a temperature rise of 30 degrees C. The single-break inductive load interrupting rating of switches must not be less than 1.5 amperes for 125 volts DC or 10 amperes for 115 volts AC.

### 2.6.2 Switch Features

a. Provide control and instrument switches that are suitable for the intended use and that have the features shown on the schematic diagrams and switch development drawings. Provide switches that have handles as shown or approved and are black in color unless otherwise specified.

b. Control switches for electrically-operated circuit breakers must be 3-position momentary-contact type with spring return to neutral position, and must have modern-black, heavy duty pistol grip handles. Provide circuit breaker control switches that have mechanical operation indicators to show the last manual operation of the switches and slip contacts.

c. Provide each control switch with an escutcheon clearly marked to show each operating position. Engrave the switch identifications on the

escutcheon plates or on separate nameplates. The escutcheon and nameplate markings are subject to approval.

## 2.7 TERMINAL BLOCKS

Furnish control circuit terminal blocks for control wiring that are molded or fabricated type with barriers, rated not less than 600 volts. Provide terminals that are removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals must be no less than No. 10 in size and have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement is subject to the approval of the Contracting Officer and provide no less than four (4) spare terminals or 10 percent, whichever is greater, on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. Submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

### 2.7.1 Types of Terminal Blocks

#### 2.7.1.1 Load Type

Provide load terminal blocks rated no less than 600 volts and of adequate capacity for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits except those for feeder tap units. Provide terminals that are either the stud type with contact nuts and locking nuts or the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Place the circuit designation or wire number on or near the terminal in permanent contrasting color for each connected terminal.

### 2.7.2 Marking Strips

Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations. Make wire numbers with permanent ink. Use reversible marking strips to permit marking both sides, or furnish two marking strips with each block. Marking strips must accommodate the two sets of wire numbers. For each device to which a connection is made, assign a device designation in accordance with NEMA ICS 1 and mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations. Show the general arrangement and overall dimensions of the

motor control centers, switchboards, and panelboards. Show space requirements, details of any floor supports to be embedded in concrete and provisions for conduits for external cables. Prints of drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

## 2.8 MOTOR CONTROL CENTERS

Design each motor control center for operation on 480-volts ac, 3-phase, 60-Hz system, and equipment conforming to all the applicable requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 4and NEMA ICS 6. List and label vertical sections and individual units under UL 845 where ever possible. In lieu of the UL listing, certification from any nationally recognized, adequately equipped, testing agency that the individual units and vertical sections have been tested and conform to the UL requirements of that agency will be acceptable when approved by the Contracting Officer.

a. Submit copies of electrical equipment drawings, within 30 calendar days after date of receipt of notice to proceed, for the approval of the Contracting Officer.

b. Submit an individual wiring diagram for each motor control center. Wiring diagrams must be in a form showing physical arrangement of the control center with interconnecting wiring shown by lines or by terminal designations. Provide a single-line diagram, equipment list and nameplate schedule for each switchboard and panelboard.

### 2.8.1 Combination Starters

#### [2.8.1.1 Auxiliary Contacts

Provide each controller with a minimum of three auxiliary contacts which can be easily changed from normally open to normally closed. Where indicated on the drawings, provide a fourth auxiliary contact and red and green indicating lights.

#### 2.8.1.2 Overload Relays

Except as otherwise indicated, provide three NEMA Class 20 thermal or solid state overload relays with external manual reset for each controller. Prior to shipment of the control centers, the Contracting Officer will furnish the ratings of the heater elements to be installed in the relays by the Contractor.

### 2.8.2 Wiring for Motor Control Centers

All wiring must meet the requirements of paragraph WIRING above. Provide heavy-duty clamp type terminals for terminating all power cables entering the control centers.

#### 2.8.2.1 Contractor's Wiring

Form Contractor's wiring into groups, suitably bound together, properly support and run straight horizontally or vertically. There must be no splices in the wiring. The manufacturer's standard pressure-type wire terminations for connections to internal devices will be acceptable. Add terminal blocks for wiring to devices having leads instead of terminals. Use ring tongue indented terminals on all wires terminated on control terminal blocks for external or interpanel connections and at shipping splits. Provide contact nuts and either locking nuts or lockwashers for all stud terminals.

2.8.2.2 External Connections

Power and control cables will enter the control centers at the where shown on the drawings.

2.8.2.3 Terminal Blocks

Furnish terminal blocks meeting the requirements of paragraph TERMINAL BLOCKS above. In no case must the terminals provided for circuit breakers or contactors accommodate less than the number or size of conductors shown on the drawings. Give special attention to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.8.3 Accessories and Control Devices

Provide control accessories that are suitable for mounting on the front of, or inside, the control centers as indicated on the drawings. Provide control accessories meeting the applicable requirements of NEMA ICS 2. Mount relays and other equipment so that mechanical vibration will not cause false operation.

2.8.3.1 Control Stations

Provide push-button stations and selector switches in conformance to NEMA ICS 2, of the heavy-duty, oil-tight type, rated 600 volts ac, and with a contact rating designation of A600. Provide switches with escutcheon plates clearly marked to show operating positions.

2.8.3.2 LED Indicating Lights

Furnish red and green LED's where shown on the drawings, indicating contact "open" and "closed" position. Make LED's accessible and replaceable from the front of the control center through a finished opening in the compartment door. Provide LED assemblies that are the heavy duty oiltight, watertight, and dusttight type.

2.8.3.3 Control Relays

Provide control relays that are electrically operated, magnetically held, self-reset, open type, suitable for mounting inside the starter compartments, and are 120-volt ac. Provide contacts as indicated on the drawings and have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2.

2.8.4 Metering Section

2.8.4.1 Switches

Furnish rotary switchboard type metering switches with handles on the front and operating contact mechanisms on the rear of the panels. Provide control switches suitable for operation on 600-volt AC or 250-volt DC circuits. Provide switches that are capable of satisfactorily withstanding a life test of at least 10,000 operations with rated current flowing in the switch contacts. Provide maintained-contact type selector switches with the required number of positions, and that have round notched, or knurled handles. Ammeter switches must not open the secondary circuits of current transformers at any time. Provide instrument switches for potential selection with oval handles.

2.9 FACTORY TESTS

Each item of equipment supplied under this contract must be given the manufacturer's routine factory tests and tests as specified below, to insure successful operation of all parts of the assemblies. The Contracting Officer will witness all tests required herein unless waived in writing, and no equipment will be shipped until it has been approved for shipment by the Contracting Officer.

a. Submit copies of manufacturer's routine factory test procedures and production line tests for all motor control centers, within a minimum of 14 days prior to the proposed date of tests. Notify the Contracting Officer a minimum of 14 days prior to the proposed date of the tests so that arrangements can be made for the Contracting Officer to be present at the tests.

b. Use factory test equipment and the test methods conforming to the applicable NEMA Standards, and are subject to the approval of the Contracting Officer. Submit complete reproducible copies of the factory inspection results and complete reproducible copies of the factory test results in booklet form, including all plotted data curves, all test conditions, a listing of test equipment complete with calibration certifications, and all measurements taken.

c. Report must be signed and dated by the Contractor's and Contracting Officer's Representatives. Reports of all witnessed tests must be signed by witnessing representatives of the Contractor and Contracting Officer. The Contractor is responsible for the cost of performing all tests and include in the prices bid in the schedule for equipment.

2.9.1 Motor Control Centers Tests

2.9.1.1 Dielectric Tests

For the existing motor control center, perform dielectric tests in accordance with NEMA ICS 1.

2.9.1.2 Operational Tests

Check the correctness of operation of each air circuit breaker and magnetic contactor and of all control devices, accessories and indicating lamps. Make these checks rated voltage with power supplies to the main buses. Also check all magnetic contactors for proper operation with power at 90 percent of rated voltage.

## 2.10 PAINTING

Clean interior and exterior steel surfaces of equipment enclosures thoroughly and then apply a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Exterior surfaces must be free from holes, seams, dents, weld marks, loose scale or other imperfections. Apply no less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice to exterior surfaces. Prime exterior, filled where necessary, and give no less than two coats baked enamel with semigloss finish. Equipment located indoors must be ANSI Light Gray, and equipment located outdoors must be ANSI Light Grey. Perform all touch-up work with manufacturer's coatings as supplied under paragraph SPARE PARTS.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

## 3.2 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

### 3.2.1 Motor Control Centers

NEMA ICS 1.

