1. Introduction

1.1. Background and Purpose

The current Centralized Machinery Control System (CMCS) contains numerous obsolete components and supportability has become increasingly challenging. In addition, the current Tank Level Indication (TLI) system is a stand-alone system and not integrated into the CMCS. Furthermore, the ship has undergone various modifications that have expanded the monitoring requirements. In FY2005, the Ship Service Diesel Generators (SSDGs) were upgraded to include tier 2 diesel engines. In FY2006, a bow thruster was added. In 2016 two of the ship's fuel oil storage tanks were repurposed as sewage and grey water holding tanks and two ballast tanks were repurposed as Potable Water storage tanks to expand the ship's operational time within No Discharge Zones.

This technology refresh effort is intended to replace the existing CMCS with a new system based upon a distributed producer/consumer model, consisting of Intel processor-based Human Machine Interface (HMI) displays, redundant PLC-based system, and remote alarm panels networked together. The new CMCS shall be comprised of Commercial Off the Shelf (COTS) equipment, packaged and mounted in the existing Main Control Station Console, CMCS components to be installed in a new Pilothouse Starboard Console that is being developed by another Contractor, along with Engineer's Alarm Panels, and miscellaneous other components required to provide an integrated CMCS system.

1.2. Abbreviations

Acronym	Definition
ABS	American Bureau of Shipping
ACCU	Automated Control system Certified for Unattended engine room. An ABS Class Notation for unmanned propulsion space operation
AI	Analog Input
AMR	Auxiliary Machinery Room
AO	Analog Output
ATS	Automatic Transfer Switch
CDROM	Compact Disc Read Only Memory
GFI	Government Furnished Information
CFR	Code of Federal Regulations
CDRL	Contract Data Requirements List
CMCS	Centralized Machinery Control System
CMMI	Capability Maturity Model Integration
DAU	Data Acquisition Unit
DE	Diesel Engine
DI	Digital Input
DO	Digital Output
DVTP	Design Verification Test Procedure

EAP	Engineers Alarm Panel
ECP	Engineering Change Proposal
EOS	Engineering Operating Station
EOT	Engine Order Telegraph
FAT	Factory Acceptance Test
FCB	Fire Control Box
FCP	Fire Control Panel
FM	Firemain
FMEA	Failure Mode Effects Analysis
FO	Fuel Oil
FW	Fresh Water
GUI	Graphical User Interface
HP	Horsepower
Hz	Hertz
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
MCS	Machinery Control Station
PLC	Programmable Logic Controller
PSTP	Periodic Safety Test Procedures
RTD	Resistance Temperature Detector
SCC	Ship Control Console
SW	Seawater
TLI	Tank Level Indicator
UPS	Uninterruptable Power Supply
USCG	United States Coast Guard

2. Existing Centralized Machinery Control System

2.1. Overview of Centralized Machinery Control System

The CMCS continuously controls and monitors specific points in the vessel's equipment and machinery spaces. Operators are immediately alerted to any abnormal conditions by audible alarms and visual indicators located on the Machinery Control Station (MCS) Console, Pilothouse Starboard Console, Mess Deck Engineer's Alarm Panel, and at Engineer's Alarm Stateroom Panels. Incorporated into the CMCS is a stand-alone fire detection system. Propulsion controls are provided by pneumatically driven throttle control units, along with an Engine Order Telegraph System. Propulsion engine safety shutdown controls are also provided by independent PLC systems that are part of the CMCS.

Figure 1 provides a block diagram showing the major components that are part of the CMCS.

2.2. Machinery Control Station (MCS) Console

The MCS console is the central terminal for the machinery plant monitoring and alarming. All signal conditioning and alarm functions are located in card racks within the console, providing easy access for maintenance and repair.

Dual lamp Indicators are used to display all alarms and status indication. Digital meters provide continuous display of pressure and temperature. Illuminated pushbuttons are provided to activate and display the function.

The Propulsion Throttle Control Unit, Engine Order Telegraph, Watch Call, and Attendance Monitor units are mounted on the MCS panels. A control switch transfers all propulsion control functions to the Pilothouse Starboard Console for unattended operation.

2.3. Pilothouse Console

The Pilothouse Starboard Console has full control of the propulsion system when transferred from the MCS. In addition, the console provides vital and summary alarm indicators from the monitoring and alarm system, Throttle Control Unit, Engine Order Telegraph, Attendance Monitor, and a supervised Fire Detection System Annunciator panel.

2.4. Engineers Remote Selector Panel

An Engineer's Remote Selector Panel is provided on the MCS to select either the Chief Engineer's or the 1stAssistant Engineer's (AE) Stateroom panels.

2.5. Engineers Stateroom Panel

Identical Engineer Stateroom panels, located in the Chief and 1st Staterooms, along with a panel in the Mess, allows summary alarms for the vital alarms to be visually displayed along with an audible alarm. The audible alarm on this panel only can be silenced (not acknowledged), allowing the visual indication to continue to flash, but the system audibles are active until

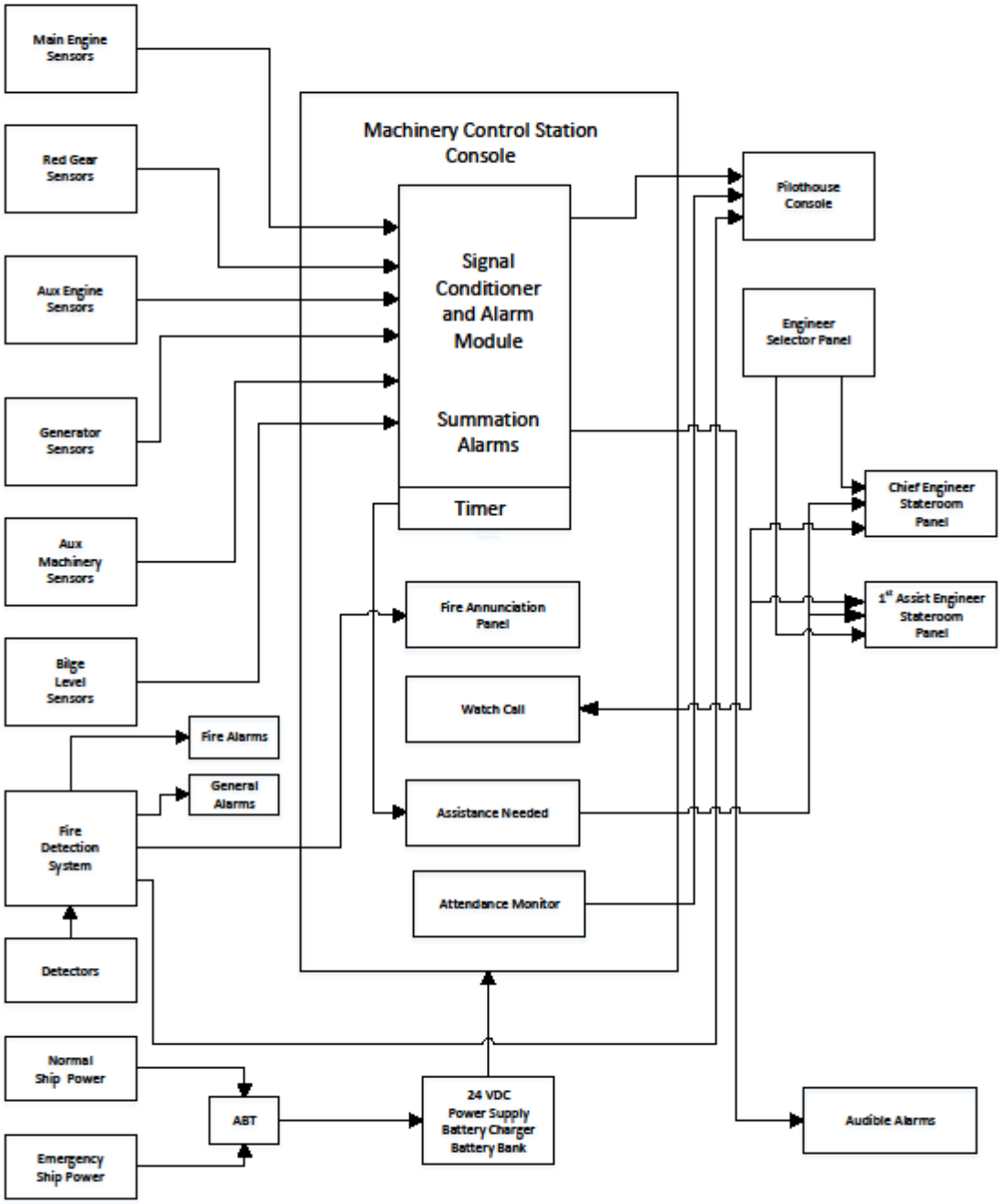

Figure 1: THOMAS JEFFERSON CMCS

acknowledged at the MCS consoles. In addition to the summary alarms displayed on the panel, Watch Call and Assistance Needed functions are also provided on this unit.

2.6. Watch Call System

The Watch Call System consists of a master control panel and remote panels located in the engineer's staterooms. To Initiate a call, the selected engineer's switch is depressed. The switch illuminates, and the audible and WATCH CALL indicates in the stateroom. The correct response by the called engineer is to depress the ACK button. This silences the audible and extinguishes both illuminated indicators. (The master station can cancel the initiated call by pressing the MASTER CANCEL switch.)

2.7. Assistance Needed Alarms

Two actions will cause the Assistance Needed Alarm to activate: either depressing the ASSISTANCE NEEDED push button on the MCS console, or failure to acknowledge any alarm at the MCS after a 30 second time delay. Visual indicators are also located on the Engineer Stateroom Panels.

2.8. Attendance Monitor

The Attendance Monitor allows the Bridge operating personnel to monitor the engineer on watch in the machinery spaces during manned operations. The Pilothouse Starboard Console initiates operation of the monitor, and the engineer on watch must respond to the periodic monitor audible and visual indicator, ATTENDANCE MONITOR, by depressing the illuminated pushbutton within a set time. Failure to respond results in a "FAIL TO REPORT" alarm which should be investigated.

2.9. Power Supply

The Main Power Supply converts the ship's supply to 24 VDC using high reliability solid state and heavy-duty components. An integral battery charger and battery bank provide instantaneous backup power in the event of failure of the normal and emergency ship's power. An Automatic Bus Transfer (ABT) switch provides rapid failover from the normal power feed to the emergency bus.

2.10. Indicators

Several types of display indicators are used in the Monitoring and Alarm System:

a. Direct Reading Pressure Gauge
b. Direct Reading DC Voltmeter
c. Digital Meter for Pressure and Temperature
d. Dual Lamp Indicator to display alarm status of a monitored point.