NEMA ICS 2.

### 3.2.2 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

### 3.2.3 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

### 3.2.4 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 FIELD QUALITY CONTROL

Submit request for settings of breakers to the Contracting Officer after approval of Motor Control Center and at least 30 days in advance of their requirement.

3.3.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and Section 26 08 00 APPARATUS INSPECTION AND TESTING.

3.3.1.1 Motor Control Center

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect anchorage, alignment, grounding, and required area clearances.

3. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.

4. Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker address for microprocessor-communication packages.

5. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.

6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

7. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

8. Confirm correct application of manufacturer's recommended lubricants.

9. Inspect insulators for evidence of physical damage or contaminated surfaces. 10. Exercise all active components.

11. Inspect all mechanical indicating devices for correct operation.

12. Verify that filters are in place and vents are clear.

b. Electrical Tests

1. Perform insulation-resistance tests on each bus section.

2. Perform dielectric withstand voltage tests.

3. Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components. 4. Perform control wiring performance test.

5. Perform phasing check on double-ended motor control center to ensure correct bus phasing from each source.5 6. Verify operation of motor control center heaters.

3.3.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings. 2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify that all maintenance devices are available for servicing and operating the breaker. 5. Inspect arc chutes.

6. Inspect moving and stationary contacts for condition, wear, and alignment.

7. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

8. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.

9. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey. 10. Verify cell fit and element alignment.

11. Verify racking mechanism.

12. Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests

1. Perform contact-resistance tests on each breaker.

2. Perform insulation-resistance tests.

3. Adjust Breaker(s) for final settings in accordance with Government provided settings.

3.3.1.3 Grounding System

a. Visual and Mechanical Inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. IEEE 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.3.1.4 Switches, Air, Low-Voltage

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, grounding, and required clearances.

4. Verify the unit is clean.

5. Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.

6. Verify that fuse sizes and types are in accordance with drawings, short-circuit studies, and coordination study.

7. Verify that each fuse has adequate mechanical support and contact integrity.

8. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey. 9. Verify operation and sequencing of interlocking systems.

10. Verify correct phase barrier installation.

11. Verify correct operation of all indicating and control devices.

12. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, in accordance with Section 7.5.1.1.A.8.1 of NETA ATS.

2. Measure contact resistance across each switchblade and fuseholder.

3. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.1 of NETA ATS.

4. Measure fuse resistance.

5. Verify cubicle space heater operation.

6. Perform ground fault test in accordance with Section 7.14 of NETA ATS.

7. Perform tests on other protective devices in accordance with Section 7.9 of NETA ATS.

3.3.1.5 Circuit Breakers

3.3.1.5.1 Circuit Breakers, Air, Insulated-Case/Molded-Case

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage and alignment.

4. Verify the unit is clean.

5. Operate the circuit breaker to insure smooth operation.

6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

7. Inspect operating mechanism, contacts, and arc chutes in unsealed nits.

8. Perform adjustments for final protective device settings in accordance with the coordination study.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.6.1.1.A.6.1 of NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.1 of NETA ATS. 3. Perform a contact/pole-resistance test.

4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer's recommendation. 5. Determine long-time pickup and delay by primary current injection.

6. Determine short-time pickup and delay by primary current injection.

7. Determine ground-fault pickup and time delay by primary current injection. 8. Determine instantaneous pickup by primary current injection.

9. Test functions of the trip unit by means of secondary injection.

10. Perform minimum pickup voltage tests on shunt trip and close coils in accordance withmanufacturer's published data.

11. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators. 12. Verify operation of charging mechanism.

3.3.1.5.2 Circuit Breakers, Low-Voltage Power

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify that all maintenance devices are available for servicing and operating the breaker.

5. Verify the unit is clean.

6. Verify the arc chutes are intact.

7. Inspect moving and stationary contacts for condition and alignment.

8. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

9. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturer's published data.

10. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey 11. Verify cell fit and element alignment.

12. Verify racking mechanism operation.

13. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

14. Perform adjustments for final protective device settings in accordance with coordination study provided by end user. 15. Record as-found and as-left operation counter readings.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.6.1.2.A.10.1 of NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Test voltage will be in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.1 of NETA ATS. 3. Perform a contact/pole-resistance test.

4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer's recommendation. 5. Determine long-time pickup and delay by primary current injection.

6. Determine short-time pickup and delay by primary current injection.

7. Determine ground-fault pickup and delay by primary current injection. 8. Determine instantaneous pickup value by primary current injection.

9. Test functions of the trip unit by means of secondary injection.

10. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.20 of NETA ATS.

11. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators. 12. Verify operation of charging mechanism.

3.3.1.6 Motor Control, Motor Starters, Low-Voltage

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify the unit is clean.

5. Inspect contactors.

(a) Verify mechanical operation.

(b) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

6. Motor-Running Protection

(a) Verify overload element rating/motor protection settings are correct for application.

(b) If motor-running protection is provided by fuses, verify correct fuse rating.

7. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

8. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.16.1.1.A.7.1 from NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with starter closed, and across

each open pole. Test voltage will be in accordance with manufacturer's published data or Table 100.1 from NETA ATS.

3. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer's recommendation.

4. Test motor protection devices in accordance with manufacturer's published data. In the absence of manufacturer's data, use Section 7.9 from NETA ATS.

5. Test circuit breakers in accordance with Section 7.6.1.1 from NETA ATS.

6. Perform operational al tests by initiating control devices.

3.3.1.7 Cybersecurity Installation Certification

Furnish a certification that control systems are installed in accordance with DODI 8500.01, DOD 8510.01, and as required by individual Service Implementation Policy.

3.3.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Trip circuit breakers by operation of each protective device. Test each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, provide the Contracting Officer 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

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ELECTROMECHANICAL OPERATING MACHINERY FOR LOCKS AND DAMS
**08/20, CHG 3: 05/23**

PART 1 GENERAL

1.1 SUMMARY

This Part specifies the technical requirements for the design, manufacture, delivery to the site, installation, commissioning, and field testing of the mechanical trashrake and accessories to be furnished, complete in accordance with these Specifications by the equipment supplier hereinafter called the Contractor

1.1.1 Equipment Overview

The following summarizes the equipment and the Contractor's responsibilities during supply and installation. The Contractor shall furnish all components and accessories that are usual and required for the intended use of the trashrake, even if they are not specifically called out herein.

a. Principal Items to be Furnished. The Contractor shall design, detail, manufacture, deliver, install, commission, and field test the following equipment complete with appurtenances, spare parts and maintenance equipment, all in accordance with its intended use and with these Specifications for manual and automatic dislodging of debris accumulated at the intake trashracks of the East Fish Ladder AWS Backup System.

   (1) One trashrake, overhead mounted, travelling type, complete but not limited to the main beam, supports, braces, trolley, telescopic boom system, raking and tilting hydraulic cylinders, power unit, bristle roller-head, festoon system, hardware, control system, and all other accessories required, for a complete working system. Rake support frame, anchors, shall be designed for worst loading conditions of the trashrake.

b. Operation of Trashrake. The trashrake shall be used to automatically and continuously dislodge the debris accumulated on intake trashracks by freeing up or and disturbing the trash to drop by gravity to accumulate at the trashrack bottom (El 104.0 or below) so that it can be washed away by the natural flow of the river. The trashrake shall be capable of helping in removing all debris which shall include but not be limited to small sticks and aquatic plant foliage, etc.

c. Supplementary Equipment to be Furnished. The Contractor shall also furnish and deliver a complete set of maintenance tools needed for the lubrication, adjustment and normal maintenance of the trashrake equipment. These tools shall be neatly supplied in a heavy-duty steel cabinet complete with locks. Any special tools related to the installation, adjustment, and maintenance of the rake shall be supplied by the Contractor.

d. The Contractor shall provide all consumable items including hydraulic oil and grease required for the initial filling/lubrication of the equipment and 2 years of operation.

1.1.2 Spare Parts

The Contractor shall also supply recommended spare parts for 2 years of operation. An itemized cost shall be furnished along with the bid with total cost for all spares included in the bid price. At a minimum the following spare parts must be supplied:

1.1.2.1 Mechanical Spare Parts

a. Bristle Roller: qty 6
b. Boom System Cable (15 m): qty 4
c. Boom Chain Master Link: qty 4
d. Side Travel Chain (15 m): qty 1
e. Boom Roller Kits: qty 2
f. Brushes: qty 6
g. Hydraulic pump-motor assembly: qty 1
f. Seal Kit- Tilt Cylinder: qty 1
g. Suction Strainer: qty 5
h. Return Filter Cartridge: qty 5
i. Hydraulic Fluid: qty 5 gal
j. Tilt Cylinder: qty 1
k. Grease - Food Grade: qty 4 lb.
l. Set of Hoses 1

1.1.2.2 Electrical Spare Parts

a. Contactor Coils: qty 4 sets
b. Fuses: qty 6 sets
c. Sensors: qty 2 sets
d. Indicating lights: qty 6 sets
e. Pushbuttons: qty 6 sets
f. Directional Valve Solenoid Coil: qty 4 sets
g. Flat Cables: qty 1 set

1.1.3 Field Measurements

The Contractor shall be provided with the civil general arrangement drawings and trashracks "As Installed" drawings. The Contractor shall visit the project site, confirm all dimensions shown on the drawings and collect any additional measurement and data required for the proper design, fit, and functioning of the trashrake equipment before starting the fabrication of the trashrake.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI B31.1 | (1994) Power Piping |
| ANSI B93.18 | (1987) Non-Integral Industrial Fluid Power Hydraulic Reservoirs |

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

| | |
|---|---|
| ASNT SNT-TC-1A | (2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B46.1 | (2020) Surface Texture, Surface Roughness, Waviness and Lay |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2020; Errata 1 2021) Structural Welding Code - Steel |
| AWS D1.6/D1.6M | (2017) Structural Welding Code — Stainless Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A276/A276M | (2024) Standard Specification for Stainless Steel Bars and Shapes |
| ASTM A380/A380M | (2017) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems |
| ASTM A564/A564M | (2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes |
| ASTM B21/B21M | (2020) Standard Specification for Naval Brass Rod, Bar, and Shapes |
| ASTM D3233 | (1993; R 2014) Standard Test Methods for Measurement of Extreme Pressure Properties of Fluid Lubricants (Falex Pin and Vee Block Methods) |
| ASTM D3951 | (2018) Commercial Packaging |
| ASTM D4172 | (1994; R 2016) Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method) |

CSA GROUP (CSA)

| | |
|---|---|
| CSA W47.1 | (R 2024) Fusion Welding of Steel Company Certification |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 112 | (2017) Standard Test Procedure for Polyphase Induction Motors and Generators |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2021) Motors and Generators

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10/NACE No. 2 (2015) Near-White Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AS4059 (2022) Cleanliness Standard

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shop Test Information; G

Installation and Alignment Procedure; G

Equipment Protection Plan; G

Materials List; G

Commissioning; G

Pre-Functional Checklist

Functional Checklist

SD-02 Shop Drawings

Detail Drawings; G

Materials Orders

Shipping Bills

SD-03 Product Data

Manufacturer's Literature and Equipment Data; G

SD-05 Design Data

Trashrake Equipment; G

Design Data Calculations

SD-06 Test Reports

Electric Motors

Final Operating Test; G

Startup and Acceptance Test

Inspection Log

Shop Assembly and Tests

Final Alignment Test Report

SD-07 Certificates

Equipment Manufacturer's and Fabricator's Qualifications

Qualification of Welders and Welding Operators

Equipment Warranty

Erecting Engineer Installation and Operation

Nondestructive Examination Certification

Commissioning Document

SD-08 Manufacturer's Instructions

Cleaning of Corrosion-Resisting Steel; G

SD-10 Operation and Maintenance Data

Operations and Maintenance (O&M) Manual; G

## 1.4 QUALITY ASSURANCE

### 1.4.1 Manufacturer and Assembler

Manufacturing, assembly, supervision of installation, commissioning and testing of the trashrake equipment shall be by Atlas Polar Company Ltd.,60 Northline Road, Toronto, ON M4B 3E5, Canada. All documents, certifications, memberships to standards and/or professional organizations, the manufacturers comply with, shall be submitted.

### 1.4.2 Erecting Engineer Services

Provide the services of one or more erecting engineers from the manufacturer onsite during the installation and startup of each defined major piece of equipment and subassembly, if trashrake manufacturer is not the installer. The erecting engineer(s) are responsible to technically supervise and provide instruction for the equipment to be installed and operated.

Upon completion of the work and at a time designated, provide the services of one or more erecting engineers for training Government personnel in accordance with the requirements of paragraph FIELD TRAINING.

1.4.3 Warranty

All equipment supplied shall be guaranteed to perform properly for a period of 2 years after the equipment is accepted by the Owner.

1.5 SYSTEM REQUIREMENTS

The trashrake shall be an overhead mounted, double telescopic boom type, running on main beam, mechanically and hydraulically operated, rake machine, as manufactured by Atlas Polar, similar to their trashrake model DT9300 with bristle roller. The overall design of the rake shall follow ASME/ANSI/ASTM standards for design and safety. All rake machinery, accessories, appurtenances and their installation shall meet the requirements of these specifications and contract drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery Location

Upon completion of fabrication, testing, and at the Contracting Officers direction deliver specified equipment to the Dalles Dam.

1.6.2 Delivery, Storage and Handling of Equipment

Protect equipment and components from corrosion, deformation, and other types of damage. Store items in enclosed and secured areas free from contact with soil. Provide moisture proof weather protection for all equipment stored in outdoor locations. Transport, handle and store all equipment in accordance with the manufacturer's written instructions. Remove and replace damaged items with new items. Do not prepare the major pieces of trashrake equipment and subassemblies for shipment until they have been inspected and accepted for shipment at origin by the Contracting Officer, unless inspection has been waived in writing. Ship each subassembly completely assembled. Submit the shipping bills with the delivery of finished pieces to the site.

1.6.2.1 Packaging

Provide equipment and subassemblies with adequate protective pads, supports, and blocking. Securely restrain equipment and subassemblies to prevent distortion or damage to the painted surfaces in transit. Any loss or damage during shipment, including damage to the painted surfaces, is the responsibility of the Contractor. Replace or repair lost or damaged items without cost to the Government. Coat all parts with a rust preventative, wrap in heavy-duty plastic, and securely contain in wooden crates. Clearly mark each crate with its contents (including contract number and Corps mark number) on the outside, with a non-ferrous metal tag, engraved with the contents, and secured to the crate with non-ferrous screws. Provide a means for inspection of the crate's contents without destroying the crate. Pack all accessories and spare parts separately in containers plainly marked "ACCESSORIES ONLY," or "SPARE PARTS ONLY." Package each spare part or spare part assembly in a durable treated wooden crate with metallic, plastic or suitable outer shell for weathertight protection and with provisions for handling and long-term storage (60

months). Provide and deliver the component and assembly spare parts as delineated on the drawings. Place a separate packing list, listing the contents of each crate, in a moisture-proof envelope securely fastened to the outside of the crate. Standard commercial packaging in accordance with ASTM D3951 is acceptable except where a different method or standard of packaging is specified.

1.6.2.2 Shipping, Preservation, and Storage

Provide all packing, crating, e.g., necessary to ensure safe shipment of equipment. The crates become the property of the Government unless specifically waived. Fill or protect the equipment with the necessary fluids, coatings, and/or preservatives to maintain in a stable condition without corrosion, deterioration, or degradation for an extended period of storage of up to 12 months. All shipping charges, and brokerage charges are the responsibility of the Contractor. Items subject to open storage for several months at the jobsite shall be suitably protected from weather damage. Where necessary, heavy parts shall be mounted on skids or shall be crated, and any articles or materials that might be otherwise lost shall be boxed or steel banded in bundles and plainly marked for identification. All parts exceeding 150 lb., gross weight, shall be prepared for shipment so that slings for handling may be readily attached while the parts are on a car, truck, special trailer. Boxed parts, where it is unsafe to attach slings to the box, shall be packed with slings so that attachment to the handling equipment can be readily made. All parts subject to damage from moisture shall be packed in hermetically sealed metal containers or plastic envelopes with sufficient quantities of a hygroscopic material inside, or in other approved containers, within their respective packing cases. Protect stored equipment from the weather, humidity, temperature variation, dirt and dust, or other contaminants.