All continuous displays of monitored parameters are indicated on digital meters. Red, seven segment LED, 0.3 inches high characters are used in the display. A filter snaps on the front to provide easy, glare-proof visibility. The two-meter scales used on the MCS console are 250

mv for 250 full scale and 1.2 volts for 1200 full scale. The displays are used for pressure and temperature parameter readings.

2.11. Sensors

The basic elements of the monitoring system are the sensors. The various types used are dry contacts (positioned mechanically), pressure switches, temperature switches, flow switches, level switches, thermocouples, RTDs and transducers. Each perform a specific function or provides an analog signal that is processed for either display, alarming at setpoints, or both.

All switch type sensors operate in the same manner: a movement of a normally open microswitch actuator caused by either a mechanical roller or shaft, pressure diaphragm, capillary tube or liquid flow. Normally closed contacts that open for abnormal conditions are used to indicate the alarm status and as a secondary function, monitors the two conductors (cable) status. A cut cable or broken connection will cause the alarm to activate.

Resistance Temperature Devices (RTDs) are made of 100-ohm platinum and measure temperature accurately by changing resistance with temperature.

RTDs are sensor inputs to a Transmitter Module that processes the change in resistance to a current loop (4-20 ma) output. The 4-20 ma signal is further conditioned at the Receiver Module to provide means of calibrating the channel by an adjustment to the zero and span. An adjustment setpoint provides an alarm output signal and drive a digital display meter.

Thermocouples (TC) are normally used to monitor engine cylinder and exhaust temperatures. The thermocouple generates a small voltage which is a function of the temperature at its tip (junction). These sensors receive the same signal conditioning as RTDs for monitoring and alarms. TCs also can be monitored by a microprocessor-based monitor to continuously scan each channel for display, alarms for high temperature, as well as differential temperature.

2.12. Temperature Monitor

The TM-5O00E is a computerized Temperature monitor designed to sample up to 32 channels of either thermocouples or resistance temperature alarm devices (RTD's). The TM-5OOOE processes the measured values, calculates group averages, and the difference between channel and averages. Measured and calculated values are then compared to setpoint values. When setpoint levels are exceeded, one or more alarm relays are actuated and alarm statements appear on the display.

Specific characteristics (i.e. number of channel's, groupings, alarm and setpoints) are programmed into the computers READ ONLY MEMORY (ROM) per the application requirements. Field changes are accomplished by replacing the ROM.

All channels are continuously sampled and compared in less than 2 seconds, although the display is updated at the slower rate of one channel every two seconds. A channel status

statement, sent over a serial link, at 300/1200 Baud, indicates channel number, measured and differential readings, and each alarm relay status. This information can be sent to other computers, terminals, data loggers, printers, and modems if so required. Setpoint values can be viewed directly on the LCD display and pre-programmed with the front panel keypad and program switch. There is no loss of protection while setpoint values are being changed.

2.13. Engine Order Telegraph

The Engine Order Telegraph System or EOT allows the Bridge operating personnel to communicate propulsion orders to the engineer on watch at the MCS Console for attended operation.

Indicators display the command and response action and an alarm bell advises of any misaligned selectors. A WRONG DIRECTION alarm bell or buzzer will sound if the MCS selector is aligned in the opposite direction and until the shaft has stopped and rotates in the ordered direction.

2.14. Machinery Junction Box Units

Junction-Box Units provide the interface between the machinery and the MCS console. Various cables enter each junction-box from the sensors located on or near the particular machine. Each J-Box contains pressure transducers, signal conditioning for RTD or TC inputs and routes the signals to the MCS via one (1) cable. Junction-Box units are used for the Main Engine, Auxiliary Engine, each Generator Engine, and the Emergency Generator Engine.

2.15. Fire Detection System

The Fire Detection System is a supervised, stand-alone, US Coast Guard approved system. The Fire Alarm Panel houses the electronics that monitor the various sensors in the system. Ionization (smoke) detectors, thermal (rate of rise) detectors, and manual pull stations normally are used in a system, depending upon the area to be monitored. Power from the ship's normal and emergency bus, together with an internal battery bank, insure continuous operation under all conditions. Transfer to the battery bank causes a system Trouble Alarm to be activated with associated audible and visual alarm indication.

2.16. Control Air System

The Control Air System provides single lever Main Engine and Auxiliary Engine control from one location: Pilothouse Starboard or MCS Consoles or at the local control station for the propulsion engine. The design incorporates the following functions:

a. Only one engine will drive the propeller at any time.
b. Engine selection or transfer may only be accomplished if the receiving engine is running.
c. Control must be in neutral, all clutches exhausted, disengaged, and the shaft brake engaged.
d. To engage the Auxiliary Engine Ahead or Astern, the Auxiliary Gear Forward or Reverse must be engaged before engaging the Auxiliary Input Clutch on the Main Gear.

e. Provides interlocks to prevent Auxiliary Engine overspeed following engine transfer.
f. Provides an interlock to prevent engine stall following high speed reversal.

The control air system consists of an air treatment panel, control heads (Mathers throttle control units), transfer switch, main engine clutch control, auxiliary engine clutch control, shaft brake control, and air regulator.

2.17. Miscellaneous MCS Subsystems

2.17.1. Shaft Revolution Counters

The Shaft Revolution Counter employs a non-contact method of counting the total number of revolutions a shaft has accumulated, turning in either direction. The system consists of a small steel target attached to the propeller shaft or shaft coupling, one proximity sensor, and one junction box. A centrally located driver and readout module completes the system.

The MCS enclosure contains all the remaining circuitry, printed circuit board, power supply, digital display, battery back-up, and other components required for system operation. The Digital Revolution Counter display is a self-contained, 8-digit, 7-segment LED PCB which contains all the circuitry necessary to provide a continuous total revolution count readout for the shaft. A means of clearing (reset) each display is provided. Inadvertent resets are prevented by use of a keylock switch located on the MCS console.

2.17.2. Automatic Shutdown PLC for Main and Auxiliary Engines

Automatic shutdown of the Main and Auxiliary Propulsion Engines are accomplished with SLC-150 and SLC-100 Programmable Logic Controllers (PLC). The programs for the PLCs are standard ladder logic programs stored on an EPROM.

2.17.3. Generator Shutdown Panel

The electric plant generation system includes a Generator Shutdown Panel that provides an automatic standby start functionality if an SSDG fails. This functionality is implemented in an Allen-Bradley Model 1745 programmable controller.

2.17.4. Bilge Level System

The bilge level is monitored in the Steering Gear compartment (two each), Forward Machinery space, Aft Machinery space, Bow Thruster Void, Transducer Void, and Potable Water Machinery Room (two each).

The level sensors for machinery bilges are located at different levels to monitor high and/or high-high levels. The Oily Waste Separator running time is monitored and set for 30 minutes to detect excessive run time due to flooding of the bilge.

2.17.5. Ground Fault Detection

Ground fault on the 24VDC power system is provided by two lamp indicators. For normal plus (+) and minus (-) DC voltage floating above ground, both indicators will be equally illuminated DIM. A ground fault on the +24VDC bus will extinguish its indicator (L1) and

cause the 24VDC common indicator (L2) to be illuminated brightly. Partial grounds or leakage will cause an imbalance in the intensity of each indicator. The lowest intensity indicator indicates the fault.

3. CMCS Technology Refresh Requirements

3.1. General CMCS Requirements

The new CMCS shall be designed in accordance with ABS Steel Vessel Rules and shall retain the ACCU notation and ABS certification of the present CMCS. System and hardware requirements shall also meet USCG CFR Part 62 Vital System Automation and Subchapter J, and IEEE-STD-45.

The new CMCS shall be based on a redundant PLC hot back-up solution, providing automatic failover on the loss of the primary PLC processor and without loss of CMCS functionality. PLC redundancy modules and a dedicated high-speed data link shall be used to provide the hot back-up failover capability for the PLC pair.

The PLCs shall be manufactured in the United States with a history of supportability greater than 20 years. The PLC make and model shall be supportable for 10 years after it is installed on the vessel.

The new MCS design shall utilize a minimum of ten (10) slot chassis with a minimum of two spare slots in order to provide the most effective and efficient distribution of shipboard I/O, as well as limiting the loss of I/O and control capability in the event of a chassis failure. The redundant PLC pair shall reside in the MCS console. PLC Remote I/O chassis may be used for interfacing signals not directly interfaced to the PLCs in the MCS console. PLC processors shall include a removable, non-volatile, solid state memory card for backup storage of the machine level code. All PLC units shall be provided power from dedicated power supplies. PLC modules shall be hot swappable allowing for removal and re-insertion while under power.

HMI workstation display computers shall be provided to give the CMCS operator(s) machinery monitoring and control capability and situational awareness. Each HMI workstation shall be capable of displaying all monitored data. Monitoring data shall be synchronized at all HMI workstations. Commands issued from the HMI workstations shall be sent to the PLC processors and acted upon as plant conditions allow.

PLC processors and HMI workstations shall interface with each other using a dedicated redundant Ethernet Local Area Network (LAN)providing protection against a single cable fault.

New CMCS enclosures shall be rated NEMA 4 or IP65. The CMCS shall satisfy environmental requirement of ABS SVR Part 4, Chapter 9, Section 8. Any reused existing enclosures shall be restored to their degree of enclosure prior to any modifications.

All incoming signal wires to the MCS and Pilothouse Starboard Consoles, and junction boxes shall be wired to terminal blocks.

3.2. Machinery Control Station Console

The Machinery Control Station (MCS) Console enclosure shall be retained and re-purposed for the new CMCS components. The MCS has two upper panels and two lower panels. The majority of the components shall be removed from both the inside the MCS enclosure and from the face and desk panels of the MCS. The old MCS Console panels themselves shall be discarded and new console panels shall be fabricated and installed in their place.

The following panel-mounted components shall be retained and mounted in the new panels:

a. Control Air System components
b. Shaft Revolution Counter
c. Rudder angle indicator
d. Steering station non-follow-up control lever
e. R/O system remote control panels

For MCS console's two upper panels, a total of four HMI display units shall be installed: two on each panel. Each HMI display shall be a minimum of 19-inch viewable image size. The HMI displays may be either LCD or LED and shall be touch screen units and include connections to shared keyboards and trackballs. A total of two keyboard/trackball units shall be installed in the lower panels: one on each panel.

The panel-mounted HMI displays shall be connected to fan-less brick style ruggedized HMI workstation computers. Each HMI station shall be capable of monitoring the entire machinery plant.