All machined surfaces shall be heavily coated with a rust-preventing compound. Each case, crate, bundle, and single item shall be marked clearly with the purchase order number and project name, shipping address and number of boxes. Each container shall be clearly marked, and the contents identified for proper warehousing. All fasteners and miscellaneous plates, templates, and fixtures required for field connections, splices, alignment, etc. shall be shipped in marked boxes keyed to the erection drawings. A complete packing list shall accompany each shipment. The following additional requirements shall apply:

1.6.2.2.1 Spare Parts and Tools

All spare parts and tools shall be packed separately in containers plainly marked "Spare Parts Only" or "Tools Only" and indicating the item of equipment to which they belong. A packing list, indicating the contents of the container, shall be securely fastened in a moisture-proof envelope to the outside of each container. The packing list shall also provide the following information; as applicable:

(a) Manufacturer;
(b) Purchase order and project name; and(c) Identification, including manufacturer's part number, relevant drawing

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

All materials incorporated in the fabrication of trashrake shall be new and both workmanship and materials shall be of first-class quality, free from defects and imperfections, and, where indicated by the Specifications, of the classification and grades designated therein. Materials not specifically designated shall be suitable for the purpose

and shall comply with the latest specifications of the ASTM or equal.

a. The use of cast iron shall be limited to parts of a non-structural nature.

b. Materials having relative motion shall be selected so that they are non-galling with respect to each other. Also, all dissimilar metals shall be isolated from each other using insulating material.

c. All parts, components and assemblies which are heavier than 32 lb. shall be provided with suitable provisions for handling such as eyebolts, lugs, hooks, tapped holes for eyebolts or holes with rounded corners for passing slings.

d. Equipment shall be suitable for outdoor use and storage.

2.1.2 Selection of Materials

Materials for major items of trashrake equipment shall be as follows:

a. Structural Members: Structural steel ASTM A36/A36M or approved equal.

b. Journal Bearings: Self-lubricating bronze bearings as manufactured by reputed bearing manufacturer shall be used for heavy bearing conditions.

c. Bolts and Axles: All bolts and axles on which will be subject to frequent assembly and disassembly, shall be of corrosion resistant steel. All such nuts shall be of bronze in accordance with ASTM B21/B21M, Alloy 464, half-hard, naval brass, or of corrosion resistant steel compatible with the corrosion resistant steel bolts which will not cause galling.

d. Pins: All pins shall be of stainless steel or chrome plated cold rolled steel.

e. Rigid Electrical Conduit: Hot-dip galvanized steel.

f. Locking of Bolted Connections. All screws, bolts, and nuts shall be provided with a locking device such as locknuts, lock washers or pins.

2.2 EQUIPMENT

2.2.1 General

Furnish equipment under this specification consisting of one (1) trashrake intake cleaning machinery equipped with a rotating brush and other necessary items to provide a complete and operable system. The trashrake shall be overhead traveling type with double telescopic booms and mechanically and hydraulically operated. The trashrake shall have automatic control as well as manual controls (from pendant pushbuttons and a local cabinet), along with all sensors, timers, and switches required for automatic operation, also called indexing. The trashrake shall be equipped with boom system and rotating bristle brush to dislodge the debris from the trashracks. Trashrake shall be provided with load limiting device which will constantly monitor pull force on the rake. In case of erroneous operation resulting in rake getting stuck, device will shut down and signal an alarm condition.

2.2.2 Operating Conditions

The trashrake shall be capable of dislodging the debris described above and dislodging it to the intake bottom at El. 104.0 or below, so that it is washed away by the natural flow of river. There shall be no flow through the trashracks during raking operation, however, a crossflow velocity of 5.5 ft/sec will be present as natural river current during river high flows. The control shall facilitate manual, automatic, continuous operation and adjustability for automatic intermittent operation

2.2.2.1 Environment

The trashrake shall be designed for outdoor service for removing the debris such as small sticks and aquatic plant foliage, etc. that accumulates at the forebay intake. The rake shall be capable of operation between 20F and 110F site temperatures. For normal operation during extreme cold conditions, thermostatically controlled heaters shall be installed in the oil reservoir, electrical control cabinet.

2.2.3 Equipment Layout

The trashrake shall be a double boom system, raking system and other accessories mounted on the running rails supported on the pier top at El 185.0 as shown on the Contract Drawing. The running rails must include drip catchment basins located in the machinery parking location and access platforms for operator access to service and maintain the equipment within the machinery enclosure.

2.2.4 Equipment Interlocks

All electrical and hydraulic system shall be protected against any overload or unusual operation, with manual reset required at the control panel

2.2.5 Mechanical Features

The mechanical features of the equipment shall comply with the following general guidance:

a. All parts subject to wear or damage caused by dust shall be totally enclosed in dust-proof housings where possible.

b. All bearings shall be selected for a B-10 life of not less than 50,000 hours under design speed and load conditions. All bearing housings shall be of cast iron, cast steel or welded steel construction.

c. Provisions shall be made for proper lubrication of all parts. All high-speed gears chain, sprocket, if provided shall be provided with adequate lubrication. Bearings shall be provided with means of pressure lubrication. The trashrake shall be provided with all necessary lubrication fittings. Suitable drip pans shall be provided to collect oil and grease which may drip from operating parts. Drip pans shall be accessible for draining and cleaning.

2.2.6 Electrical Features

Conform electrical equipment, including limit switches, motor starters, conduit, conductors, controls, etc., to the requirements of Section 26 05 00 COMMON ELECTRICAL WORK, Section 26 05 19.10 INSULATED WIRE AND CABLE and Section 40 60 00 PROCESS CONTROL.

2.2.6.1 Electrical Equipment

The electrical equipment such as the PLCs, HMI, motor starter, control transformer, timers, relays, overload protections, status & alarm contacts, fuses and other control devices shall be mounted in a weather-proof lockable enclosure (minimum NEMA 4X enclosure rating) on the intake forebay deck. A thermostatically controlled space heater shall be provided to prevent condensation within the enclosure. Electrical supply to the trashrake will be 480V, 60 Hz, 3-phase. Adequate light shall be provided under the traveling chassis of the rake so as to sufficiently illuminate the raking area.

2.2.6.2 Control Overview

Control of the traskrake and brushing system is described as follows:

a. Operation of the rake shall be possible in auto as well as manual mode. Handheld pendant pushbutton stations shall be provided with plugs at both ends of the rake with a minimum of 15 ft of cable lengths for manual (local-pendant mode) operation.

b. In the local-automatic mode, a cycle start command from the HMI will start the cleaning operation in automatic mode.

c. Remote unit status contacts will be provided in the enclosure to include unit ready, start, stop, running, and alarm conditions.

d. Rake shall be capable of continuous or intermittent manual or auto operation by adjusting the timer in a 24-hour period.

e. Rake shall be capable of running based on an external signal to start contacts based on level differential across the trash rack under remote-automatic mode.

2.2.7 Nameplate

Provide an engraved or raised stainless steel nameplate that is mechanically attached to each piece of equipment. Include the manufacturer's name, model designation, serial number, unit rating, application factor, hydraulic oil specs, unit weights, and any other applicable information on the nameplate.

2.2.8 Equipment Submittal Data

Submit Equipment Data and Detail Drawings for the trashrake showing capacities, lifts, and orientation at extreme positions. The drawings shall show all interfacing details with the trashracks, including provisions made for dislodging of debris from the racks and for depositing at the rack bottom area. All major tolerances shall be clearly shown. Structural and mechanical assembly and detailed drawings for the trashrake, including those of hydraulic cylinders, stroke, operating speeds, power unit, motor horsepower, speeds, etc. Hydraulic schematic, electrical full-line diagram, front of the panel layout and control drawings. Drawings shall show full material list table including weight for each component. Dimensions and weight for the major assemblies shall be clearly shown on the drawings.