The functionality of the following panel-mount pushbuttons shall also be retained but replaced with new pushbuttons:

a. Main engine in control button
b. Auxiliary engine in control button
c. Generator start buttons
d. Generator emergency stop buttons
e. Main engine emergency stop button
f. Auxiliary engine emergency stop button

The components inside the MCS console shall be removed with the exception of the Control Air pneumatic components related to propulsion control. The new MCS components shall be installed in their place. These items shall include the redundant PLC equipment as detailed in Section 3.14 along with wiring harnesses to terminal blocks, HMI displays and workstation

computers, redundant Ethernet communications, DC power supplies, and power distribution components.

The TLI enclosure located to the right of the MCS console still retains some TLI circuits but it was re-purposed to house the Main and Auxiliary Propulsion Shutdown PLCs. The Main and Auxiliary Propulsion Engine Shutdown PLCs shall be removed and integrated into the CMCS as detailed in Section 3.14. This enclosure shall be retained and reused. Any miscellaneous components no longer needed shall be removed. New I/O terminal blocks shall be installed to interface field wiring and new install cable harnesses for replacement the Main and Auxiliary Propulsion Shutdown and TLI functionality. This enclosure may also be used to house any other PLC equipment required to integrate these functions into the new CMCS.

The EOT units at the Machinery Control Station, Pilothouse Starboard, and at the local control station shall be removed and replaced by new (Prime Mover Controls (PMC) EOT system being provided as GFE by NOAA.

The existing Mathers Throttle Control Units at the Machinery Control Station and Pilothouse Starboard Consoles shall be retained and re-installed in the new MCS face panels. Additional details are provided in Section 3.12.

The existing CMCS 24VDC Power Supply Unit shall be removed and replaced with a new CMCS UPS and redundant 24 VDC Power Supplies as detailed in Section 3.6.

The Dynalco TM-5000E equipment and associated thermocouple cables that connect to the unit shall be removed. This functionality shall be integrated into CMCS. This includes the associated datalogging equipment.

The following local control boxes behind the MCS console shall be removed and their functions shall be incorporated into the HMI:

a. Overboard Open/Close
b. Firemain Crossover Open/Close
c. Saltwater Supply Open/Close
d. Ind Bilge Suction Open/Close
e. Bilge Pump Off/On
f. Fire Pump Off/ON

The existing Datalogger enclosure and associated cabling to the MCS console shall be removed and be integrated into the new CMCS.

3.2.1. SSDG1, 2, and 3 I/O Interface

A number of I/O signals from the SSDG engines are currently provided via a serial data bus from the SSDG Engine Control Module to the MTU Monitoring Boxes located on top of the MCS

Console. These signals shall be integrated into the CMCS design. The MTU Monitoring Boxes shall be removed along with any unused cabling. Note that a second serial data line is interfaced from the SSDG engines to a separate standalone Engine Diagnostic PC Unit. This external PC unit and its signal interface shall be retained and will not be part of the CMCS.

There are redundant SSDG engine sensors that currently interface to the CMCS, cabling to these redundant sensors shall be removed. NOAA will remove the sensors.

The Control Air transducer from SSDG 1 shall be integrated into the CMCS.

3.2.2. Auxiliary Propulsion Engine I/O Interface

Existing signals and functionality that interface the Auxiliary Propulsion Engine to the CMCS including the Auxiliary Propulsion Engine Shutdown function shall be provided in the new CMCS.

3.2.3. Main Propulsion Engine I/O Interface

The EOT unit on the gauge panel will be removed and replaced by the GFM PMC EOT unit and integrated with the EOT unit in the Pilothouse Starboard and MCS Consoles. As detailed in Section 3.8

Existing signals and functionality that interface the Main Propulsion Engine to the CMCS including the Main Propulsion Engine Shutdown function shall be provided in the new CMCS.

The existing Ballast Tank Level Indicator (TLI) panels in the Main Engine Room shall be removed and replaced by a new CMCS Operator Interface Panels (OIP) as detailed in Section 3.4.

3.3. Pilothouse Console

The Pilothouse Starboard Console which includes CMCS equipment is being re-designed by another Contractor as part of this overall Technology Refresh program. The Contractor shall provide and integrate a combination of existing and new CMCS components. The Contractor will be required to provide instruction on removal of the existing CMCS components and integration of the new CMCS upgrade for this Pilothouse Starboard Console.

Space will be reserved for a single HMI display which shall be installed on the front panel of the Console. The HMI display shall be a minimum of 19-inch viewable image size.
This HMI displays may be LCD or LED units and shall be touch screen units and include connections to shared keyboards and trackballs. The keyboard/trackball unit shall be installed in the lower panel.

Since there is only a single HMI in the Pilothouse Starboard Console, some existing hardwired controls and indications may be retained to ensure continued safe operation in the event of the HMI failure.

In addition to the HMI display, space shall be reserved for the new contractor provided HMI brick computer, remote PLC I/O rack, any associated signal termination panels, and Ethernet switches as required to be mounted inside the Pilothouse Starboard Console.

The legacy EOT unit will be removed and replaced by GFE PMC EOT unit.

The Mathers Throttle Control Unit shall be retained along with the associated Control Air components and re-installed in the new Pilothouse Starboard Console.

3.4. TLI Operator Interface Panels (OIP)

Currently, four Tank Level Indicator (TLI) local gauge manifolds are mounted in two locations. Two Ballast Tank TLI manifolds are mounted on the inboard side of the ladder by the Auxiliary Engine. These shall be removed and replaced by a new TLI OIP. Two Fuel Tank TLI manifolds exist on the STBD side of the Main Engine and will be removed and replaced by a second OIP.

The new TLI OIP shall include an HMI touchscreen display, HMI PC brick computer, power supplies, and speaker. HMI display may be either LCD or LED and shall be a minimum of 19-inch viewable image size. Display information shall be restricted to appropriate TLI information at that location.

The recently added TLIs for the Sewage and Grey Water Holding Tanks and Potable Water Storage tanks shall also be integrated into the CMCS.

3.5. Engineer's Operator Interface Panel

A new Engineer's OIP that can display all CMCS information but does not provide control capability shall be installed in the Chief Engineer's office/state room. The new Engineer's OIP shall include an HMI touch screen display, HMI PC brick computer, power supplies, and speaker. The HMI display may be either LCD or LED and shall be a minimum of 19-inch viewable image size.

3.6. Power Supply

The existing CMCS 24VDC Power Supply unit shall be removed and replaced by a new Uninterruptible Power Supply (UPS) system that feeds 120 VAC UPS power to redundant 24VDC power supply units in the Machinery Control Station Console. The new UPS shall be fed from both Main and Emergency 450 or 120 VAC ship's power sources. An Automatic Bypass Switch (ABT) shall be incorporated in the UPS design to automatically switch between the two input power sources. Any transformers required to interface the UPS to ship's power system shall be provided by the Contractor.

The new UPS System shall be located near the Machinery Control Station. The UPS shall be capable of powering the entire CMCS for a minimum of 30 minutes when all shipboard power is lost or secured. The UPS shall include a manual Maintenance Bypass Switch, located external to the UPS in order to maintain continuous power to the CMCS, while performing UPS battery or other UPS maintenance actions. The UPS battery tray(s) shall be hot swappable and provided

with slide out or open access for removal and maintenance activity. Selection of UPS and batteries should consider commonality with other ship UPS systems.

The CMCS 24 VDC Power Supply Units shall be an N+1 design so that when a power supply fails, the CMCS continues to operate normally. Failure of either the UPS or any 24 VDC Power Supply shall be alarmed.

3.7. Sensors

A preliminary CMCS Alarm Signal List is provided in Section 9.4.1 reference f. This list summarizes information for the alarm signals that interface to the MCS Console. The Contractor shall validate and update this information prior to incorporating it into the new CMCS design.

A new signal interface specification shall be developed by the Contractor using the NOAA CMCS Signal List to encompass new derivations and setpoints for the new signal requirements.

This new Signals List shall be delivered in iterations, as required, to NOAA when there is an official revision that impacts the baselined software or hardware. See Section 4.3 drawing requirements for details.

The existing pressure transducers for main and auxiliary engines that are currently located on associated junction boxes shall be replaced. These sensors must be equivalent performance standards and integrated to the new CMCS. New sensors or transducers shall be approved by NOAA prior to use.

To support a future CMCS enhancement to integrate the Bow Thruster and HVAC Systems, the CMCS design shall incorporate installed spare capacity that includes an Ethernet port for interfacing to the Bow Thruster and a serial communication interface (details to be provided during design phase) for the HVAC units.

3.8. Engineer Order Telegraph (EOT)

Currently two pairs of Engine Order Telegraph (EOTs) units exist on the ship. One pair connects the Pilothouse Starboard Console to the MCS Console. The second pair allows the MCS Console to send orders directly to the engine room. These four EOT units will be removed and replaced with three 8202 series units manufactured by Prime Mover Controls Inc. (PMC). These three units will all be interconnected thus eliminating the need for two EOT units in the MCS Console. This EOT unit will be GFE but the Contractor will be required to integrate this system into the new CMCS.

3.9. Watch Call and Assistance Need System

The existing Engineering Alarm Panel System shall be removed. This includes Engineers Stateroom Panels in Chief Engineer's and 1st AE's Stateroom, Mess Alarm, and the Engineers Remote Selector Panel on the MCS Console. All associated cabling with this system shall be removed.

The Contractor shall provide and install a new Watch Call and Assistance Needed System that satisfies ABS ACCU requirements and integrate it with the CMCS. The new system shall be based on a serial data design. The new system shall include panels in the Chief Engineer's, 1st AE's, 2nd AE's, and 3rd AE's Staterooms as well as the Mess Deck. Current functionality in the existing Engineer's Alarm Panel System shall be incorporated.

3.10. Attendance Monitor

The Contractor shall incorporate an Attendance Monitor function into the CMCS that satisfies ABS ACCU requirements and that provides the Bridge personnel with a means to ensure that the engineer on watch is not injured, is alert, and is able to respond to the monitor. When enabled, every thirty (30) minutes, CMCS shall provide visible and audible notification to the CMCS watchstander that he/she needs to press the Attendance Monitor HMI button. When this button is pressed, the next thirty-minute cycle will begin. If the button is not pressed within two (2) minutes of the notification, CMCS shall generate a Fail to Report alarm.

3.11. Fire Detection System

The existing Fire Detection System is a Concilium system with a MODBUS interface. The System includes two remote panels: one in the Pilot House Starboard Console and one in the MCS Console. Subject to ABS approval, these two remote panels shall be removed, and their functionality integrated into the new CMCS. This integration shall include receiving alarms, monitoring and control signals and output alarm acknowledgment and controls.

3.12. Control Air System

The existing Control Air System shall be retained and re-installed as part of the updated CMCS. The MCS Console Control Air System pneumatic air connection to the existing Mathers Control Head throttle unit shall be modified as needed and a working system re-established at the MCS Console.

Similarly, the Control Air System pneumatic air connection from the MCS Console to the existing Mathers Control Head throttle unit at the Pilothouse Starboard Console shall be re-installed and modified as needed and a working system re-established.

3.13. Data Log Printing

A color laser printer shall be provided as part of the updated CMCS. This printer shall support two-sided printing. The printer shall be attached to the CMCS network so that it is available from other CMCS units. The printer shall be integrated into the CMCS design to allow the printing of HMI screens, reports, and data logs. The operating system software shall support the replacement of or addition of future printers by NOAA with the inclusion of available software drivers.

3.14. Proposed CMCS Architecture

The Contractor shall develop a PLC-based system architecture as detailed in this section. The Contractor will be responsible for the final design and its implementation.

The two identical and redundant PLC processor racks shall be installed in the MCS console located at each end. Upon startup one of the processors shall become the primary while the other shall become the backup. The primary processor shall perform all monitoring and control of the system, while the secondary is constantly synchronized with the primary via the redundancy link. In the event of any failure of the primary processor, control shall immediately transition to the backup processor as it shall then be the master controller. A means shall be provided to allow the operator to switch between primary and backup PLCs.

The ACCU functionality of Main and Auxiliary Propulsion Engine Shutdown PLCs in the MCS Console shall be incorporated into either the new CMCS PLC pair or into new dedicated Shutdown PLCs in MCS console, depending Contractor's design and approval by ABS. In addition, no electronic back-up or paper copy of either the Main or Auxiliary Shutdown PLC program are available from NOAA. Guidance on the propulsion shutdown functionality is provided in Section 9.4.2 reference a, but the Contractor shall be responsible for implementing this new design.

A similar ACCU functionality exists for electrical system. An SSDG Standby Generator PLC is located in the Shutdown Panel near the Switchboard nears to be replaced and integrated into the CMCS, as detailed in Section 3.19.

HMI workstations and OIPs shall have a COTS-based industry-standard operating system.

Loss of a CMCS workstation shall not result in the loss of any other CMCS component.

3.15. HMI Design

The Human Machine Interface shall be designed in accordance with Section 9.3 reference i.

HMI display type may be either LCD or LED type and shall include touch screen capability. Keyboards and trackballs shall be incorporated as noted earlier. Hardwired pushbuttons, indications, and gauges shall be installed as required to meet ABS certification requirements or operational requirements.

For information displayed to the operator in alphanumeric form, the update rate shall be 1 Hz or greater for non-tank level indications. The update rate for tank level indications shall be optimized or configured for filtering to reduce cyclic behavior due to ship's motion.

For analog information for which the rate of change is significant to the operator, the information update rate shall be presented in graphical format and shall be updated at 2 Hz or greater.

For commands to machinery, the update rate shall be sufficient to ensure the absence of undesirable dynamic behavior such as limiting cycling, hunting, instability, or jitter within the operational limits of the machinery device.

For discrete information displayed to the operator, the display rate shall be 2 Hz or greater,

The application shall incorporate provisions to disable the keystroke combinations that permit immediate system shutdown, access to concurrently running applications and direct access to the operating system. These keystrokes are as follows: CTRL-ALT-DEL, ALT-TAB, ALT-ENTER, ALT-F4, SHIFT-DELETE, CTRL-F4 and CTRL-ESC.

For touch screens, a means shall be provided for the operator to disable the touch screen such that the display can be cleaned without activating HMI functions, without interruption of the display of HMI Graphical User Interface (GUI) pages, and while maintaining control of the HMI functions from the keyboard and trackball with two select pushbuttons.

In combination with operating system security measures, the HMI application shall incorporate security features to require and distinguish between user access levels. HMI screens for Operator use at the Pilothouse Starboard Console shall be monitoring only.

In situations where there are local and remote controls, the local/remote switch position shall be monitored and displayed. Remote control functions shall be unavailable when in local control.

Abbreviations used on MCS HMI screens shall conform to Section 9.3 reference p.

This hierarchy of the screens, as a minimum, shall include the following: overview, system, and subsystem levels as required to display all relevant data. Links to any other required applications shall be provided. The use of keystroke combinations as the means of accessing separate applications shall be avoided. Upon return to the HMI application, the operator shall be returned to the previously displayed HMI/GUI mimic page.

The main window shall display the node name, user currently logged on, the current user access level, and provide the proper access and control capabilities for the application. Any required access to the operating system, application, or system configuration shall be coordinated from this area. Any system management or configuration actions or other actions associated with particular user rights shall be initiated from this page. This area shall also be used to display general application information including software versions.

System status page - A page shall display the current status of the MCS equipment and its network. The systems shall initialize as abnormal until it is recognized and reported as no fault. Once a fault or alarm is diagnosed by the system then the appropriate description and level of alarm shall be reported to the system status page to inform the operator. This

information shall be displayed sequentially, in a predetermined order, on a series of system-based pages. As a minimum, the display shall present parameter name, engineering units, actual value, alarm set points, and range. Alarms shall be clearly differentiated from other parameters. Parameters shall be grouped by system.

3.16. Machinery Control System Network

A fast switching redundant local area network system, based on the Ethernet family of standards in Section 9.3 reference m, shall be installed inside an enclosure to communicate between all components of the CMCS, such as PLC chassis, HMI display workstations, Portable laptop units, OIPs, and data loggers.

Ethernet cables routed between CMCS components shall be copper for connections within the same ship space and shall be fiber optic when the cable routing is between two or more ship spaces. Ethernet copper cabling shall be a minimum CAT 5E. Fiber Optic cables shall include a full set of spare fibers with fiber terminations for easy field substitution.

Network component switchover shall not cause malfunction of the MCS for longer than 3 seconds, during which time the MCS will continue to operate at the last inputted parameter. A malfunction is defined as the inability of MCS units to communicate with MCS component for more than 3 seconds. All nodes shall identify and attempt to recover from communication errors by re-transmitting messages over the original communication path. If original path retransmission fails, retransmission over alternate paths shall be attempted. The MCS shall send test/health messages between its units at least once every minute and all errors shall be reported to on the MCS System Status Page.

3.17. Supervisory Control HMI Processing

The HMI workstations and OIPS shall utilize an HMI software package that is widely used, 3rd - party supplied, industry standard, and that has been previously integrated with the PLC sub-system being used.

3.18. Monitoring and Control System Requirements

All CMCS display stations shall have the ability to monitor all the engineering plant signals and status of the CMCS system. Control shall be at any console with the applicable privileges based on the operator rights and the node designated for control of a machinery and or space(s).

3.18.1. General Software Requirements

The Contractor shall demonstrate Capability Maturity Model Integration (CMMI) Level 2 or 3 type practices without the necessarily requiring certification (some are outlined below to endorse repeatability and good software development practices).

Creation and development of software shall be disciplined with proper development and change management processes. There shall be no ad-hoc software builds or patches in a deployed or locked down version of the MCS software package. The Contractor shall establish a Configuration Control Board (CCB) and shall conduct documented peer reviews and Software

Quality Assurance approvals. All discrepancies from the system test shall be documented and reviewed in the CCB for the purpose of analysis, correction, implementation in a future revision, and subsequent testing. NOAA shall be included as an observer and invited participant for the formal CCB meetings.

All source code and executable files shall be managed in a central repository and maintained using commercially available configuration management software and then turned over to the NOAA program office after successful commissioning of the developed system and again as an updated version at the conclusion of each warranty year period.

PLC programming languages shall be in accordance with Section 9.3 reference g or similar.

The Contractor shall prepare software documentation as detailed in Section 4.3.

The Contractor shall follow Section 9.3 reference o or later to establish a common framework for software processes, activities, and tasks that are to be applied during development of CMCS. The overall system requirements shall be identified and documented in the System Design Requirements (SRDs). These system requirements shall be further derived into software and hardware requirements specifications documented as HWRS & SRS respectively. After completion and acceptance of these requirements by NOAA, then the Contractor shall proceed with software and system development.

The Contractor shall prepare and conduct CMCS Design Reviews as detailed in Section 4.2

3.18.2. Signal Interface Requirements

The MCS software shall allow the operator to specify any sensor or equipment known to be unavailable for monitoring. The operator shall have the option of setting the signal(s) out of service or entering a default value (override) for the sensor. The signal's displayed value shall be clearly distinguished as being either out of service or having a default (override) value set. If the signal is set out of service, the signal input value shall also be unavailable for any automatic sequencing control.

An MCS page shall be provided to display a list of out of service signals and their default values.

3.18.3. Monitoring and Control HMI Software

3.18.3.1. Alarm Requirements

Each signal along with new MCS derived signals shall be checked and verified in accordance with the information and updated requirements of this section. Alarm audible tones shall be annunciated and listed in the highest order at the associated station in control on a priority basis, such that higher priority alarm unacknowledged tones will mask lower priority alarm unacknowledged audible tones.

Alarm information messages shall be displayed on the video displays in one of three modes: "Unacknowledged", "Acknowledged" or "Reset". The three modes shall be clearly differentiated using different color text in the alarm page. Alarms shall only be acknowledged at the station-in-control. The acknowledgement and reset of alarms shall be recorded and shall include the time of event and the MCS station acknowledging the alarm. Nuisance alarms due to secured equipment, ship motion, and normal transients shall be prevented by use of inhibits, time delays, hysteresis, or other techniques. Set points, alarm logic and circuitry shall protect applicable components or systems without being affected by normal changes of the signals. Alarm messages shall include alarm or parameter name, alarm state, such as low and high, signal value, units, and set point, as applicable.

Alarms shall be listed and viewable in the alarm window per the highest level of priority as unacknowledged following order by Priority levels of audible alarms shall be provided as follows:

a. Level 1 shall be a red alarm defined as main propulsion shutdown, electrical system shutdown, or any ship control failure/shutdown, or pose as a direct hazard to personnel
b. Level 2 – Not used
c. Level 3 shall be a yellow alarm defined as malfunction or fault in the machinery plant that require attention as the local level
d. Level 4 shall be blue/cyan and defined as minor faults in the system defined per built in diagnostics; communication faults or diagnostics of MCS equipment.

3.18.3.2. Cybersecurity Requirements

Physical locks shall be provided to all enclosures with connectivity to the Network. Each new MCS enclosure shall be provided with an intrusion door switch and alarming to the MCS HMI which can terminate inside of a PLC.

Network shall use VLANs when applicable to differentiate traffic for control information and non-control information. New VLANS may also be created to separate categories of data traffic.

Unique user login credentials shall be required for each user and specified role for all control and management functions other than monitoring of the CMCS.