Submit a materials list for fabricated items at the time as the detail drawings submittal.

Submit copies of all materials orders including purchase orders, mill orders, shop orders and work orders for materials prior to using the materials in the work.

Submit Manufacturer's Literature and Equipment Data for approval. Provide catalog cuts and material data for the proposed equipment that clearly indicates compliance with the requirements of these specifications and the drawings. Include the names of the manufacturers of all machinery and other equipment contemplated for incorporation into the work, performance capacities and other pertinent information about the equipment.

Submit Design Data calculations showing adequacy for the structural members, mechanical, and hydraulic components. Design calculations shall be stamped by a registered Professional Engineer of the appropriate discipline.

Approval of the material submitted in no way relieves the Contractor from the responsibility of complying with the requirements of the specifications as to the suitability and quality of materials and workmanship and the adequacy of capacity, operating speed and other essential characteristics of the trashrake operation controls. Submit drawings, catalogs, and design data necessary to clearly show the details of any changes proposed in conformity with the requirements of this specification. Equipment, materials, and articles of construction installed or used without such approval will be at the risk of subsequent rejection.

2.3 DESIGN CRITERIA

Provide equipment and machinery to meet the anticipated operating conditions as specified by the following design criteria.

2.3.1 Design Parameters

The principal design parameters for the trashrake and machinery are shown below.

a. Purpose. The trashrake shall be used for dislodging the debris, including small sticks and aquatic plant foliage, accumulates at the intake of the AWS Backup System.

b. Quantity of Supply. One

c. Type. Overhead mounted, travelling type, double telescopic boom type, running on main beam/running rails, mechanically and hydraulically operated.

d. d) Cleaning Head. Cleaning head shall be rotating bristle roller/brush type, 15 inch diameter min., driven by hydraulic motor with 4-5 ft. roller width.

e. Location. Forebay intake deck EL 185.0 in the East Fish Ladder AWS Backup System.

f. Trashrack and Bar Spacing. Total size of intake trashracks is 23 ft. wide, 66.0 ft. high, 1'-7.25" thick rack panels (total eleven panels

of 6.0 ft height). The sill elevation for the trashracks is El 104.0 m, where all the debris shall be collected, so that it can be swept away by natural current of the Columbia River.

g. Maximum trashrack flow velocity. There shall be no flow through the trashracks during raking operation, however, a crossflow velocity of 5.5 ft/sec will be present as natural river current during maximum river high flows.

h. Maximum head on trashracks sill. 56 ft. (max. pool level: El 160.0)

i. Trashrake Travel Length. Minimum travel 30.0 ft. (assuming minimum 2 ft trolly clearance from nearby trashrack panel slot in the pier).

j. Operating Speeds.

o Raking speed: 20-45 ft/min.
o Trolly travel speed: 25-45 ft/min.o Bristle Roller rpm: 25-30 rpm. o One stroke up/down cycle time: 5 minutes or less.
o Total intake cleaning time: 30 minutes or less.

k. Environment. Trashrake shall be suitable for outdoor use where it is directly exposed to wind, rains and snow. The minimum and maximum temperatures expected at dam site are 20 degrees F - 110 degrees F respectively.

2.3.2 Allowable Stresses

The maximum allowable stresses in materials used for various parts of the equipment are specified herein. However, the Contractor shall be responsible for a design based on factors proven in practice and shall use lower working stresses where conditions indicate, or as dictated by operating conditions.

2.3.2.1 Maximum Allowable Stresses

2.3.2.1.1 General

Adequate factors of safety shall be used throughout the design, especially in the design of parts subject to alternating stresses, vibration, impact, or shock.

2.3.2.1.2 Structural Members

(1) Normal Loading Conditions. Under normal loading conditions maximum shear stresses in cast iron shall not exceed 10 percent of the ultimate tensile strength. The allowable stresses in the structural steel members under normal loading will be 90 percent of those given in AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings". For structural members not covered by AISC, the maximum stresses in tension or compression shall not exceed 60 percent of the yield strength or 20 percent of the ultimate tensile strength.

(2) Seismic Load Condition. The maximum stresses shall not exceed 80 percent of the minimum yield strength of the material used.

2.3.2.1.3 Mechanical Components, Shafts, and Pins

The working stresses, bearing pressures, and other design criteria for the mechanical components shall be based on consideration of functional requirements, dynamic loading, impact, and stress concentration effects. Stresses computed for rated load capacity in no case shall exceed 20 percent of the ultimate strength of the materials involved. Under seismic load conditions, the stresses shall not exceed 80 percent of the minimum yield strength of the materials used.

## 2.4 OPERATION SEQUENCES

The equipment sequence of operation, interlocks and electrical controls are as indicated on Sheet M-106 of the Contract Drawings and Section 40 60 00 PROCESS CONTROL.

## 2.5 EQUIPMENT COMPONENT DETAILS

The trashrake equipment arrangement and components details are as follows:

### 2.5.1 Trolley Layout

Main beam/running rail for the trashrake shall be supported on the steel columns/brackets mounted on piers. A rope and pulley arrangement with hydraulic cylinder based telescopic boom system shall be mounted on a trolley-running over the main beam or running rails. The length of the main beam shall be such that a parked trolley at one end of the rail does

not interfere with the handling or replacement of trash rack panels during trashrack handling. Beam/running rails shall also confirm that retracted boom would not interfere with the vehicles traveling on the bridge. The support brackets shall be of welded construction and suitably anchored to the piers to stabilize against the maximum overturning moment, with adequate safety factor. All structural members of the support frame shall be designed to resist the compressive loads resulting from the worst condition of operation.

2.5.2 Raking Arrangement and Tilting Cylinder

Raking operation shall be accomplished double boom system, which is multi-stage and telescopic, operated mechanically and hydraulically, and capable of raising or lowering the boom system and bristle roller/brush head. Separate tilting cylinders shall be capable of moving the booms in or out of the intake-flow direction, providing adequate force and clearance between rake head and trashracks before starting the trash cleaning operation, so as to dislodge the debris for accumulation at the trashrack bottom. Tilting hydraulic cylinders shall tilt the booms to hold the rake against the racks at a constant pressure while the boom is lifted up or down. An integrally mounted load holding device shall be provided to prevent uncontrolled lowering of the boom in the event of hydraulic system failure.

2.5.3 Bristle Roller/Brush (Rake) Head

The Bristle Roller shall be provided as follows:

a. Rake head shall have an approximately 15 inch diameter bristle roller, mounted on the twin telescopic booms and operated with hydraulic motor. Bristle shall be capable of dislodging the debris, including small sticks and aquatic plant foliage, leaves, etc. to accumulate at the bottom of intake.

b. The effective raking width shall be minimum 4.0 feet during the working stroke.

c. Bristle roller/brush shall be made of nylon other suitable material with good wear resistance and service life, while smoothly riding the uneven trash rack bar surfaces while dislodging the debris.

2.5.4 Hydraulic Actuators

2.5.4.1 General

a. The trashrake shall be equipped with hydraulic actuators comprising of hydraulic cylinders and hydraulic power system. The actuators shall be designed to perform their intended functions in accordance with the requirements of these Specifications.

b. All hydraulic actuator parts and components, such as seals, gaskets, pumps, valves, and hoses; that are normally or may accidentally come in contact with hydraulic fluid shall be compatible with the hydraulic fluid used. All hydraulic actuator parts and components that might be

exposed to submergence, splash water or humid weather shall be suitable to resist without damage due to water and the corrosive and other effects of submergence and exposure. To prevent galvanic corrosion, non-metallic insulators shall be used between dissimilar metals.

c. The system hydraulic pressure shall be limited to 2250 psi only, and all hydraulic equipment shall be designed with adequate safety margin over the system design pressure.

d. Hydraulic fluid shall be biodegradable and environmentally friendly, suitable for cold temperatures in accordance with EM 1110-2-1424 "Lubricants and Hydraulic Fluids".

e. Hydraulic arrangement shall ensure that cylinders and piping are permanently and completely full of hydraulic fluid under normal working conditions at all times, to avoid internal corrosion effects of moisture and other corrosive agents contained in air.

f. Hydraulic arrangement shall ensure, insofar as possible, that there is a positive fluid pressure within cylinder and piping, so that in the event of any lack of tightness, no air or water shall enter the hydraulic system.

g. Flexible pipe connections shall be provided to prevent distortion of pipes due to expansion and contraction under extreme temperatures and to facilitate convenient field assembly of the piping where necessary.

2.5.4.2 Hydraulic Cylinders

2.5.4.2.1 General

a. A hydraulic cylinder assembly shall include a cylinder tube, cylinder heads, piston, piston rod, seals, piston rod scraper/wiper, accessories, and appurtenances.

b. In addition to other required specifications, hydraulic cylinder assemblies shall conform to all applicable requirements of Section VIII, Division 1 of the ASME Code or equivalent. ASME certification is not required, but the cylinder shall be fabricated by a reputable manufacturer of hydraulic cylinders.

2.5.4.2.2 Cylinder Body

The cylinder body shall be a seamless tube, machined in one piece. If manufacture of un-machined tubes of the required length is not feasible, the cylinder tube shall be built from a maximum of 2 separate tube sections welded together with full strength 100 percent radiographically inspected welds and then machined in one piece. The cylinder shall be straight and true and shall be of sufficient wall thickness to resist maximum operating pressure and bending forces that could be imposed upon it.

2.5.4.2.3 Piston Rod

a. The material for piston rod shall be solid bar of corrosion-resistant steel (ASTM A 564, type 630), with a hard-chrome plated outer surface.

b. For hard-chrome plated piston rod, the minimum plating thickness shall be 0.001 in. after machining.

c. Outer surface of the piston rod, which contacts the piston rod guide bushing and seals, shall be ground and polished to a uniformly concentric finish having a surface roughness equal to, or better than, 8 micro-inches.

2.5.4.2.4 Pins

Connecting pin, where used, shall be of corrosion-resistant steel ASTM A564/A564M, Type 630 or equal. The pin shall be positively secured against axial movement by either a shoulder on one end and a washer and retaining pin on the other end, or by a washer and retaining pin on both ends, or by bolted retaining plates.

2.5.4.2.5 Seals

Piston seals and piston rod piston seals shall be of the chevron-type or superior packing seals for piston and for piston rod, mechanically locked in place. Seals shall resist roll, turn, and extrusion. On hoist cylinders designed for fluid pressure acting from either side, a set of piston seals shall be provided on each side.

2.5.4.3 Hydraulic Piping

All the piping and appurtenances shall conform to the applicable requirements of ANSI B31.1, "Code for Pressure Piping-Power Piping" or equal. All piping or tubing shall preferably be of corrosion-resistant steel with corrosion-resistant steel flanges and fittings. All pipe fittings shall be of the socket-welding type. All pipe supports such as pipe hangers, anchors, guides, clamps, etc., shall be furnished and shall conform to the applicable requirements of ANSI B31.1 "Code for Pressure Piping-Power Piping" or equal.

2.5.4.3.1 Flexible Connections

The flexible connections shall allow reconnection of the hydraulic power unit or hoist cylinder without realignment and shall also permit the necessary freedom of movement of the hoist cylinder in its mounting. For flexible connections either flexible hoses or steel pipes designed for flexibility shall be used.

2.5.4.3.2 Flexible Hoses

All flexible hoses shall have a hydraulic fluid resistant inner tube and adequate braids of high-strength steel wire reinforcement separated by layers of synthetic rubber. The hoses shall have an oil, weather and abrasion resistant synthetic rubber cover. The allowable design pressure will have adequate factor of safety over the hose burst pressure.

2.5.4.4 Hydraulic Power System

The hydraulic power unit shall include a hydraulic reservoir, electric motor driven pumps, pressure relief, counterbalance, check, flow control and directional control valves, pressure and temperature gages, filters and strainers, piping, and all accessories, appurtenances, and wiring required to provide an operational fluid power system for the operation of the rake according to the requirements of these Specifications. All of the components shall be mounted on the hydraulic reservoir.

2.5.4.4.1 Fluid Reservoir

The hydraulic fluid reservoir shall be of corrosion resistant steel (ASTM A276/A276M, type 304) and shall conform to ANSI B93.18 or equal. The reservoir shall be provided with baffle plates and an access opening for clean-out. The reservoir shall also be equipped with a sight fluid level gage, thermostatically controlled heaters, minimum oil level indicating device, thermometer to indicate fluid temperature, valve drain connection, a magnetic plug type drain arranged to permit complete drainage, a filler pipe provided with a strainer, and a breather cap with filter. The breather cap shall be a dust filter or silica gel type and shall be mounted directly on the hydraulic reservoir. The breather shall function as an air filter to eliminate moisture and particulate contamination within the reservoir. The reservoir shall be provided with lifting and jacking lugs as required for its handling.

2.5.4.4.2 Hydraulic Valves

All valves shall be rated to withstand pressure not less than 25% greater than the maximum system pressure. All pressure relief and flow control valves shall be preset in the shop to their operational setting. Each manually operated valve shall be furnished with a corrosion-resistant tag suitably engraved or stamped to identify the valve according to its designation on the hydraulic circuit drawing and according to its function in the system.

a. All shut-off valves shall be ball valves.

b. All check valves shall be spring-loaded for closure with minimum shock. Pilot operated check valves shall be provided where the check valve has to open against pressure.

c. All directional-control valves shall be of standard manufacture and nominally rated for zero leakage.

d. All pressure-relief valves shall be of the hydraulically operated

type. The valves shall be adjustable and shall maintain the pressure within 5 percent of the preset value.

e. All flow-control valves shall be of the adjustable type with an integral check valve for free return. All valves shall be shop tested to pass the required flow within 5 percent.

f. All velocity fuses (line rupture protection valve) shall be cartridge type valves. Valves shall be rated to pass at least 10 percent more than the required flow.

2.5.4.4.3 Filters and Strainers

Filters shall be of the disposable, replaceable-element type. Strainers shall be of the cleanable, replaceable-element type. Elements of all filters and strainers shall be stainless steel or Monel woven or wound wire.

2.5.4.4.4 Hydraulic Fluid

The hydraulic fluid used shall be environmentally friendly oil with the workable viscosity range for all temperatures encountered at the site. The temperature in the winter could go as low as 20 degrees F - 110 degrees F, thus trashrake must be able to work without any adverse impact on its working. Before filling the system with hydraulic fluid, the system cleanliness shall conform to SAE AS4059, Class 7.

2.6 ELECTRIC MOTORS

Provide a motor with Horizontal shaft, squirrel cage induction, high slip, high torque, 460 volt, 3 phase, 60 Hertz type motor controlled by [across the line magnetic starter rated for continuous duty and conform to the applicable requirements of NEMA MG 1 and rated at a minimum of 8 percent and maximum of 13 percent slip for [both high and low speed] windings. The enclosure is to be totally enclosed, fan cooled, and weatherproof type. Provide the motors with a removable stainless steel drain. Remove the drain as specified by the motor manufacturer. Motor installation is in an exterior location subjected to the weather elements. Speed/torque characteristics are to be as described herein. Locate conduit boxes on the side of the motor as indicated. Seal the motor shaft with a labyrinth type seal where the shaft penetrates the front and back of the motor.

2.6.1 Construction

Motor frame size shall be in accordance with NEMA. Temperature rise cannot be greater than 176 degrees F. Provide an internal heater of the strip type as part of the motor. The heater is to have a minimum capacity of 90 W and have separate leads terminating in a separate conduit box. Heater power supply is to be 120 volt, 60 Hertz, single phase. Use Class F insulation throughout the motor. Impregnate motor windings with the insulating compound by the vacuum/pressure impregnating method. Repeat the procedure until all voids in the winding are completely filled with the insulating material. Provide antifriction type motor bearings incorporating a suitable method for lubrication. Bearing ratings are to meet or exceed a L-10 life of 30,000 hours at full radial load. Provide the motor with a visible nameplate indicating motor horsepower, voltage, phase, hertz, RPM, full load amps, frame size, manufacturer's name and model number, service factor, and serial number. Submit motor performance data at the time the motors are submitted. The data includes: percent efficiency, percent amperes, percent power factor, and percent slip plotted against 0 to maximum allowable motor overload above 100 percent for both high and low speed windings; and torque (ft-lb.) and amperes plotted against 0-100 percent synchronous speed for both high and low speed windings.