Password protection shall be employed at the following levels for the new HMI

a. Ship's Operator (For Control Actions)
b. System service or Maintainer
c. System Administrator

Password level protection shall be employed for administration for the programming environment for development, creating new executables, and downloading software or firmware into the new MCS. These levels shall include:

a. System Administrator
b. Programmer

Password level protection shall be provided for the Network Switch for

a. System service or Maintainer
b. System Administrator

The Chief Marine Engineer shall have Admin Rights to modify alarm setpoints, etc.

3.18.4. MCS System Supportability

The new CMCS system must be 3rd party supportable. The software delivery shall include all MCS non-commercial software products and changes to commercial software products developed, managed, and built for the purpose of making the MCS system optional as a whole. The Contractor shall conduct its oversight of subcontractors who are developing non-commercial software and changes to commercial software in accordance with configuration and change management processes.

The Contractor shall identify all software products used in the design, development, testing, or troubleshooting of the MCS system including the network, PLCs, GUIs, component level firmware, and configuration. The Contractor shall provide the configuration of and data within all software products. This shall include but is not limited to pseudocode, automated configuration management tools, test software, troubleshooting tools, simulation programs, compilers, and linkers. The source code, configuration and data for all noncommercial software shall be provided.

Two laptops for troubleshooting and maintenance shall be provided, which shall include the following:

a. Transfer of data logs from system and recording onto removable media.
b. Loading, configuration, and management of software to all components in the new MCS
c. Ability to select and view all signals in electrical and engineering units, setpoints, coefficients, etc.
d. Other maintenance, troubleshooting and system recovery functions as required.

All software tools shall be provided to configure and load software programs

3.18.5. Software Data Rights

All software developed and used for this delivered CMCS, including the commissioning, shall be provided with Government Purpose License Rights. All licenses for software shall be transferred to Government at the acceptance of the system.

3.18.6. Data Logging and Recording System (DLRS)

Redundant Data Loggers shall capture and record all analog and discrete signals in the system with date and time stamp at a frequency of no less than 2 Hz. The recorded data shall be viewable on-demand at an HMI console. Viewing of recorded data shall be filterable by date and time, entry type, and parameter. Log data shall be exportable to an external laptop and or removable media. The exportable data shall be in a text and *.CSV format or similar. The ability to manage the data logger storage capacity by off-loading data to removeable media shall be provided. Alarms shall be provided when the data logger storage capacity is reaching a limit.

The following electronic Data Log Reports shall be provided:

a. Engineering Log – The Engineering Log report shall provide a record of operator commands, automation commands, plant status, and status changes. Plant status shall include periodic logging of analog parameters and ordered, answered, and actual shaft speed. Status changes shall include transfer of control. Each record shall include the date, UTC time, parameter identification, and parameter name, signal identification as applicable, and parameter value in engineering units.
b. Alarm Log – The Alarm log shall provide a record of all alarms and alarm resets, status alerts, error messages, Changes to alarm and alarm reset setpoints, placing equipment or signals in or out of service shall be logged. Error messages shall include equipment failures/faults, and communication failures/faults. Each record shall include the date, UTC time, parameter identification, and parameter name, signal identification as applicable, and parameter value in engineering units.

Data Log information shall be printable on-demand.

3.18.7. Master Clock

The MCS shall interface to the ship's master clock equipment, Microsemi Model S650, using an Ethernet connection, available at the Bridge Deck to obtain a time reference for the CMCS.

Local time shall be displayed at each HMI. A means shall be provided for an operator to set local time, if local time is not available from the ship's master clock. Local time shall be updated on each applicable unit at power-up and reset at least once in every 12 hours thereafter.

3.19. New CMCS SSDG Functionality

The legacy electric plant Generator Shutdown Panel and its Allen-Bradley Model 1745 programmable controller that provides the automatic standby start of the Emergency

Generator is no longer functional. This Emergency Generator Standby Start functionality shall be incorporated into the overall CMCS upgrade design. The Contractor's design must be approved by ABS. In addition, no electronic back-up or paper copy of Generator Shutdown PLC program is available from NOAA. Guidance on the shutdown functionality is provided in Section 9.4.1 references g through j, but the Contractor shall be responsible for implementing this new design.

The following new SSDG functionality shall be added to the new CMCS

a. The ability to bypass idle and go directly to rated speed and frequency
b. Start permissive for Normal Start when pre-lube is at 5 psi
c. Independent setpoints for low fuel pressure for Idle and Rated Speed
d. Off/Local/Remote input to MCS from existing switch
e. Shutdowns for Low Lube Oil Pressure and Overspeed
f. Ability to automatically start a generator and bring online.

4. Scope of Work and Contractor Data Requirement List (CDRL) Deliverables

4.1. Detailed Design (Base Contract, CLIN 0001)

4.1.1. General Program Management

The Contractor shall provide program activities to include preparing, submitting, and adjudicating comments on all CDRLs, developing and maintaining a program Integrated Master Schedule (IMS) (CDRL 007), providing monthly status reports (CDRL 010) and conducting program status review meetings as required. The Contractor is responsible for submitting program review and design review documents, agendas, minutes, and tracking action items (CDRLs 001/002/003/004/005). The Contractor shall maintain and update submittal records.

The IMS shall include submittal dates for all CDRLs. IMS shall include all design phase, product and factory testing phase, and shipboard installation, testing, and commissioning phase activities. The following information shall be included in the IMS as a minimum:

g. Kickoff Meeting
h. Design Verification Ship Check notional planned start date and duration
i. All initial CDRL submission dates, including ABS/US Coast Guard submittals
j. All Design Review Meeting (SDR, HMIDR, PDR, CDR, TRR) dates
k. Major hardware assembly start and completion dates
l. Major software component coding start and completion dates
m. Major hardware component testing start and completion dates
n. Major hardware/software integration milestones
o. Environmental testing start and completion dates as required)
p. Factory acceptance testing start and completion date
q. Shipboard installation start and completion date notional dates and Phase 2 planned dates as required)
r. Shipboard testing and trials start and completion dates

In-person meetings are to be held at a NOAA Norfolk area facility, the Contractor's facility, or at a location identified by the NOAA Project Manager.

Meeting minutes shall be reviewed and approved by NOAA prior to official release. The Contractor shall maintain a database of the status of all action items assigned during meetings. The action item database shall include who the action item is assigned to and an expected completion date.

A Post Award/Kickoff Meeting shall be held within 10 days of contract award date.

Biweekly status review meetings or teleconferences shall be held throughout the project. When a formal design review meeting is being held, it shall satisfy the requirement for a biweekly status meeting.

4.2. Design Reviews

4.2.1. System Design Review (SDR)

The Contractor shall conduct an SDR, within 60 days of the Kick-off meeting to address design and integration with other ship systems, including design, reliability, safety, electromagnetic compatibility, maintenance, training, testing, and support, fault detection and isolation, and fail-safe/fail-set conditions. The Contractor shall present a conceptual CMCS system architecture. Allocation of requirements to hardware and software configuration items, and the ability of the proposed design to meet the requirements specified in this specification shall be addressed. The Contractor shall include a functional overview of the Computer Software Configuration Items (CSCIs) and Hardware Configuration Items (HWCIs), the allocation of requirements to each, all interfaces to the CSCIs/HWCIs including CSCI to CSCI and HWCI to HWCI interfaces, and requirements traceability.

4.2.2. Human Machine Interface Design Reviews (HMIDR)

The Contractor shall conduct two HMIDRs to address the functional design of the HMIs, including hardware and software features, human engineering, display and control modes, use of colors, and symbols. The first HMIDR shall address the Contractor's overall hardware and software design, and the display design guidelines. A subsequent detailed HMIDR shall include the demonstration of HMI features required by this section, including the layout, presentation, and function of all displays and display pages, including log sheet. The proposed package of graphic displays shall be provided in outline form as part of the PDR, with details on the number of screens per system and their hierarchy. The complete set of graphic displays shall be provided as part of the Critical Design Review package for NOAA review and concurrence prior to implementation. Final approval of mimics shall be during Factory Acceptance Testing. The HMIDRs shall also address the results of the HMI task analysis.

Equipment arrangements shall be addressed at the HMIDRs. The following layouts shall be submitted to NOAA for approval prior to construction of the equipment:

a. CMCS enclosures and internal cabinet layouts
b. SCC Panel Front and internal cabinet layouts for CMCS-related equipment

4.2.3. Preliminary Design Review (PDR)

The Contractor shall conduct a PDR within 90 days of the Kick-off meeting for the CMCS design to address both the hardware and software aspects of the design.

The preliminary design is to include the following as a minimum:

a. Preliminary system architecture
b. Preliminary description of system operations
c. Preliminary CMCS Signal List
d. Preliminary desktop layouts and enclosure front panels
e. Preliminary console and enclosure layouts
f. Preliminary hardware and software specifications

As part of the entrance criteria for the PDR, PDR-related CDRL artifacts shall be submitted for review and comment in accordance with the CDRL submittal schedules
The hardware portion of the PDR shall address subjects such as requirements allocation, functional flow, schematic diagrams, hardware and firmware logic, preliminary equipment assembly drawings. thermal analysis and design, reliability and maintainability assessment and allocation, electromagnetic compatibility, power conversion and distribution, grounding, mechanical design of enclosures, racks and drawers, safety, human engineering, and preliminary parts selection and life-cycle supportability.

The Contractor shall also demonstrate that the selected PLC equipment has a history of supportability and backward compatibility with existing hardware and software applications when new upgrades are provided. End of manufacturing and supportability dates shall be addressed.

The software portion shall address software architecture, allocation of system requirements and resources, such as processor, I/O, and memory, resources to each CSCI, inter-unit and intra-unit communications, and timing requirements. In addition, the PDR shall address operating system selection and post-delivery software update scheme.

4.2.4. Critical Design Review (CDR)

The Contractor shall conduct a CDR within 60 days of the PDR meeting. The CDR has a goal to obtain NOAA approval to proceed to production. NOAA approval shall be required to proceed to manufacturing and assembly of CMCS hardware and for coding and production of the CMCS software.

The following shall as a minimum be addressed at the CDR:

a. System architecture
b. System Description of Operations
c. CMCS Signal List
d. HMI Design Report
e. Console and enclosure layouts
f. Hardware and software specifications
g. ABS/USCG required drawings/documents approval
h. List of equipment to be retained and reused

As part of the entrance criteria for the CDR, CDR-related CDRL artifacts shall be submitted for review and comment in accordance with the CDRL submittal schedules

4.2.5. Test Readiness Review (TRR)

The Contractor shall conduct a TRR within 90 days of the CDR meeting. The purpose will be to evaluate the readiness of the CMCS for factory acceptance testing.