2.6.2 Electric Motor Factory Tests

Factory test all motors to ensure that they are free from electrical and mechanical defects. Perform tests in compliance with IEEE 112 and NEMA MG 1. Document test results in accordance with the guidance indicated in IEEE 112 and NEMA MG 1. Testing includes the following. Additionally, perform all tests normally conducted by the manufacturer as part of its quality control program, but not specified herein.

2.6.2.1 No Load Test

For each winding (high and low speed); at no load and rated frequency and 100 percent rated voltage; record the current, voltage, frequency, kilowatt input, and RPM.

2.6.2.2 Locked Rotor Test

For each winding (high and low speed); with the motor blocked and at rated test frequency and 50 percent rated voltage; record the voltage, current, frequency, and kilowatt input. Repeat for 100 percent rated voltage.

2.6.2.3 High Potential Test

For each winding (high and low speed): Record voltage and duration.

2.6.2.4 Stator Winding Resistance Test

For each winding (high and low speed): Record resistance in ohms between the stator winding terminals. Record the temperature in degrees C.

2.7 PAINTING

Paint all exposed ferrous surfaces on the equipment. Painting preparation shall be in accordance with SSPC SP 10/NACE No. 2, to a near white metal finish. Surfaces shall be painted with Amercoat 68 as zinc primer (3-5 mils), Amerlock 2/400 as epoxy intermediate coat (6-8 mils) and Amer shield as Polyurethane coat (3-5 mils), as manufactured by PPG Protective & Marine Coatings, One PPG Place, Pittsburgh, PA-15272 or approved equal. Color selections shall be subject to owner's approval. Color selections shall be subject to owner's approval

2.8 SHOP ASSEMBLY AND TESTS

2.8.1 General

a. The trashrake equipment is to be completely assembled in the shop and tested in the presence the Contracting Officer. Notify the Contracting Officer at least 10 calendar days before testing of each machinery unit. This notification includes information on how many units will be tested and the estimated time frame involved with each test.

b. The witnessing of a particular test may be waived by the Contracting Officer; however, the approved commissioning shop test procedures, notification, and documentation should still be performed as required by these specifications. Once informed that Government personnel will

witness the test(s), notify the Contracting Officer that a particular test is scheduled as planned a minimum of 48 hours prior to the test(s). Perform all necessary preparations and preliminary testing prior to issuing the 48 hour notification.

c. Commence testing upon the arrival of Government personnel at the scheduled location and time. Design and furnish a test rig and facilities (within the continental United States) suitable for performing the tests. Submit details of the test rig and its location. Address in the submittal aspects including adequacy of rig strength, including, but not limited to, foundations; access to the test rig; availability of suitable power and cranes; how the work will be protected; how the test measurements will be made; and how test results can be verified. Clean all bearing surfaces and lubrication lines and lubricate reducer bearings, couplings, and gears before tests are begun. Fill all speed reducers with the specified lubricating oil; transfer of lubricating oil from one unit to another is not allowed. Electrically connect and operate the motors, hydraulics, and controls at rated voltage. .

d. Reimburse the Government for all travel, lodging and per diem costs incurred for any Government witness tests that fail to meet the contract specifications or performance requirements and result in the factory testing being terminated, postponed or rescheduled to correct the deficiencies.

2.8.2 Anti-Seize Lubricant

Assemble threaded portions of the assemblies using an anti-seize lubricant that prevents galling of parts and corrosion, allows for easy disassembly of parts, and reduces friction unless otherwise noted or specified. Select anti-seize lubricant that is a standard product designed for the intended use.

2.8.3 Acceptance

All readings taken from the equipment, components or assemblies are required to be within the specified limits. Failure of any part to meet these contract requirements is cause for rejection of the entire quantity until action is taken to correct defects and prevent recurrence and such actions have been approved by the Contracting Officer. Retesting is subject to the same random sampling and testing procedures as the original lots.

2.8.4 Gages

Make gages available to the Government at the fabrication site for use in checking critical dimensions. Gages are steel tape, vernier, micrometer, Gar S22 Surface Finish Comparator, etc.

PART 3 EXECUTION

3.1 FABRICATION

3.1.1 General

Fabricate components and assemblies in compliance with modern practices in the design and manufacture. All work shall be done by personnel skilled in the related professions. All parts shall be made accurately to standard gages so as to facilitate replacement and repairs.

3.1.2 Material

Straighten material before being laid off or worked. If straightening is necessary, straighten by methods that do not impair or alter the metal. Sharp kinks, bends, or overcuts of material are cause for rejection of the material. Material with welds will not be accepted except where welding is specified, indicated, or otherwise approved. Flame cutting of material is not allowed. Shearing is to be accurately done, and all portions of the work neatly finished. Ensure corners are square and true unless otherwise indicated.

3.1.3 Dimensional Tolerances for Structural Work

Tolerances shall be selected by the Contractor to correspond to the accuracy required for the proper operation of the equipment, considering the nature and function of the part. All tolerances shall be submitted for Engineer's review.

3.2 MACHINE WORK

3.2.1 Finished Surfaces

a. Surface finishes indicated or specified herein, are to be in accordance with ASME B46.1. Determine compliance with specified surface by sense of feel and by visual inspection of the work compared to Roughness Comparison Specimens in accordance with the provisions of ASME B46.1. Values of roughness width and waviness height are not specified but have to be consistent with the general type of finish specified by roughness height. Flaws such as scratches, ridges, holes, peaks, cracks, or checks which will make the part unsuitable for the intended use are cause for rejection.

b. The quality of all surface finishes shall be selected with due regard for the nature and function of the surface and in accordance with conservative design practice and the class of fit required. Maximum surface roughness of any surface is 250 micro-inches. Indicate surfaces to be machine finished by symbols which conform to ASME B46.1.

3.2.2 Unfinished Surfaces

In so far as practicable, lay out all work to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, chip and grind smooth or machine to secure proper alignment. Unfinished surfaces are to be true to the lines and dimensions indicated and have to be chipped or ground free of all projections and rough spots. Fill depressions or holes not affecting the strength or usefulness of the parts in a manner approved by the Contracting Officer.

## 3.3 CASTINGS

Castings shall be free from injurious defects and shall be satisfactorily cleaned for their intended use. All bronze castings for bushings and bearings shall be centrifugally cast. Surfaces of castings which are not machined shall be dressed for good appearance and for painting. The location of existing defects shall be determined, and all defects which impair the strength or utility of the casting shall be removed to sound metal before repair. The structure of the castings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a casting will be cause for its rejection.

Before assembly, all bearing surfaces, journals, and grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. Solvents shall not be used on self-lubricating bearings. After assembly, each lubricating system shall be filled with an approved lubricant. Self-lubricating bearings shall not be greased and shall be assembled dry according to the manufacturer's instructions.

## 3.4 WELDING

Unless otherwise specified, conform welding to the provisions of AWS D1.1/D1.1M, or CSA W47.1. Welders and welding operators are to pass the qualification tests as prescribed by AWS D1.1/D1.1M, Section 5 before being assigned to production work. Submit certifications showing qualification of welders and welding operators prior to commencing fabrication. Stainless steel welding shall conform to the requirements of AWS D1.6/D1.6M.

The minimum size of fillet welds shall be 1/4 inch measured on the leg in the structural members. Welds larger than 5/16 inch shall be made in not less than 2 passes. All groove welds including butt welds shall be full penetration, welded from both sides.

## 3.5 NONDESTRUCTIVE EXAMINATION

### 3.5.1 NDT Agency Requirements

Conduct NDT examinations using suitable equipment and qualified personnel. Provide written approval of the examination procedures and perform the examination tests in the presence of the Contracting Officer. Persons performing the NDT examination are to be qualified for the specific procedure used in accordance with ASNT SNT-TC-1A. Submit nondestructive examination certification of qualified persons, procedures and equipment performing or used for nondestructive testing.