The review shall address the following:

a. Status of the test procedures,
b. Test environment,
c. Hardware and software configuration management,
d. Test schedule,
e. Process for managing and recording the tests and test results.

As part of the entrance criteria for the TRR, test related CDRL artifacts shall be submitted for review and comment in accordance with the CDRL submittal schedules

4.3. Engineering Documentation

The Contractor shall prepare and provide engineering documentation to include an updated Ship Drawing Index, Drawings and Associated Lists, and Technical Publications/Technical Manuals.

The Contractor shall be responsible for obtaining ABS and US Coast Guard regulatory approval of the design and shall include all drawing and design documentation required by ABS SVR. First submission cost shall be provided by NOAA, re-submission costs shall be borne by the Contractor. Copies of all submittals and regulatory correspondence required for Coast Guard and ABS certification shall be provided as part of this engineering documentation (CDRL 008/009), to include Design Verification Procedures (CDRL 052) and Periodic Safety Test Procedures (CDRL 053) in accordance with ABS SVR and USCG requirements.

NOAA approval of the drawing and design documentation shall be obtained prior to the Contractor proceeding to detail design, production, or testing, as applicable.

The Contractor shall provide NOAA with copies of the USCG required FMEA/DVTP for review and comment prior to submittal to USCG/ABS (CDRL 015).

Drawings shall be prepared as electronic media in AUTOCAD; versions 2012 to 2019 are acceptable. Drawings shall be in accordance with Section 9.2 reference g. Drawings, plans, and technical manuals for the CMCS shall be in the English system of engineering units. Drawing abbreviations shall conform to Section 9.3 reference p. Drawings shall be prepared in size D and be formatted for printing in PDF on 11-in x 17-in paper in monochrome.

Submittal of drawings and associated lists (CDRL 020) for review shall be provided in PDF compatible file format. Submittal shall not include any restriction markings.

The Contractor shall provide preliminary versions of the drawings, technical manuals, and logistic support documents to NOAA for review and comment in accordance with CDRL submittals requirements. The Contractor shall incorporate the changes into a final version of the drawings, technical manuals, and logistic support documents.

The Contractor shall deliver the Final engineering drawings and lists in accordance with CDRL submittals (CDRL 020) requirements. The electronic copies shall include both AUOTCAD and PDF compatible read-only versions of the drawings.

The Contractor shall be responsible for providing all updates to all engineering documentation to document the "as built" condition reflecting post-commissioning configuration of the vessel.

The Contractor shall review the current Ship Drawing Index spreadsheet and redline the list of ship drawings and technical manuals that are no longer applicable, update the revision level on drawings that are being revised, and add references for new drawings/documents that are being added. The Contractor shall provide this updated Ship Drawing Index (CDRL 019).

The Contractor shall prepare several categories of ship drawings and associated lists (CDRL 020):

a. New CMCS drawings and lists to document new CMCS equipment for life cycle support, including block wiring/system architecture diagrams, assembly drawings, connection diagrams and schematics, elementary wiring drawings, and procurement specifications.
b. Redline markup electronically any ship drawings to document updates to existing ship drawing documentation. These shall include general arrangement drawings of the spaces where new CMCS equipment is being installed, detailing overall dimensions and required maintenance area.
c. Updated Signal List that provides as built signal list with all available information fields filled in.

The CMCS Signal List shall be developed using reference technical data provided in Section 9.4.1 and 9.4.2 as a starting baseline. The Contractor shall ship check and document the current CMCS I/O signals and interface information. This list shall be updated and maintained as necessary throughout the project to reflect the new CMCS signal interfaces to machinery plant equipment and instrumentation.

The Contractor shall propose the Signal List fields to be used and shall provide them for review and consent by NOAA. The Signal List shall contain information to assist during the CMCS development and for life cycle maintenance. Signal List fields shall include but not be limited to the following types of signal information:

a. Signal Tag ID
b. Machinery Plant subsystem function
c. Signal Name
d. Signal Type
e. Associated Equipment
f. Ship Space ID (Deck/Frame/Location)
g. CMCS Interface Unit
h. I/O Software Address
i. Signal Cable ID
j. Signal Termination Plug/Pin/Wire ID
k. CMCS Subsystem
l. Alarm Type and Setting Info
m. Signal Range Info
n. Alarm/Criticality Info

The Contractor shall prepare a CMCS Technical Manual (CDRL 042) that detail how the COTS components integrate together and how to troubleshoot problems and determine which component is faulty. Parts list and installation instructions shall also be provided. In addition to the operating instructions, content requirements of Section 9.2 reference c, interface instructions shall also be provided. NOAA review and approval of the manual shall be required.

The Contractor shall provide a separate

Commercial manuals may be included as part of the technical manual set when the contents of the commercial manual meet the requirements of an equipment manual. These commercial manuals shall meet the requirements of Section 9.2 reference c. The Contractor may make minor changes to the commercial manuals via inserts, cut sheets, supplements and appendices before submission to NOAA for approval as part of the CMCS Equipment Manual set. In cases where commercial technical manuals apply to more than one equipment configuration, the manual shall clearly identify the specific configuration that is applicable to the CMCS, preferably by removing information that is not applicable.

Review copies and final copies shall be submitted in PDF compatible format. The Contractor shall also prepare and provide change pages where applicable for all other systems and equipment technical manuals affected by new CMCS design. All final copies of CMCS Manuals shall also be provided in electronic MS Word format, and authored in standard American English.

The final electronic version of all shipboard technical manuals and drawings to reside on the ship shall be provided in a PDF compatible read- only format. Paper copies of technical manuals shall only be required for the final set to reside on the ship, at the Port Engineer's library and at NOAA Marine Engineering Department.

A Software User's Manual (CDRL 032) shall be prepared to define for users of the CMCS, the operational aspects of the CMCS. This manual shall include instructions for loading software updates. Portions or this entire manual may be incorporated into the CMCS Technical Manual.

A Software Development Plan (CDRL 021) shall be prepared that details how software will be developed for this project,

CMCS software requirements and design documentation shall include a System Architecture and Requirements Specification (SARS) (CDRL 023), Software Requirements Specification (SRS) (CDRL 024), Interface Requirements Specification (IRS) (CDRL 025), Software Design Description (SDD) (CDRL 026), Database Design Description (CDRL 027), HMI Design Guide and Report (CDRL 028) and an Interface Design Description (IDD) (CDRL 029).

The software documents shall include sufficient detail to permit ABS and NOAA approval and verification of the software design and that specifications have been met. Design tools and methods such as PDL, UML, or similar approach shall be used to develop the software design.

CMCS hardware requirements, hardware design documentation, and copies of the Contractor's hardware procurement specifications (CDRL 017) shall be provided.

The final as built CMCS software shall be delivered as a Software Product Specification (CDRL 030). The documentation shall include, but not be limited to, the following:

a. The source code for the software in electronic form compatible with the required support hardware and software.
b. Executable versions of all real-time CMCS programs in a format compatible with the CMCS system.
c. The final software documentation shall include intermediate software design products (i.e., Program Design Language (PDL), Unified Modeling Language (UML), etc.), Automated Configuration Management Tools, COTS software, Software Development Files (SDF), Non-development software (NDS), developmental software, simulation programs, graphics pages, and similar items.

A final Traceability Matrix that provides a complete trace of requirements from this SOW through the SARS, SRS/IRS, SDD/IDD, and acceptance test requirements shall be provided in accordance (CDRL 022).

A Software Version Description document shall be prepared and provided with each software delivery (CDRL 031).

A Firmware Support Manual (CDRL 033) shall be provided that details how the firmware can be regenerated, maintained, and modified using support software and hardware that the Contractor shall supply with the system.

A Software Transition Plan (CDRL 034) shall be prepared to detail how support of the CMCS Replacement System is to be transitioned to NOAA.

Engineering Calculation Records (ECRs) as required shall be prepared by the Contractor (CDRL 018) to document calculations or models used to verify system operating parameters in support of validating/verifying system design compliance with performance and/or specification requirements. Also, ECRs shall be used to document software and/or mathematical algorithm used for the modeling and the results of the system calculation effort.

4.4. System and Hardware Requirements

The Contractor shall design and furnish the CMCS Replacement System as a complete system and shall be responsible for design, selection, assembly, programming, ABS certification, shipboard installation, testing, commissioning, and supportability of all components comprising the CMCS.

System and hardware shall meet the requirements of Section 3, the ABS Rules for Building and Classing Steel Vessels, USCG 46 CFR Part 62 Vital System Automation and Subchapter “J”, and IEEE Standard 45.

The new CMCS installation design shall consider maintainability features by limiting maintenance access to within 18 inches of cabinet openings and mounting of drop-in panels to be hinged and bracketed for easy access and for maintenance access, troubleshooting and repair.

4.4.1. Detailed Design Verification Ship Check

A ship check shall be performed by the contractor to gather all of the information required to complete the detailed design and installation drawings. The time and location of the ship check shall be determined by the ship’s schedule. For bidding purposes, the contractor shall assume that the ship check will take place at the vessel’s home port at Norfolk, VA. Additional ship checks prior to installation must be coordinated via NOAA. The number and names of people required to perform the design verification ship check shall be provided in advance to NOAA.

A Design Verification Ship Check Plan for the ship check shall be submitted (CDRL 004) no later than 10 days prior to the ship check. The Contractor shall prepare a summary of findings in a Design Verification Ship Check Report (CDRL 005) at the conclusion of the design verification ship check including any problems noted or items that could not be completed (CDRL 004). This report shall be provided within two weeks of ship check completion.

The ship check shall include a comprehensive cable, sensor, and I/O survey to determine material condition of the equipment and sensors that will be retained and interfaced with the CMCS. All cabling and sensors shall be tested to verify proper operation. The Contractor shall prepare and submit Condition Found Reports (CDRL 054) listing any malfunctioning or incompatible equipment and sensors.

The Contractor shall prepare listing of cabling and sensors identified for replacement. A list detailing any new cabling and sensors to be procured, along with ordering information and cost shall be provided at the conclusion of the design verification ship check.

4.5. Design Development

Upon approval of the CMCS design following the CDR, CMCS equipment shall be constructed and software developed in accordance with approved design and the requirements of Section 3.

4.5.1. Design Modifications

New CMCS design modification requests shall be documented in an Engineering Change Proposal (CDRL 011) for NOAA review and consideration. A Notice of Revision (NOR) (CDRL 012) shall be used to issue any documentation that is impacted by incorporation of the ECP. Any Requests for Deviation/Waiver (CDRL 013) shall be submitted for NOAA review and consideration.

4.6. Detailed Installation and Test Plans

Planning for the shipboard installation and testing shall be accomplished prior to the factory testing in accordance with the CDRL schedule. The Contractor's activities and responsibilities during shipboard installation shall include, but not be limited to, the design of all shipboard modifications including foundations, bulkhead penetrations, and cabling and terminations, removal of existing elements, installation of the new equipment, preparation of test and trial procedures and supervision of tests and trials. All tests and trials shall be overseen by regulatory body and NOAA representatives for certifications. Removal of machinery control and monitoring equipment shall also include removal of any related cabling, terminal connection boxes, and other CMCS related equipment.

The Contractor shall be responsible for the majority of shipboard installation with the shipyard providing specific support services that are clearly identified by the work item defined below. The Contractor shall provide NOAA with work packages to execute the support service portion of the installations.

The Contractor shall be responsible for all installation, except for support services. The installation work will be accomplished during an availability when other work may be performed and will need to be coordinated. All installation activities shall be accomplished in coordination with NOAA. The Contractor shall maintain the required personnel pier side or in the shipyard to oversee both the Contractor's efforts as well as providing on-site and off-site guidance for the installation support services work.

The Contractor shall prepare Ship Installation Plans and Procedures documents (CDRL 014) that detail the following items as a minimum:

a. Plans and procedures that are the responsibility of the Contractor.
b. Required shipboard personnel support for running of machinery to support testing.
c. Coordination of ABS services for ACCU Certification.
d. Tag out/Lockout requirements of all machinery to support modifications.
e. List of removals to NOAA for early identification of items to be retained.
f. Required third-party support services, including estimated the hours and shifts per day that will be required to accomplish the work effort. The Contractor shall list any shipyard or shipboard support restrictions and/or requirements that are needed to complete the installation in the required time.
g. Special tools and test equipment for installation and testing. These shall be provided in sufficient quantity to support the overall schedule.
h. Safety procedures that will be used during removal and installation.

The Contractor shall develop support requirements (CDRL 014) for the shipyard availability in accordance with Section 9.2 reference e to detail the following as a minimum:

a. Removal and Installation Plans and Procedures with sufficient detail to allow a shipyard or third party to perform the Non-Contractor work and estimate for all manpower and material costs to support the complete removal, installation, dock and sea trial procedures.
b. Clear definition and detail of support service labor such as welding, crane service, rigging, foundation installation, bulkhead penetrations, gas free certification, fire watches, preservation, painting, temporary service such as lighting, power and ventilation and lagging restoration in accordance with Section 9.2 reference d.
c. Define the requirements for removal paths and necessary access cuts.
d. Complete disassembly and rebuilding of previous or current MCTs affected by this work with all new blocks.
e. All required modifications to the ship required, including any required changes to supply necessary power and data communications to all CMCS equipment.
f. Required shipyard Safety Procedures.

Detailed drawings shall be prepared to support the Removal and Installation Plans and Procedures. They shall be submitted to ABS and NOAA for approval and be documented as part

of the Ship Installation Plan and Procedures documents of CDRL 014. The procedures shall include a Booklet of Standard Wiring Practices as required by ABS SVR. The drawing set shall include:

a. Rip-out drawings and instructions that detail removal and modifications to be made to existing machinery control and monitoring subsystems or interfacing equipment
b. Installation drawings and procedures for CMCS equipment, including dimensions, locations, size and type of all piping and electrical connections to vessel's systems, as applicable.
c. Specialized footprint drawings shall be provided detailing the foundation/mounting areas and specifying any special interface requirements as may be necessary.
d. Detailed drawings showing each CMCS major components and including maintenance access, mounting requirements, cable connection, weight and center of gravity, and any other installation requirements

The exact location for installation of all CMCS equipment shall be included on CMCS installation drawings/procedures and approved by the NOAA Port Engineer.

A Post Installation Shipboard Test Plan and Post Installation Shipboard Test Procedures (CDRL 049/050) shall be prepared by the Contractor and submitted for approval to ABS and NOAA.

The plan shall be based on a progressive test scheme that covers all phases of shipboard testing (post installation, dockside, and at sea) and address installation and checkout, local testing, remote testing, integration testing, and performance testing covering all normal and emergency operations. The plan shall also include procedures for regression testing software/hardware changes that have been made to the system.

The Contractor shall prepare a CMCS Design Verification Test Procedure (CDRL 052) described in Section 9.2 reference b.

The Contractor shall prepare an updated Periodic Safety Test Procedure (CDRL 053) as described in Section 9.2 reference b.

4.7. Training

The Contractor shall develop a Crew Training Plan (CDRL 039) that incorporates the following:

a. An 8-hour CMCS classroom and hands-on Orientation Training program at the Contractor facility to provide general HMI and system operation training, in sufficient detail to allow NOAA and ABS representatives to witness and participate in the CMCS Factory Acceptance Testing program. Assume 10 people.
b. A 16-hour classroom and shipboard CMCS Operator Training program, including hands-on training that covers general HMI and operation of the CMCS system.

c. A 16-hour classroom and shipboard CMCS Maintenance Training program, including hands-on training, that covers troubleshooting and repair of the system. Operator training shall be a prerequisite for Maintenance training.

NOAA will provide classroom facilities and computer and audio-visual equipment for the CMCS Operator and Maintenance Training classroom training.

Student and Instructor Guides shall be prepared and provided for use in these training classes (CDRL 040). The Student Guides shall include applicable COTS equipment reference manual material or separate reference manuals shall be provided along with the Student Guides for each student. The training shall include the utilization and application of the CMCS technical manuals. The Instructor Guides shall be prepared in standard training format (Navy or Vocational are acceptable). The Instructor Guide shall include all overhead or visual aids that shall be utilized.

4.8. Data for Provisioning

The Contractor shall provide copies of all purchase orders (CDRL 017) required to develop the CMCS equipment.

The Contractor shall provide certain Data for Provisioning (CDRL 037) that includes drawings, commercial technical manuals, catalog data and product specification sheets, which form the minimum data to provision a system or piece of equipment. Examples of the DFP include, but are not limited to: certification data, name plate data, component characteristics data, commercial specification sheets, end item/component prices, manufacturer's identification (or Commercial and Government Entity Code (CAGE)), part number, shelf life, and special material/operating requirements. This data will then be used for NOAA's identification, cataloging, selection, and determination of initial requirements for support items to be procured through the provisioning process.

As a minimum, the Contractor's DFP shall be detailed enough to include:

a. A listing that identifies all the Line Replaceable Units (LRU), which can be assembled, re-assembled, and/or replaced.
b. General arrangement, diagrammatic drawing and/or detailed Technical Publication that describes the end item, end item's equipment and/or piece parts material, mechanical, electrical, dimensional characteristics, location, and their function within the assembly.
c. Drawing List and Submittal Schedule Arrangement drawing developed for showing the CMCS system and all attached components, in sufficient detail, to justify the basic configurations and space allocations reflected in the Contractor's design.
d. Plan view, inboard profiles and sectional views shall be used so that all major components are shown in at least two views. Drawings shall indicate required access clearances for routine maintenance and repair.

e. Electrical interconnecting cabling, wiring diagrams and wiring lists (pin-to-pin or point-to-point).
f. A list of special tools and test equipment if any required to maintain the end item.

DFP is required for each piece of equipment being procured by NOAA under this contract.

The Contractor shall require any lower-tier subcontractors and suppliers to comply with the DFP requirements of this specification. The DFP that NOA requires from the Contractor's vendors/subcontractors shall be provided by the Contractor.

The Contractor shall provide a list of recommended shipboard replacement spare parts for the CMCS in CDRL 035. The recommended list shall address 30-day, one year, and five-year time periods. The list shall contain a minimum of one (1) of each type of electronic module or printed circuit board. The list shall give a full description of each part with component manufacturer’s part number, ordering data, including source for the part, and (NSN) National Stock Number if available. Parts shall be priced individually.

4.9. Factory Acceptance Testing

The Contractor shall prepare a Factory Test Plan (CDRL 046), Test Procedures (CDRL 047), and Test Report (CDRL 048) that cover formal software, hardware/software integration, any required first article environmental testing if required by ABS, and factory acceptance testing phases to support the requirements in ABS SVR and as defined herein.

If the contractor uses equipment that is already ABS approved/qualified, an environmental testing waiver may be prepared and submitted to NOAA and ABS for review and approval.

A combined factory testing approach shall be used as approved by NOAA, ABS, and US Coast Guard. The factory-testing scheme shall include a realistic level of simulations and stimulators to adequately represent the propulsion, electrical, and auxiliary machinery plant and other shipboard sensors and actuators in operating conditions and plant configurations.

A mock-up framework of the MCS and Pilothouse Starboard Consoles that generally mimics the intended installation shall be used to temporarily install the various CMCS components, along with test cabling to other new standalone CMCS units such as OIPs, Watch Call and Assistance Needed Panels, any remote PLC I/O enclosures, and to simulations and stimulators required to provide a realistic test environment.

The test shall demonstrate system automatic controls, system alarms, interlocks, safety shutdowns, operator-initiated sequences from the display stations under the various plant configurations.

A maintainability test shall be included as part of the factory testing to demonstrate loading of the CMCS software from the CMCS laptop, along with procedures required to troubleshoot and

isolate various hardware and firmware problems using the newly developed CMCS Technical Manuals and diagnostic software provided with the system. All routine maintenance actions and specific troubleshooting actions to demonstrate self- sustainability shall be shown to prove CMCS capability to troubleshoot down to a Line Replaceable Unit (LRU) level and replacement of defective part.

Notification of factory test event dates shall be provided to NOAA (CDRL 045) for the purpose of witnessing the factory acceptance testing.

Test Reports shall include those tests observed by NOAA representatives and those certified and witnessed by ABS. The reports shall include raw data and summary data.
The reports shall contain any open items remaining in an action items list. Action Item status is to be updated every 30 days.

4.10. Packaging, Preservation and Shipping

The Contractor shall determine the best packaging and preservation methods for all CMCS components in accordance with Section 9.2 reference i. Packaging and preservation procedures shall be submitted for NOAA approval (CDRL 044).

5. Installation, Testing and Trials (Option: CLIN 1001)

5.1. Installation, Testing, and Trials

All rip out, installation, and test work shall be accomplished by the Contractor in accordance with Section 9.2 reference d and approved ABS SVR plans and procedures.

The Contractor shall coordinate all support services identified in detailed installation test plan via Port Engineer. The Contractor shall coordinate the shipboard services for certification by ABS. Cost for ABS shipboard services for installation and testing shall be provided by NOAA.

The Contractor shall make reasonable effort to clean and restore existing equipment that is being retained and reused in the new CMCS, such as equipment within or part of the CMCS Console, as necessary to match surroundings and provide a neat appearance.