### 3.5.2 Nondestructive Testing (NDT) for Flaws

For all components to be furnished, critical welds shall be tested in accordance with the applicable standards of AWS or CWB. All certifications to be supplied upon request.

## 3.6 FIELD QUALITY ASSURANCE

Perform all specified quality control inspections and tests. Implement and maintain an inspection log to include copies of all descriptive data for all specified inspections and tests. Make the inspection log available immediately to the Government's inspector upon request. Submit a complete copy of the inspection log to the Government at the end of specified inspections and tests. The Government reserves the right to witness any and all specified quality control (QC) procedures. Provide the Government with one-week advance notice of QC procedure scheduling to allow time for witness coordination. Fully test replacements for all rejected parts as specified herein for the original lots.

## 3.7 MISCELLANEOUS PROVISIONS

### 3.7.1 Cleaning of Corrosion-Resisting Steel

After fabrication, remove oil, paint, and other foreign substances from corrosion-resisting steel surfaces. Clean by vapor degreasing or by the use of cleaners of the alkaline, emulsion, or solvent type. After the surfaces have been cleaned, final rinse with clean water followed by a 24 hour period during which the surfaces are intermittently wet with clean water and then allowed to dry for the purpose of inspecting the clean surfaces. Visually inspect the surfaces for evidence of paint, oil, grease, welding slag, heat treatment scale, iron rust, or other forms of contamination. If evidence of foreign substance exists, clean the surface in accordance with the applicable provisions of ASTM A380/A380M. Submit the proposed method of treatment. After treatment visually reinspect the surfaces. Brushes used to remove foreign substances may only have stainless steel or nonmetallic bristles. Remove any contamination occurring subsequent to the initial cleaning by one or more of the methods indicated above.

### 3.7.2 Protection of Finished Work

Submit an equipment protection plan with detailed information on the method [s] proposed to protect the existing equipment from such operations as power washing, abrasive blast cleaning, welding, placement of concrete, and painting. Thoroughly clean machined surfaces of foreign matter. Protect all finished surfaces by suitable means. Unassembled pins and bolts are to be oiled and wrapped with moisture-resistant paper or protected by other approved means.

### 3.7.3 Lubrication

Lubricate all the components of the equipment requiring lubrication using only the lubricants specified. Provide and lubricate the components and assemblies, in their entirety, after assembly with a food grade lubricant which meets the following minimum characteristics:

| | |
|---|---|
| ISO Grade | 46 |
| Four Ball Wear Test (ASTM D4172) | 0.39 mm |
| Falex EP (ASTM D3233) | 100 pounds force |

## 3.8 FIELD ERECTION AND TESTS

### 3.8.1 General

The trashrake shall be assembled, erected, and tested by the Contractor under supervision of the erecting engineer under the provisions of paragraph ERECTING ENGINEER. Submit the installation and alignment procedure and install in with the approved procedure. In the submittal provide detailed manufacturer's instructions concerning the installation and alignment procedures for the equipment to be furnished. The procedure has to include consideration of all the other work that is obligated to be performed at the site; and also, the operating regime for the AWS Intake which the Government will enforce. Base the procedure on a proper sequence of construction that will complete the work with safety, efficiency, and in full accordance with these specifications. During installation repeated checks of the tolerances shall be made so that the equipment as installed is within the specified tolerances.

### 3.8.2 General Test Procedure

Submit the commissioning, pre-functional and functional checklist test procedures, with a blank test results data sheet for each, prior to the commencement of any tests. Complete all pre-functional checklists prior to performing Functional operational tests. The trashrake shall be completely assembled and tested to verify the compliance with the operational requirements of this section, including functions such as the following:.

a. Cleaning roller head full lowering and raising;

b. Operation of tilting cylinder for adequate sideway pressure;

c. Traversing rake across the intake bay;

d. Dislodging of trash from the trashracks;

e. Indexing by rake after cleaning stroke;

f. Automatic and manual operation under all modes.

Stop the test immediately if there is any undue noise, vibration, or overheating in any of the equipment. After correction of alignment and/or all other causes for the interruption of the test, reinspect the unit and resume testing when permitted by the Contracting Officer. The trashrake shall be operated for at least 3 full cleaning cycle operation of entire intake, with each cycle comprising of cleaning the full intake trashracks with multiple up and down strokes by rake head. A written test report shall be prepared and placed on the file with all running voltage, amperes, hydraulic pressure, speeds, and other critical parameters recorded. Submit final operating test results.

## 3.9 ERECTING ENGINEER

Furnish the services of one or more competent erecting engineers from the equipment manufacturer/fabricator to supervise and direct the erection and installation of this equipment.

a. The erecting engineer(s) are required to be present for all shop erection, inspections, tests, installation and operation of all equipment at the project site.

b. The erecting engineer has responsibility for the equipment meeting all the requirements of these specifications and fulfilling all the Contractor's guarantees.

c. The erecting engineer will verify the fit and alignment of mating components prior to erecting in the field and be present during final connection and all commissioning and field testing for contract compliance. The erecting engineer will keep records of all measurements taken during installation and testing.

d. Upon completion of the installation, commissioning and startup for each specified major equipment or subassemblies, erecting engineer will submit an erecting engineer installation and operation certification approving the installation and operation of the equipment.

## 3.10 FIELD TRAINING

Provide field training conducted by the erecting engineer for operating staff after each system is functionally complete but prior to final acceptance. The training will be given for a period of not less than 8 hours. The training will cover all pieces of equipment and include items contained in the operation and maintenance manuals. Do not conduct training until operation and maintenance manuals have been approved. Provide a one-week advance notice of the scheduled training date to the Government. Digitally record all training conducted and provide two DVD copies of the training to the Government. The recording will be compatible with common DVD players in the United States.

## 3.11 STARTUP AND ACCEPTANCE TEST

Submit the pre-functional checklist for approval that includes checks, recordings, measurements and verifications to be performed prior to start up. Signature by all parties is required for acceptance. Following the completion of installation, checkout, adjustment, and setting the limit switches, controls, interlocks, perform a startup and acceptance test on each machinery unit. Perform the startup and acceptance test in accordance with the approved commissioning functional checklist, record and submit the results on test result forms of the procedure. Signature by all parties is required for acceptance. Include a demonstration of proper functioning of the limit switches, controls, interlocks in the acceptance test. For acceptance, the machinery unit(s) are to be successfully operated through a minimum of three complete cycles to satisfy the Contracting Officer that the requirements of the contract have been met and that the performance of the equipment is satisfactory for the purpose intended.

Upon successful completion of the field tests, the accessory items and equipment will be examined by the Contracting Officer, Erecting Engineer, Contractor, Project Personnel, and if found to comply with the contract it will be accepted by signature of all parties in a prepared commissioning document. Signatures and Acceptance will not occur until all found deficiencies have been corrected. submit copies of the signed commissioning document document to the Contracting Officer.

3.12 EQUIPMENT WARRANTY

Submit manufacturer's standard warranty or guarantee for equipment, e.g., speed reducers, or any other equipment. Identify any warranties that extend beyond a 2-year period.

3.13 OPERATIONS AND MAINTENANCE DATA

Unless otherwise specified, all operation and maintenance manuals are to be comprehensive to the electro-mechanical and hydraulic operating system with independent sections for each unique piece of equipment. Include six copies of the following bound information.

a. Safety precautions
b. Operator prestart
c. Startup, shutdown, and post-shutdown procedures
d. Normal operations
e. Emergency operations
f. Environmental conditions
g. Lubrication data
h. Preventive maintenance plan and schedule
i. Cleaning recommendations
j. Troubleshooting guides and diagnostic techniques
k. Wiring diagrams and control diagrams
l. Maintenance and repair procedures
m. Removal and replacement instructions
n. Spare parts and supply list
o. Product submittal data
p. O&M submittal data
q. Parts identification
r. Warranty information
s. Testing equipment and special tool information
t. Testing and performance data
u. Contractor information

Submit six copies of the OPERATIONS AND MAINTENANCE (O&M) MANUAL [in accordance with paragraph OPERATIONS AND MAINTENANCE MANUALS and in compliance with Data Package 3 in Section 01 78 23 OPERATION AND MAINTENANCE DATA.]

-- End of Section --