The Contactor shall rip-out and remove the unneeded existing CMCS equipment from the vessel. All unneeded cables shall be removed. As part of the removal process, prior to any equipment removal, the NOAA Representative shall be notified for possible re-use. Removal and salvage of existing equipment is to be accomplished so that first level assemblies remain intact. The existing equipment is to be turned over to NOAA after removal from the vessel. Care and protection of the equipment is expected during the removal and storage prior to delivery to NOAA.

As part of the removal process, the Contractor shall test all existing machinery control and monitoring system cabling to be retained for insulation resistance levels and continuity back to the sensor or actuator.

Any electrical cable removal or re-use shall be done in accordance with Section 9.2 reference d and approved rip out and installation plans and procedures. When there is a need to disconnect any wiring or equipment, the Contractor shall record all wiring information. The Contractor shall verify that all cable tags and wire markers agree with approved drawings. Recorded information shall be submitted to the NOAA Representative for approval prior to performing any disconnections.

For existing cabling and wiring, the verification shall be accomplished at the field device location and at the CMCS interface point. In addition, the Contractor shall replace all illegible or missing cable tags and wire markers on CMCS related cabling. The Contractor shall retain all mounting and connecting hardware for later reuse.

The Contractor shall provide proof of satisfactorily performance of all equipment and systems during dockside and sea trials.

The Contractor shall provide all required support and any necessary monitoring and test equipment to perform all required testing after installation on the ship up to and including the dock and sea trials.

The shipboard test and trials shall be in accordance with ABS SVR and requirements of this specification.

The dockside testing program shall include conducting the approved CMCS Design Verification Test Procedure to the satisfaction of the ABS inspector.

The dockside testing program shall include conducting an approved CMCS Periodic Safety Test Procedure to the satisfaction of the ABS/USCG inspector.

All CMCS equipment shall be tested to demonstrate its control and monitoring functionality for all system hardware to the maximum extent possible at the dock up to and including shaft breakaway.

The Contractor shall prepare and demonstrate satisfactory performance under sea trial conditions outlined below.

The following tests are the minimum requirements for the CMCS. The Sea Trial Plan shall include additional operational tests or inspections to fully verify that the assembled CMCS meet all requirements of this specification and ABS SVR. Sea trial tests shall include but not be limited to the following tests:

a. Operator initiated propulsion mode transitions.
b. Test Propulsion System automatic propulsion mode transitions at the extreme limits of speed ranges allowed in each mode.
c. Test ability of Propulsion System algorithm to minimize speed error and demonstrate linearity in increments of 10 percent over the full range.
d. Test ability of Propulsion System algorithm to minimize speed error and demonstrate large speed increment changes (at least 30 percent) in all drive modes.
e. Operate at full power ahead for a period of not less than 2 hours
f. Crash astern until maximum steady state astern speed is attained from full power ahead.
g. Crash ahead until maximum steady state ahead speed is attained from full power astern.
h. Operate thruster in all operating modes.

The sea trials testing shall be conducted in conjunction with overall ship availability sea trial program. Coordination with other shipboard testing outside the scope of this specification may be required.

Post Installation Shipboard Test Reports (CDRL 051) shall be prepared for all formal test phases and test events by the Contractor and submitted for approval to ABS and NOAA.

5.1.1. Trials Acceptance Support

The Contractor shall provide technical support and troubleshooting for propulsion sea trials and acceptance sea trials.

5.1.2. Crew Training

The Contractor shall provide crew operational and maintenance training during a 14-day period following the completion of the installation.

5.1.3. Post Sea Trials Support

The Contractor shall provide a ship rider for up to 14 days on the vessel's first mission. The rider shall provide technical assistance to the ship's crew in resolving technical issues, performing any corrective maintenance, conducting informal training when requested, obtaining crew feedback on CMCS system performance, and cataloging potential system improvements that might be implemented in future updates to the CMCS.

5.1.4. As-Built Technical Manuals and Drawings

The Contactor shall provide updated as-built technical manuals and drawings to reflect the final CMCS acceptance configuration.

5.2. Shipboard Spare Parts and Logistics Support (Option: CLIN 1002)

The Contractor shall provide one ship set of onboard spare parts based on the approved list of recommended spare parts in CDRL 035.

The Contractor shall provide one ship set of special tools and test equipment required for onboard diagnostics and maintenance based on the approved list of recommended special tools and test equipment in (CDRL 035).

5.3. Extended Warranty and Maintenance (Option: CLIN 1003)

The Contractor shall provide an option to extend the warranty period from one full year to two full years and to provide for any required hardware and software maintenance/assurance. In addition to the Contractor's OEM equipment and software products, the extension shall include conducting the approved CMCS Periodic Safety Test Procedure to the satisfaction of ABS/USCG inspector and third-party COTS software technical support and any new software releases to cover the full year time period.

5.4. Extended Warranty and Maintenance (Option: CLIN 1004)

The Contractor shall provide an option to extend the warranty period under the RFQ Part IV, Section 12 from two full years to three full years and to provide for any required hardware and software maintenance/assurance. In addition to the Contractor's OEM equipment and software products, the extension shall include conducting the approved CMCS Periodic Safety Test Procedure to the satisfaction of ABS/USCG inspector and third-party COTS software technical support and any new software releases to cover the full year time period.

5.5. Signal Function Diagram Drawings (Option: CLIN 1005)

The Contractor shall provide an option to develop a new set of Single Function Diagrams for each MCS signal that provides a continuous trace from the sensor or control element in the field all the way to the MCS processor. All intermediate and final signal terminations shall be identified including enclosure designation and ship space identifiers, terminal block designations and terminal number, cable type and cable tag designations, cable connector types and signal pin information, and termination wire tag designations and color details. The drawing shall be included as part of CDRL 020 and incorporated into the final MCS Technical Manual under CDRL 042.

6. Government Furnished Information (GFI) (will be furnished to quoters):

NOAA will provide the Contractor with the documents listed in Sections 9.4.1 and 9.4.2 in ".pdf" format. Where drawings are available in AutoCAD format, they will be provided where required updates are identified during the design phase. Due to the age of the vessel and the number of modifications that have occurred, the contractor should expect to see up to 15% errors in the data in the documents. This should be considered in the proposal price.

7. Deliverables/Milestones

Contract Data Requirements List (CDRL) items and dates and milestones are provided in the CDRL List document.

8. Schedule (major events)

The request for proposal document provides a schedule for major events.

9. Applicable Specifications

The CMCS shall meet the requirements of this Technical and Performance Specification, using the latest version of the reference documents in Sections 9.2 and 9.3 at time of contract award, unless otherwise noted. Rules and regulations which are in effect at the time of award shall be used, unless otherwise noted. Guidance in order of precedence is provided in Section 9.1. Government Furnished Information is provided in Section 9.4

The Contractor shall be responsible for acquiring the services of all regulatory bodies involved for certification and design approvals, materials testing, construction survey, shop inspections and shipboard trials for all CMCS components and other parts as required.

9.1. Order of precedence

In the event of a conflict between specification requirements the following precedence shall be invoked. Any specification conflicts shall be brought to the attention of NOAA.

1. This Technical and Performance Specification
2. ABS Steel Vessel Rules
3. U.S. Coast Guard Regulations
4. General Requirement for Ship Repair Contract Work on NOAA Ships

9.2. Reference documents

a. 46 CFR, Subchapter J, Electrical Engineering
b. 46 CFR, Part 62, Vital System Automation
c. MIL-DTL-24784/4B, Associated Detail Specification Manual, Commercial Off the-Shelf (COTS) Equipment Manual Requirements.
d. General Requirement for Ship Repair Contract Work on NOAA Ships, Standard Specification 000-1H
e. Military Sealift Command Work Item Preparation Guide, Drawing 7081124
f. General Specification for Ships of the US Navy, Section 305, Electrical and Electronic Designating and Marking and Section 504 Instruments and Instrument Boards
g. Military Sealift Command Preparation of Computer Aided Designed (CAD) Drawings for USNS Ships, MSC Drawing 803-7080803
h. MIL-PRF-85045, Cables, Fiber Optics, (Metric), General Specification For
i. MIL-STD-2073, Standard Practice for Military Packaging

9.3. Non-Government Documents

a. ABS, "Rules for Building and Classing Steel Vessels", Part 4, Machinery Equipment and Systems (1991)
b. ABS, "Rules for Building and Classing Steel Vessels", Part 4, Machinery Equipment and Systems (2019)

c. US Supplement to ABS Rules for Steel Vessels for Vessels Certified for International Voyages
d. ANSI C39.1 "Requirements for Electrical Analog Indicating Instruments"
e. ANSII/NCSL Z540-1, Calibration Laboratories and Measuring and Test Equipment General Requirements
f. ASTM A167 Stainless & Heat Resisting Cr-Ni Plate
g. IEC 61131-3, Standard for Programming PLC's (Programmable Logic Controllers).
h. IEEE-STD-45, Recommended Practice for Electric Installations on Shipboard
i. ANSI/ISA-101.01-2015 - Human Machine Interfaces for Process Automation
j. ISA-S37.1 Electrical Transducers, Nomenclature and Terminology
k. NEMA 250 Enclosures for Electrical Equipment – 1000 Volts Maximum
l. National Electric Code, Section 250.
m. IEEE 802.3, IEEE Standard for Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan networks, Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
n. IEEE 830, Recommended Practices for Software Requirements Specifications
o. IEEE/IEA 12207, Standard for Software Life Cycle Processes
p. ASME Y14.38-2013, Abbreviations and Acronyms for Use on Drawings and Related Documents

9.4. Government Furnished Information (GFI)

In the event of a conflict between technical manual drawings and GFI detail drawings, the latest revision of the drawing shall apply.

9.4.1. GFI Drawings and Documents

a. 252-6634698 Propulsion Control Elementary Wiring Diagram
b. 436-6634707 Rev C ACCU Elementary Wiring Diagram
c. 426-6634704 Tank Level System Elementary Wiring Diagram
d. 561-6634699 Steering Control System Elementary Wiring Diagram
e. L-T5971-COT-010 Rev 7, dated 10/20/1996, Thomas Jefferson Periodic Safety Test Procedure
f. Thomas Jefferson CMCS Alarm List
g. M9651 Main Generator Switchboard
h. M9651-1 Generator Shutdown System Connection
i. M9651-l Generator Shutdown Panel
j. M9651-S Selector Panel

9.4.2. GFI Technical Manuals

a. TT9252-AK-MMO-010, Centralized Machinery Control System (CMCS), Technical Manual, Operation and Maintenance Instructions For
b. TN9252-AF-MMC-010, Tank Level Indication (TLI) System Maintenance Manual For
c. DCJS#11-5214, Hiller Systems Inc, Operations Manual for Fire Alarm System Thomas Jefferson